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# PEARL OYSTER

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INFORMATION BULLETIN

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## Note from the editor

Maybe I am getting old and opinionated, or maybe I am just getting opinionated, but there are a couple of areas where I have been a little irked of late by comments passed around a bar or over a desk, or articles in various journals. 'Something needs to be said to put that right,' I would mutter to myself, and hold my tongue. Well, nobody ever did say anything, so I guess I am going to have to stand up, spit in the dust, and vent my spleen.

It seems a little inappropriate to abuse my editorial prerogative, and to turn the editorial page into a bully pulpit from which to fulminate and rant and brow-beat you all. I have therefore taken off my Editor's visor, taken off the gloves, and launched into a couple of dogmatic diatribes under the aegis of 'Opinion' pieces on the inside pages.

I hope some of this tirade moves some of you, or maybe even moves some of you to reply. We all work a little in isolation, and there needs to be some forum for debate. The *Pearl Oyster Information Bulletin* could also serve a useful function as a medium for 'Pearl Oyster Bull'. I would be pleased as Punch if someone took issue with one of these pieces and lobbed a shot back across my bows. My attitudes and opinions are, as an anvil, a useless tool on their own. All of our ideas are formless without the regular whack of a clanging hammer of contradiction, the forging heat of debate, and the cold water of clarity, which tempers and shapes us.

So, look for a regular 'Opinion' section in these pages. Better yet, be a part of it. I promise to publish all but the most profane. We are supposed to be a little bit impassioned about our pearls, and we needn't necessarily confine ourselves to scholarly debate. Just, please, don't leave us as a lonely, plaintive voice whining and bleating in the wilderness.

## Inside this issue

On a more measured note, we are pleased to be able to publish some scholarly debate as well. This issue contains some original research from Rick Braley and Dorothy Munro, based on their recent trials at the Tongareva Marine Research Station in the Cooks. Mario Monteforte provides a review of the research and development programme at CIBNOR, La Paz, and outlines their path towards commercial farm development. Kelvin Passfield also provides an interesting assessment of the Penrhyn 'pipi' pearl fishery and market.

And we are also happy to report—albeit second-hand—on the research programmes under way on Rangiroa, in French Polynesia, and at Orpheus Island, in North Queensland. We have also excerpted an excellent article on the commercial *P. maxima* hatchery run by Pearl Oyster Propagators, Pty Ltd. in Darwin Harbour. Good reading, good pearling!

Neil Antony Sims, Editor

# RESEARCH NOTES AND REPORTS

## The French Polynesian Multidisciplinary Pearl Oyster Research Programme (PGRN) publishes Phase 1 results

**Source:** *Te Reko Parau*, no. 5, October 1996, published by EVAAM (Institute for the Development of Aquaculture and Maritime Activities), French Polynesia

### Phase 1

Although the 'Plan Contract' was signed in January 1990, the first PGRN research work only officially began at the end of 1992. The first phase ended with a workshop attended in February 1995 by scientists and representatives of pearl farmers' organisations, at which the results obtained were tabled for the industry. One of the specific comments made by industry representatives was that the research carried out in Phase Two should yield more practical results.

### What is the PGRN?

After the large scale-mortality which decimated pearl-oyster farms on some atolls in 1985, French Polynesia decided to set up the general Research Programme on the Pearl Oyster (PGRN), a multidisciplinary programme involving both the various scientific organisations present in the Territory and laboratories in 'metropolitan' France. The administrative, logistical, technical and financial coordination of this research programme is the responsibility of EVAAM.

The cost of these research activities, which are included in the State–Territory 1989–1993 'Plan Contract' (10th Plan), is 210 million CFP francs (CFP francs 100.00 ≈ US$ 1.00). The PGRN is funded as follows: French Polynesia: 80 million CFP francs, the French Government: 80 million CFP francs and the European Community: 50 million CFP francs (6th FED).

The objectives of the two-phase research programme are :

- To identify causes of mortality in oyster farms;
- To improve understanding of the biology of pearl oysters;
- To establish reliable data for the management of lagoons and pearl farms.

## Research topics

1. Discovery of an infectious disease. Systematic screening for pathogens
   - *What can cause disease in pearl oysters?*
   - *What parasites can be found in pearl oysters?*
2. Contribution to the knowledge of a protozoan gregarine which is a parasite of the pearl oyster (project not carried out)
   - *More detailed study of a parasite observed in the pearl oyster's intestine*
3. Study of biological deterioration of pearl oyster shells (thesis completed on 10/05/96)
   - *What plants and animals live in the thickness of the shell?*
   - *How is the pearl oyster's shell formed?*
4. Identification of molecular markers in the pearl oyster *Pinctada margaritifera*
   - *Are all the pearl oysters of French Polynesia genetically similar?*
5. Anatomy of the pearl oyster *Pinctada margaritifera*
   - *How is the mother-of-pearl formed?*
   - *What organs are observed in the pearl oyster?*
6. Cytological study of gametogenesis, sex ratio and the reproductive cycle in the pearl oyster *Pinctada margaritifera* (L) var. *cumingii* (Jameson), (Molluscs, Bivalves). Comparison with the cycle of *Pinctada maculata* (Gould) (thesis completed on 22/04/93)
   - *Microscopic study and description of the sexual cells of the pearl oyster*
   - *When and how many times does a pearl oyster spawn during the year?*
   - *Do the pearl oyster and the 'pipi' (*Pinctada maculata*) spawn at the same time?*
7. Environmental physiology of the pearl oyster; a study of the relation between the growth of the oyster *Pinctada margaritifera* and the environment in Takapoto Lagoon.
   - *How and in what conditions does the pearl oyster grow?*
8. Study of the respiration and filtration processes of the pearl oyster *Pinctada margaritifera*
   - *How does the oyster breathe?*
   - *How does the oyster eat?*
9. Contribution to the understanding of population dynamics in pearl oysters and in natural stocks in various lagoon (Thesis not completed)
   - *How many oysters are there in the natural stocks in four pearl-farming lagoons?*
10. Stock of organic particulate matter (OPM): elementary and taxonomic composition
    - *What are the very small organisms which float in the water and on which the oysters feed?*
    - *What quantity of food is available?*
11. Geochemical composition of organic particulate matter in Takapoto Lagoon
    - *What is the chemical composition of particles floating in the water?*
12. Primary productions
    - *Lagoon content in terms of very small algae*
    - *Replenishment of food that shellfish, including oysters, eat*
13. Study of the production and conversion of organic particulate matter (OPM): bacteria in the pearl oyster's environment
    - *Do pearl oysters eat anything other than small algae?*
    - *What is the role played by bacteria in the renewal of the food and the waste from pearl oysters?*
14. Study of the loss of organic particulate matter to the oyster due to planktonic competitors
    - *What small animals eat the same food as the oyster?*

- *What quantity of food do they consume?*

15. Loss of organic particulate matter (OPM) to the pearl oyster and organic sedimentation. Production and consumption of ammonium in pearl oyster farms

    - *What happens to the food not consumed by the oyster: is it lost?*

16. Takapoto Atoll molluscs: quantitative evaluation of the lagoon population. Malacological survey of the reef flat. 1993 study and interpretations

    - *How many shellfish are there on Takapoto Atoll?*

    - *What are the different species of shellfish present in the Takapoto Lagoon?*

17. Study of the metabolism of the pearl oyster's main competitors.

    - *What other shellfish have the same diet as the oyster?*

    - *How do other shellfish which eat the same things as the oyster feed and breathe?*

18. Studies designed to evaluate the impact of pearl farming and produce a development strategy (quality; production; new markets) (study not carried out, postponed to Phase 2)

    - *What is the effect of pearl farming on French Polynesia as a whole?*

    - *What tactics should be used to develop this activity successfully?*

19. Study of the nutrition of the pearl oyster *Pinctada margaritifera*

    - *What exactly does this oyster eat?*

## Results

The many topics addressed now make it possible:

- To more fully understand the way the pearl oyster functions in terms of reproduction, growth and general biology;

- To appraise the nutritional potential of Takapoto Lagoon and obtain information on the way the lagoon functions.

Most of this research work was carried out on Takapoto.

The new knowledge acquired may be summarised as follows:

### *Activity 1*

**Systematic screening for organisms causing diseases in farm pearl oysters and the natural stock was carried out.** Only one type of parasite of the digestive tract was discovered. This was a gregarine. But this parasite is present in all the animals studied, whether healthy or diseased. This gregarine cannot therefore be considered, according to current understanding, as being responsible for the mortality observed.

At the same time, and in connection with the disease and mortality problems, research on the graft, the nucleus, the formation of the pearl sac and the nacreous layer secretion process was carried out. Healing after grafting is very quick and does not usually lead to any infection. After five weeks, the pearl sac has completely enveloped the nucleus; the pearl then begins to form.

The causes of mortality after grafting are not yet understood, but it should be borne in mind that the graft is nothing less than a surgical operation, with all the risks that this may involve.

### *Activity 2*

More specific research on the gregarine could not be carried out, because the scientists concerned were not available.

### *Activity 3*

**This activity concerned oyster shell damage problems caused by various drilling organisms, and also the shell formation process.** These boring organisms make the shells fragile by boring tunnels and cavities, which means that they often break when being opened. The mother-of-pearl is lost when this happens. Also, they may cause growth problems.

Two types of boring organisms may be distinguished: micro- boring organisms invisible to the naked eye and micro- boring organisms visible to the naked eye. These organisms are algae and fungi which attack the shells first. These then open the way for macro- boring organisms such as orange sponges, worms and a type of shellfish. Orange sponges are sometimes visible inside the shells under several layers of mother-of-pearl. Such shells are very badly damaged and cannot be polished or fashioned.

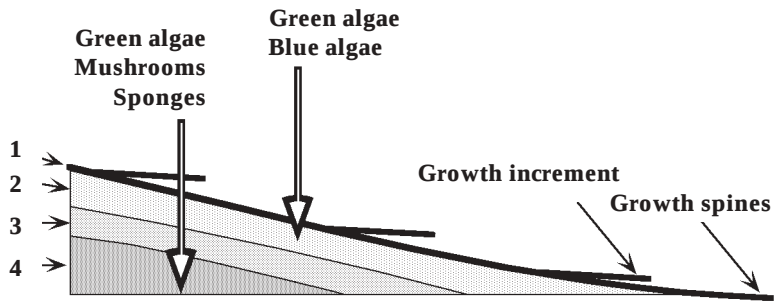
The shell is secreted by the outer surface of the mantle (facing the shell). From the outside to the inside, four layers may be observed (see figure):

1. The periostracum, which is a thin (black) organic layer, covering the mineral part, which is white;

2. A non-nacreous white calcitic layer;

3. A transition layer formed of fibrous aragonite;

4. The layer of mother-of-pearl, pigmented and non-pigmented, formed of aragonite. This layer is the nearest to the inside of the shell and also the thickest.




Electron microscope examination of the general form of the aragonite crystals (the mother-of-pearl) is thought to be an indicator of the growth status and good health of the oysters.

This study also revealed that frequently-brushed shells suffer more damage than unbrushed shells and that the boring orange sponges are more likely to appear on brushed shells. But not cleaning the oysters is also conducive to fouling, which may hinder the oysters' growth.

Brushing must not be carried out too frequently, because it favours shell perforation. Neither is it necessary to completely remove the 'kapi-kapi' during cleaning, because they protect the mother-of-pearl from being invaded by drilling sponges.

This is particularly important for re-grafts or re-re-grafts, because they represent a significant source of added value to the pearl farmer: repeated use of the oysters requires a shell-cleaning frequency to be determined that will enable the oysters to grow properly with minimum shell damage . This system of cleaning depends on the lagoon environment, in other words, the amount and speed of fouling of the oysters' shells.

## *Activity 4*

**This task involved checking whether all the pearl oysters in French Polynesia were genetically similar.** This activity is unfortunately only in its preliminary stages for the moment and should be pursued in order, for example, to provide important answers to the many questions concerning oyster transfers and the dangers thereof.

The initial results, carried out on proteins from the adductor, revealed that the Takapoto and Marquesas oysters are different from those of Manihi, Takaroa and Arutua. These differences particularly concern the pigment in the mother-of-pearl and the pearl, which may be characteristic in some atolls.

## *Activity 5*

**The production of a complete anatomical diagram was essential for the animal to be fully understood.** It presents all the organs of the oyster with many photographs. Thus, everyone can now give the same name to all the parts of the oyster and there will be no mis-understandings. This activity made it possible to better comprehend how the oyster functions.

This first publication (available at EVAAM to pearl farmers for 1000 CFP) is very technical. A laminated booklet entitled 'Pearl oyster anatomy and filtration' is available free of charge, as are the previous issues of *Te Reko Parau*.

## *Activity 6*

**This project has yielded information on how and under what conditions the oyster and the 'pipi' (*Pinctada maculata*) reproduce.** The oyster reproduces all year round, with peaks at the time of seasonal changes, from May to July and from September to December. In fact, it is usually abrupt temperature variations which trigger off spawning.

The oyster is first male, then experiences a hermaphrodite phase (male and female simultaneously) which is non-functional, subsequently becoming female when all the conditions are conducive to this change. This phase is reversible. Under unfavourable conditions, females may revert to a male identity and become female again later.

Most grafted pearl oysters are males, as are the majority of farmed pearl oysters. It is therefore essential to maintain a natural stock of oysters in order to be sure of collecting enough spats. The 'pipi' reproduces in the same way as the oyster and spawns abundantly in July / August (winter) and December / January / February (summer), but the 'pipi' reproduces much more rapidly than the oysters. The collecting of the 'pipi' therefore corre-

sponds to a 'pipi' farm, where the 'pipi' spawn when conditions are unfavourable (water cleaning, declamping, submerging stations to greater depths, etc. ) which makes 'pipi' collection easier.

## Activity 7

**A better knowledge of the growth characteristics of farmed oysters on Takapoto was gained through this study.** Oysters grow regularly and do not show any marked seasonal variations. This reflects the stability of the lagoon environment. The oysters do not have any reserve organs (similar to the human liver, for example). Only the gametes (spermatozoids and eggs) contain reserves.

The gametes could be re-used by the oysters in the event of famine, an event which is known to empty the oysters, whose pearl pouch is invaded by the gonad (sexual gland).

## Activity 8

**This research has made it possible to understand how the oyster breathes and what it filters in order to feed.** It was used as a basis for the design of a laminated leaflet called 'Anatomy and Filtration' which also appeared in the fourth issue of *Te Reko Parau*.

The size of the particles (microscopic algae) which are the oyster's preferred food varies between 5 and 60 µ, in other words 0.005 and 0.06 mm.

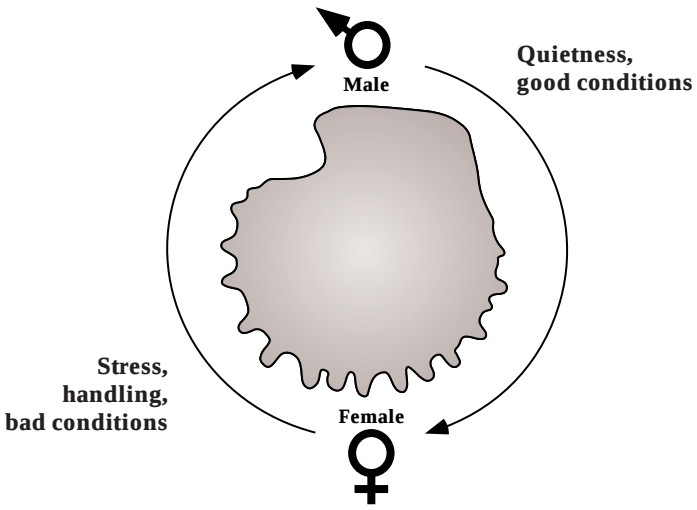
The oysters are more open at night than during the day; this event has not yet been explained . Perhaps they are not so frequently disturbed by fish at night and therefore open more fully.

The results concerning filtration rates suggest a very high volume, but need to be confirmed by other research work. Such data are important for gaining a better knowledge of the requirements for oyster transfer and handling.

## Activity 9

**This study was to yield information about the number of oysters naturally present on Takapoto (apart from those in farms and collector systems).** It was unfortunately not completed.

However, more recent work, (November–December 1995), carried out by another team indicates that there are approximately 4.5 million natural oysters on the bottom of Takapoto Lagoon (51% between 30 and 40 m).




## Activity 10

**This project was designed to gather information about the quantity of organic particulate matter (OPM, which is in suspension in the water and makes it murky) present in the water of the lagoon and what proportion of the oysters' diet it accounts for.**

The OPM of Takapoto Lagoon is very small in size. Seventy-five per cent of the particles are less than 0.003 mm in diameter, and 50 per cent are less than 0.001 mm. In other words, they are too small to be ingested by the oysters. The percentage of debris (non-living particles) is high and represents more than 70 per cent of particles smaller than 0.001 mm in size. The quantity of bacteria (smaller than 0.001 mm) is very high.

Particles in suspension comprise a mixture of living organisms (algae and microscopic animals) and debris on which very large quantities of bacteria develop. There is no seasonal variation in the quantity (but possibly in the quality) of particles in suspension in the lagoon . However, the quantity of particles in suspension in the water depends on how agitated the lagoon water has been (wind and swell). It increases by 54 per cent when the lagoon waters are disturbed.

## Activity 11

**The purpose of this project is to determine the composition of particles in suspension in the water and their nutritional value for oysters.** Their protein content is 40 per cent higher in summer than in winter (0.025 to 0.035 mg/l).

Analysis indicates that the chlorophyll content of the sea water (which is responsible for the photosynthesis process in the phytoplankton) does not vary in time or space over the eight study sites on the atoll.

The means are very low, as in other lagoons of French Polynesia, unlike those recorded in temperate zones where they may be from 4 to 100 times higher.

## Activity 12

**The purpose of this study is to gain a clearer understanding of the abundance of phytoplankton (microscopic algae) in suspension and their renewal rates.**

If the lagoon were to be compared with a field containing grass and cows, with the cows representing the oysters and the grass the algae, what we would be trying to do is know how much grass was available for the cows and at what speed browsed grass grows again.

The question then is what quantity of algae is available for the oysters and how fast the microscopic algae reproduce.

The maximum quantity of microscopic algae for oysters on Takapoto is located at a depth of around 20 m. But the maximum production (speed of growth) of microscopic algae is observed at depths at about 5–7 m on Takapoto. The daily raw production rate was found to be 0.9 mg of carbon per $m^2$ per day.

## Activity 13

**The purpose of this project was to define the role in the oyster's diet of the many bacteria present in the lagoon water.**

The role of the bacteria would appear to be important from the mineralisation point of view: the bacteria make it possible to sustain growth and renew the microscopic algae consumed by the oysters.

The bacteria therefore also play the role of fertilizer-producing factory for the lagoon. Oysters appear to consume very few (almost no) bacteria.

## Activity 14

**This project's aim was to show whether the animals in suspension in the water (the zooplankton) were in competition with oysters for food.** The oyster is not the only animal feeding off particles and microscopic organisms in suspension in the water.

The zooplankton represent 17 per cent of the living organisms in suspension in the water. They consume 30 per cent to 80 per cent of the microscopic algae present in the water, with the percentage varying from atoll to atoll.

The consumption of microscopic algae in suspension in the water by zooplankton is quite considerable, meaning that the zooplankton is a strong competitor with the oyster for food .

However, if it were confirmed that oysters consume particles smaller than 0.035 mm (size of the small zooplankton), the zooplankton would then itself become an abundant food source for the oysters.

## Activity 15

**The objective of this activity was to determine what happened to particles in suspension in the water which were not consumed by the oysters.**

Seventy per cent of the particles form sediment on the lagoon floor and are thus lost to all the living organisms in suspension in the water.

This organic matter is either consumed on the bottom by other organisms or re-mineralised by the bacteria living on the lagoon floor, which will produce the minerals necessary for the growth of the microscopic algae in suspension in the water.

If the lagoon waters are stirred up, this organic matter will return to a state of suspension in the water and again become available for the oysters.

## Activity 16

**Better knowledge of the main shellfish of Takapoto was gained through this study.** The main species concerned are the 'pipi' (*Pinctada maculata*), 'pahua' (*Tridacna maxima*), 'uu' (*Arca ventricosa*) and another shellfish (*Chama iostoma*). This work was carried out only to a depth of 7 m and was just a preliminary survey.

In 1993, in the zone between 0 and 7 m alone, it was estimated that there were 500,000 oysters (*Pinctada margaritifera*), 11 million 'pahua' (*Tridacna maxima*), 6 million *Chama iostoma*, 26 million 'uu' (*Arca ventricosa*) and 125 million 'pipi' (*Pinctada maculata*).

These data only concerned the 'pipi' living in a natural environment, not those 'farmed' with the oysters. It is estimated that there are 25 times more 'pipi' than farmed oysters. These oyster-stock figures are not very highly representative of the natural lagoon stock because most of the wild oyster population lives at greater depths (see Activity 9).

Apparently, stocks of shellfish other than 'pipi' have become impoverished since the first studies were carried out in 1976. In addition, the mollusc fauna of Takapoto is twice as rich in term of species numbers as the 1976 estimate.

### *Activity 17*

**This project made it possible to verify whether certain filtering bivalve shellfish are really in competition with oysters.** Research was carried out on the respiration and filtration of these shellfish (first indicators of their diet and oxygen consumption) and their stock.

The 'uu' may well be in competition with the oyster, but the 'pipi' is its primary competitor. It behaviour, reproduction, speed of growth and diet make it a real competitor for filtration and respiration and for space. There are 25 times more 'pipi' than oysters. Research still remains to be done on diet to establish whether or not these competitors consume the same foods as the oysters.

### *Activity 18*

The purpose of this study was to evaluate the impact of pearl farming on the social and economic fabric of French Polynesia and was intended to subsequently define a pearl culture development strategy. Unfortunately, this project could not be carried out and was postponed to the second phase of the PGRN.

### *Activity 19*

**The aim of this activity was to define exactly what oysters eat so as to be aware of their food requirements.** The filtration and respiration process was illustrated in diagrammatical form, and published in the fourth issue of *Te Reko Parau*.

Oysters principally retain particles of between 0.005 and 0.06 mm. Particles under 0.002 mm in size are not retained by the gills and therefore not consumed. This is the case of the free (unagglomerated) bacteria. The oysters would appear to be more active at night than in the daytime, but these results still require confirmation.

## PGRN – What about Phase 2?

Now that the first series of activities has been carried out, EVAAM has coordinated meetings with scientists and pearl-culture industry representatives in order to determine the research projects to be carried out under Phase 2 of PGRN. These activities have been carefully outlined to meet pearl farmers' expectations, to form a consistent set of projects with regard to the scientific resources committed and also to remain within the limits of available funding.

The agreement between the French Government, French Polynesia and EVAAM, defining the general framework for this second phase, was signed on 18 March 1996, but the specific agreements between donors and scientists, for practical implementation of the activities selected are still under discussion. Let us hope this sorted out quickly and that the scientists can at last begin work.

Since the beginning of 1996, implementation of Phase 2 of PGRN has slowed right down or indeed come to a complete standstill in administrative difficulties and strategic choices which are important for the future of pearl farming in French Polynesia, but which appear to be difficult to effect.

In addition to EVAAM, the organisations involved in PGRN Phase 1 are: the *Centre d'Océanologie de Marseille* (COM), the *École Pratique des Hautes Études* (EPHE), the French Institute of Research for Ocean Development (IFREMER), the French Institute of Scientific Research for Cooperative Development (ORSTOM), the French University of the Pacific (UFP), the Montpellier University Genetic Animal Geography Laboratory and the Organic Geochemistry Laboratory of the University of Orleans.

# Preference for spat collector materials in tanks by larvae of *Pinctada margaritifera* (Linnaeus) at Penrhyn Atoll, Cook Islands

*by Richard D. Braley and Dorothy Munro*

## Abstract

A variety of spat collector materials were tested on two hatchery-reared batches of *Pinctada margaritifera* larvae, including some materials used commercially to collect spat of *P. margaritifera* in the Cook Islands and French Polynesia. The plastic tank bottom collected significant numbers of larvae, particularly in Trial 1 in which collectors were deployed at 23 days post-spawning compared to 19 days post-spawning in Trial 2. Of the collector materials deployed in the tank, the black polyethylene plastic boxes were the best collectors, surpassing collectors used commercially in the field. The

factors making the box a good collector include the black colour, the numerous 90° angles in the corners, sides, ridges and rectangular holes. The box will become a standard part of the protocol at Tongareva Marine Research Centre (TMRC) for larval culture and settlement.

## Introduction

TMRC hatchery spat production of the blacklip pearl oyster, *Pinctada margaritifera* from Penrhyn Atoll (9°S; 158°W), northern Cook Islands has been successful, but defining the preferred protocol for larval culture, including the selection of settlement/collector materials, requires fine-tuning. Several studies have compared a variety of collector materials for *P. fucata* (Alagarswami et al., 1983), and *P. maxima* (Rose & Baker, 1994), whilst only general comments were made on collection materials for *P. margaritifera* (Alagarswami et al., 1987).

This study is concerned with the settling larval preference for different collector materials which are available at this remote atoll and the resultant number of spat found on the collector materials at about two months from the spawning date. The results of this study will assist our efforts at fine-tuning the hatchery protocol at the TMRC.

## Materials and methods

Two larval batches (Trial 1 = 2 and 4 July 1996 spawning, and Trial 2 = 5 August 1996 spawning) were used as replicates in this study. They were both reared initially in a 4 t grey, circular, fibreglass flat-bottom tank, at about Day 10 transferred to a 5 t grey, circular, plastic flat-bottom tank (filled to 3.8 t) into which settlement/collector materials were placed on Day 23 (Trial 1) and Day 18 (Trial 2). About 500,000 larvae were stocked into the 3.8 t volume (0.13 larvae/ml) for both trials. Measurements were made of the various collector materials to determine the surface area available for larval settlement. An attempt was made to present an approximately equal surface area for all collector types. Human error in Trial 1 resulted in more surface area for two types of collectors, but an approximately equal surface area was used in Trial 2. Collector description and surface area are shown in Table 1. *Statistix ver. 3.5* (*Analytical Software*) was used to analyse results with a one-way ANOVA and the LSD test of means.

## Results

### *Trial 1*

The collectors were analysed 58 days post-spawning. The plastic tank bottom collected highly significantly greater ($p<0.001$) numbers of spat than all other collector types and the black plastic box collected highly significantly greater ($p<0.001$) numbers of spat than the remaining collectors (excluding tank bottom). The Christmas Tree strand collected significantly greater ($p<0.05$) numbers of spat than the remaining collectors (excluding tank bottom and box). The LSD test of means showed there were 3 homogeneous groups in which the means

**Table 1:** **Description of spat collector (haru haru) materials and surface areas used in larviculture settlement preference, Trials 1 and 2**

| Collector type / details | Surface area (both sides) | No. of pieces deployed | |
|---|---|---|---|
| | | Trial 1 | Trial 2 |
| Black polypropylene plastic folded strips (~ 7cm x 200 cm) | 2,796 $cm^2$ / strip | 4* | 3 |
| PVC pipe (3") cut in half lengthwise (~65 cm x 8.7 cm) | 1,945 $cm^2$ / PVC pipe | 4 | 4 |
| Christmas Rope (polypropylene) | 1,950 $cm^2$ / 0.5 m piece | 4 | 4 |
| Christmas Tree strand (polypropylene; combination Christmas Rope + numerous strands woven through rope) | 8,002 $cm^2$ / piece | 4* | 1 |
| Black polypropylene plastic box with holes (45 cm x 43 cm x 13 cm) | 7,631 $cm^2$ / box | 1 | 1 |
| Plastic tank bottom | 10,386 $cm^2$ | 1 | 1 |

* Human error in Trial 1 resulted in more collectors of these types being deployed than should have been. Trial 2 has correct numbers.

were not significantly different. Table 2 shows the number of spat and density for each type of collector. Figure 1 shows the ratio of the number of spat per $cm^2$ on each collector surface compared with folded black plastic (set as standard of 0.01).

The average (± s.d.) size of spat was 2.5 ± 0.4 mm at 58 days post-spawning.

### *Trial 2*

The collectors were analysed at 68 days post-spawning. The black plastic box and the plastic tank bottom did not collect significantly different ($p>0.05$) numbers of spat collected per $cm^2$ but both of these materials collected highly significantly greater ($p<0.001$) numbers of spat than the remaining collectors. The LSD test of means showed there were two homogeneous groups in which the means were not significantly different. Table 2 shows the number of spat and density for each type of collector. Figure 2 shows the ratio of the number of spat per $cm^2$ on each collector surface compared with folded black plastic (set as standard of 1.0).

The average (± s.d.) size of spat was 2.4 ± 0.5 mm at 68 days post-spawning.

## Discussion

It is suggested that the much greater numbers of *P. margaritifera* spat collected on the plastic tank bottom in Trial 1 than in Trial 2 result from the collectors being added to the larval culture tank at 23 days post-spawning (Trial 1) compared to 19 days post-spawning (Trial 2). Larvae were further developed in Trial 1 and greater numbers of competent or near-competent larvae would have been present when collectors were added in Trial 1 than in Trial 2.

Of the artificial collectors deployed in the tank, the black polyethylene plastic box was clearly superior to other collector types. This box has qualities which have been shown to enhance spat settlement and survival from larvae, including the black colour. Allagarswami et al. (1987) found improved settlement and survival of *P. fucata* spat in black tanks compared to light-coloured tanks. The boxes have a considerable surface area of 90° angles, with sides, lips, ridges, and rectangular holes around the surfaces of the box. Other tropical bivalves, such as giant clams (Tridacnidae), prefer to settle in such corners as well as on rough rather than smooth surfaces (Braley et al., 1988). The inner portion of the box also provides an area which cuts down on turbulence.

In our trials, the PVC pipes (cut in half) were scratched on both concave and convex sides. Though most spat were located on the concave sides, all were attached to the scratched/etched areas of the PVC. The Christmas Tree strand and Christmas Rope are both made of polypropylene. They have been used in commercial field collection of *P. margaritifera* spat in the Cook Islands, particularly in Manihiki Atoll. Likewise, the folded black polyethylene plastic strips are used in both French Polynesia and Cook Islands to collect *P. margaritifera*. It is interesting that when given a choice of collectors (admittedly, unconditioned for biofilms), larvae show less preference for these folded black polyethylene plastic strips than for all other collectors presented.

As an outcome of these trials, the black plastic box will be used at TMRC as a standard part of the larval rearing and settlement protocol. TMRC has sufficient stocks of this material available on Penrhyn, so that boxes may be used not only for larval settlement, but for movement of young spat to land-nursery raceways and to the ocean nursery. The protection of the spat within the box from predation is an important factor to consider in the initial move to the ocean nursery. Oyster-culture materials are expensive to land in the Cook Islands and the cost of shipping is nearly doubled on the

**Table 2:** **Numbers of spat and density of spat per unit area ($cm^2$) on various collectors deployed in the larval culture tank**

| Collector type * | Trial 1 | | Trial 2 | |
|---|---|---|---|---|
| | No. of spat | Density (spat/$cm^2$) | No. of spat | Density (spat/$cm^2$) |
| *Fold_pla* | 29, 65, 44 & 45 | 0.0163 | 6, 5 & 5 | 0.0019 |
| *PVC* | 31, 78, 47 & 67 | 0.0285 | 44, 1, 8 & 4 | 0.0073 |
| *Christro* | 48, 47, 45 & 47 | 0.0239 | 3, 9, 18 & 18 | 0.0061 |
| *Christre* | 100, 108, 224 & 152 | 0.0182 | 38 | 0.0047 |
| *Plasbox* | 362 | 0.0474 | 231 | 0.0303 |
| *Botank* | 1057 | 0.1018 | 260 | 0.0250 |

* Types of collectors are: *Fold_pla*, black polypropylene plastic folded strips; *PVC*, PVC pipe (3") cut in half lengthwise; *Christro*, Christmas rope (polypropylene); *Christre*, Christmas tree strand (polypropylene); *Plasbox*, black polypropylene plastic box with holes; *Botank*, plastic tank bottom

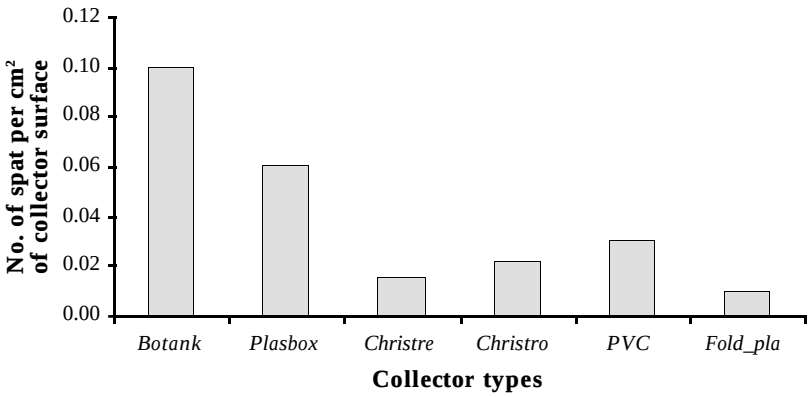



**Figure 1**

**Hatchery *Pinctada margaritifera* spat collector preference, Trial 1**

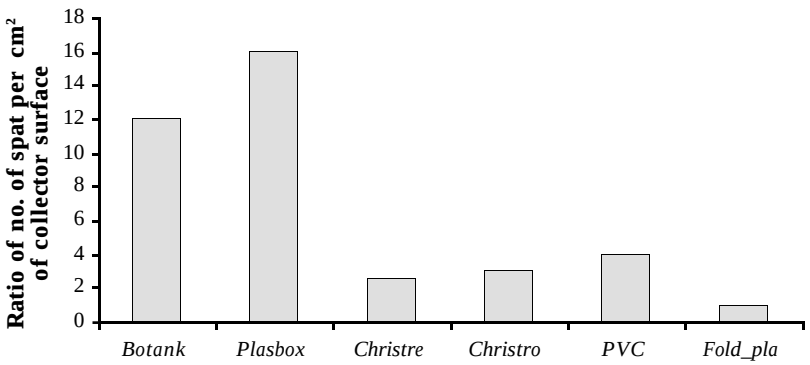



**Figure 2**

**Hatchery *Pinctada margaritifera* spat collector preference, Trial 2**

inter-island ship, therefore, the positive result from these boxes is the most economic solution to this aspect of pearl culture.

## Acknowledgements

We wish to thank the Ministry of Marine Resources, Cook Islands for its support of TMRC, and the technicians at TMRC, namely Lorangi Taime, Mataora Bill Marsters, Mohiti Faireka, and Rakei Taime, for their assistance in counting and measuring spat retrieved from the various collectors of these two larval rearing trials.

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# Tongareva Marine Research Centre (TMRC), Penrhyn Atoll, Northern Cook Islands:
## an update on the modifications to the *Pinctada margaritifera* hatchery, seawater systems and activities

*Prepared by Dr Richard Braley* [1]

The TMRC was made possible as a component of USAID's Pacific Islands Marine Resource programme, the centre being planned and set up between August 1991 and 30 September 1995 by the contractor, RDA International, Inc. The end of the contract was somewhat premature, since USAID's South Pacific Office closed. Therefore, the present ADB TA was planned, taking into account the need for in-house expertise and an equipment budget to allow the facility to function more efficiently.

The TMRC (Figure 1) is powered by a hybrid system (4 computer-operated solar arrays and a generator). It is proposed to add a wind generator to assure more stability to the system, since the tradewinds blow quite regularly here. The major modifications have been with the seawater systems: ocean system with a 23.2 t FRP reservoir tank, a 1.5 kW electric pump and sand filter to assure filtered water to the hatchery by gravity feed; lagoon system with a sub-sand intake filter box to exclude

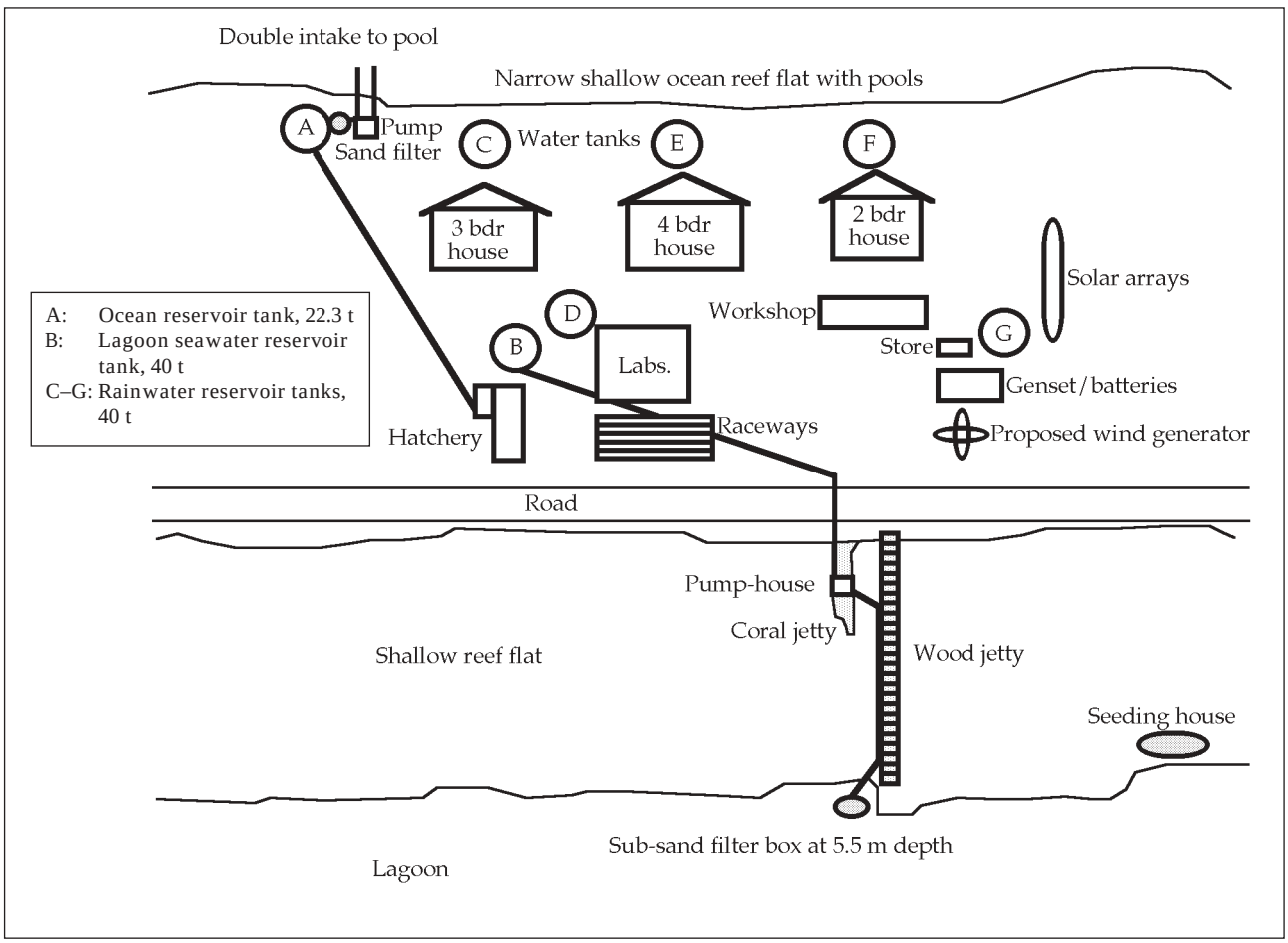


**Figure 1**
**General layout of TMRC and seawater systems**

[1] (AQUASEARCH), Asian Development Bank Consultant Marine Biologist, TMRC Project TA no. 2322-000

larvae but allow some phytoplankton and nutrients to enter. This system will service the 4 x 10 t raceways for land-nursery culture of pearl spat. The water will be pumped by a 4 kW electric pump placed on a coral jetty closer to the intake, and then go to a 40 t reservoir tank with liner near the raceway.

The first larval culture tanks were 0.15 and 0.6 t FRP tanks. These have mainly been replaced with larger tanks (1.6, 3.2, 4 and 5 t plastic and FRP tanks), as shown in the TMRC hatchery floorplan (Figure 2). The larger tanks minimise temperature variation in this open-sided hatchery. The mass algal culture capabilities have been increased with the addition of more 80 l and 250 l transparent algal cylinders, and hygiene has been improved with the use of cartridge filters to fill the cylinders directly with as little exposure to air as possible.

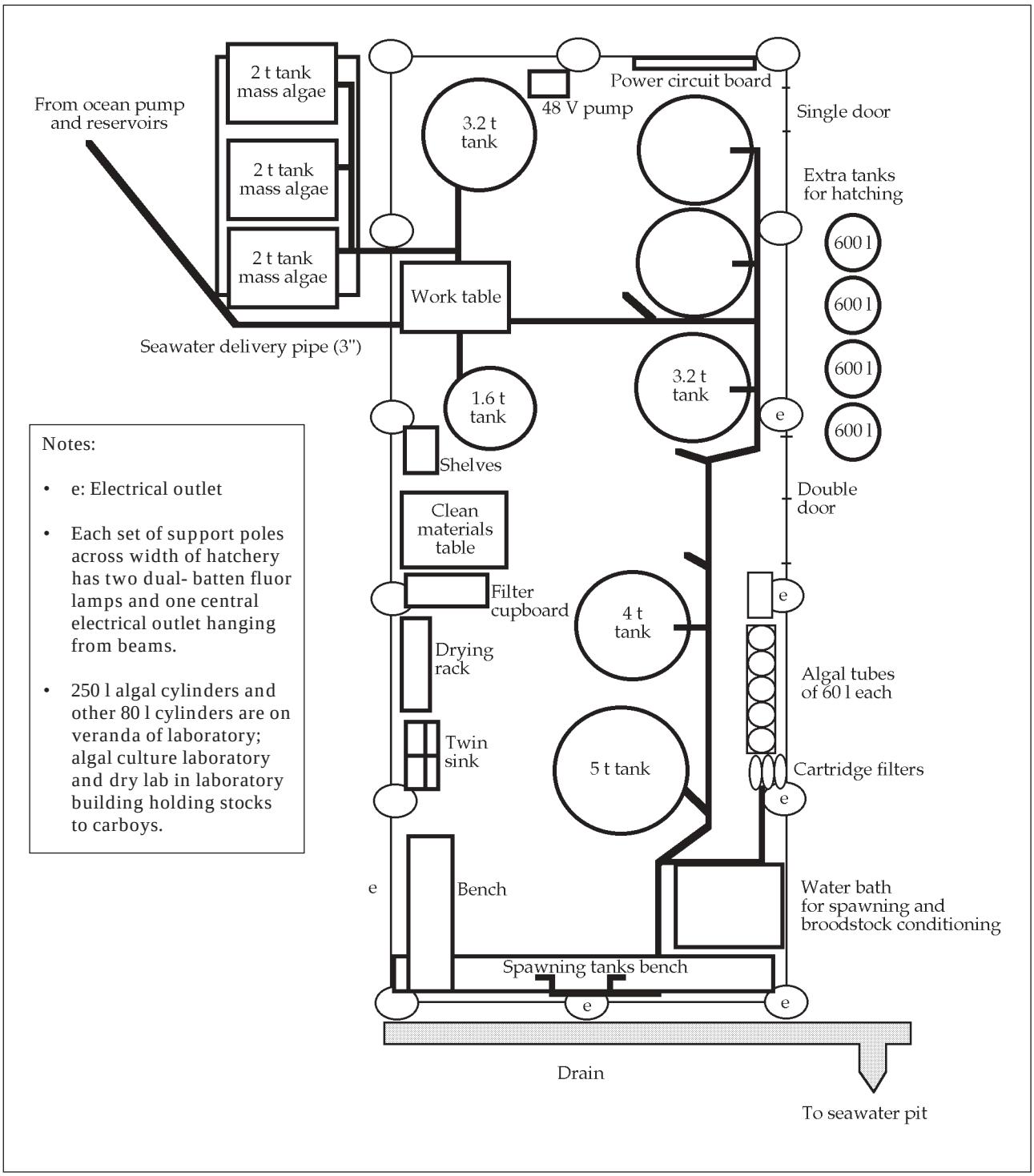


**Figure 2**

**TMRC floorplan, showing modifications to seawater plumbing and tanks**

Changes have taken place in the Algal Culture Lab as well with the Protocol used to care for stock cultures and working cultures to carboys. The TMRC hatchery floorplan (Figure 2) shows several rectangular FRP tanks used for mass algal culture to feed spat; one of these tanks is used as a waterbath during spawning (buckets with spawning oysters are held in the bath to minimise water-temperature variation) and as a broodstock conditioning tank if it is decided to feed them for 7 to 10 days prior to spawning induction—often broodstock are spawned the same day they are brought from the lagoon. The Figure 2 shows the drain going to a seawater pit; although this has not yet been completed, most of the materials are now here for this improvement.

The seawater delivery pipe from the ocean reservoir tank to the hatchery runs on the ground and on the floor of the hatchery so that multiple tanks can be filled quickly by gravity. The previous system utilised suspended seawater pipes, which required the 48 V pump to run nearly continuously to fill or flush tanks, but did not allow for enough flow to rapidly fill multiple tanks at one time. A shadecloth canopy will be placed over the entire block of raceways to cut down on water overheating and reduce filamentous algae.

Two independent pearl-oyster stock surveys have been made in Penrhyn Lagoon, which indicate that there are between 2 and 3 million stock in the lagoon. At the present time, many fishermen are freediving for shell and methodically cleaning out shell to depths of up to 25+ m. TMRC is now collecting broodstock from 10 sections of the lagoon, tagging these broodstock and banking them at the Ministry of Marine Resources experimental site on sub-surface coral rocks. To assure a good mixture of broodstock contributing to gametes during a spawning, the TMRC will be able to choose oysters from different sites. Other projects include the setting out of spat collectors each month at replicate treatment (down-current of pearl-farm longlines) and replicate control longlines (away from the effect of pearl farms), and sediment collectors set at treatment and control areas (5 m and 10 m).

# Pacific Island pearl oyster resource development

*by Dr Paul Southgate* [1]

*The following is extracted from Information Paper 18 that was presented at the Twenty-Sixth Regional Technical Meeting on Fisheries, South Pacific Commission, Noumea, New Caledonia, 5–9 August 1996.*

## Introduction

This project (PN 9131 Pacific Island Pearl Oyster Resource Development) was funded by the Australian Centre for International Agricultural Research (ACIAR) and was formally commenced in July 1993. The major focus of the project was Kiribati although the technology generated from the project is widely applicable to other Pacific Island countries and territories. James Cook University (JCU) was the commissioned Australian institution for the project and collaborating institutions were the Ministry of Environment and Natural Resource Development (MENRD) in Kiribati, Queensland Department of Primary Industry (QDPI), Australia, ICLARM Coastal Aquaculture Centre (ICLARM-CAC), Solomon Islands and the South Pacific Commission (SPC).

## Objectives

The major objectives of the project were :

1. To assess the natural stocks of pearl oysters in Kiribati and Fiji and the rates of spatfall (newly settled juveniles) of blacklip pearl oysters in the atoll lagoons of Kiribati.

2. To develop appropriate low-technology methods for hatchery culture and nursery culture of blacklip pearl oysters, allowing resplenishement of natural stocks, the development of a sustainable wild population and sufficient spat for culture operations;

3. To improve the yield of gem-quality and average-quality pearls through better bead insertion and oyster management practices.

Survey work conducted as part of Objective 1 was undertaken in Kiribati by Fisheries Division staff. Survey work in Fiji was undertaken by Fiji Fisheries staff and was coordinated by SPC. Research conducted towards Objective 2 was conducted primarily at JCU. It included collaboration with the

[1] James Cook University, Townsville, Australia

ICLARM-CAC where a trial hatchery experiment was conducted in 1994. The methods developed at JCU were implemented in Kiribati towards the end of the project, following the building of a pilot hatchery in Kiribati. Research towards Objective 3 was conducted by QDPI.

## Stock assessment and spatfall

Some previous survey data were available on stocks of the blacklip pearl oyster in Abaiang and Butaritari atolls in Kiribati (Preston et al., 1992). Initial surveys conducted as part of the ACIAR project were focused on areas where suitable pearl oyster habitat was known to exist and where anecdotal evidence suggested that pearl oysters may be present. Three atolls (Abaiang, Abemama and Onotoa) were surveyed in the first year of the project and a further two (Maiana and Butaritari) in the second year of the project.

All five atolls are in the Gilbert Island group of Kiribati. Very few live pearl oysters were found in Abaiang, Abemama and Onotoa and none were found in Maiana and Butaritari. Clearly, at best, *P. margaritifera* is present in low densities in the lagoons of these atolls. These findings confirm those of previous survey work in the Gilbert Island group which reported low densities of *P. margaritifera* (Preston et al., 1992).

Surveys of a number of reefs in Fiji were undertaken in 1995. The surveys showed that *P. margaritifera* populations are low in the areas surveyed; however, moderate numbers of the winged pearl oyster *Pteria penguin* were observed, suggesting that there may be some potential for half-pearl (mabe) production based on spat collection.

The initial objective also included assessment of pearl oyster spatfall in the lagoons of Kiribati. However, for a number of reasons, including the low number of adults found in the stock survey, delay in obtaining spat-collector materials and increasing emphasis towards hatchery production in Kiribati, studies on spatfall were not undertaken.

## Hatchery and nursery research

Initial emphasis was placed on the development of a flow-through culture system for *P. margaritifera* larvae. This system has been used successfully for rearing giant clam larvae (Braley, 1992). In this system, culture water is exchanged on a flow-through basis, with effluent water passing from the tank through a mesh sieve which prevents exit of larvae. Thus, water can be exchanged without removing the larvae from the tank or from the culture water. In conventional static culture systems, water exchange requires removal of the larvae from the culture tank every 1–2 days by sieving. Flow-through culture thus requires significantly reduced labour input. Flow-through culture is also likely to result in better water quality (by more frequent water exchange) and reduced handling stress for the larvae. Details of the flow-through system developed during the project are given in a previous report (Southgate, 1995).

A significant proportion of the research was directed at assessing the suitability of flow-through larval culture in comparison with the traditional static culture method. Flow-through culture was shown to be a feasible means of rearing *P. margaritifera* larvae.

Larval growth and survival did not differ significantly between flow-through and static culture methods, although water quality (ammonia and nitrite content) was significantly better in the flow-through tanks than in the static tanks. However, use of the flow-through larval culture technique significantly reduces the labour required for larval culture.

Micro-algae are the traditional food source for bivalve larvae reared in hatcheries. Micro-algae were used as the food source for the initial larvae rearing experiments in order to assess the flow-through system independently from nutritional factors. However, the culture of micro-algae is a major constraint to hatchery development in small island nations. It is expensive and requires specialised facilities and trained personnel.

Part of the research focus within Objective 2 was to assess artificial diets as an alternative to cultured micro-algae. A number of 'convenience' feeds (dried algae, yeast products, algal pastes, commercial microcapsules and experimental microcapsules manufactured at JCU) were assessed for *P. margaritifera* larvae in small-scale culture trials. While some yeast-based diets ('Lansy', Artemia Systems, Belgium) and commercially available microcapsules ('Booster', Frippak Feeds, UK) were of little nutritional value for *P. margaritifera* larvae, other commercial products such as dried micro-algae (*Tetraselmis suecica* marketed as 'Algae 161', Celsys, UK) and the Torula yeast-based diet ('L-10', Microfeast, USA) were shown to be of high nutritional value to *P. margaritifera* larvae and will allow at least significant partial replacement of live micro-algae without affecting growth and survival of larvae. More research is necessary to develop appropriate feeding strategies using these 'artificial' diets.

## Pearl quality research

Experiments with half pearls were conducted to evaluate several adhesives, the use of relaxants, the use of plastic half-sphere moulds with either

smooth or rough surfaces and the effect of position, number and size of the moulds within each shell valve. Experiments with round pearls were conducted to evaluate several relaxants, several antiseptics, methods of improving wound healing, and method of site preparation for pearl sac formation. Attempts were also made to culture mantle cells. Experiments to assist the speed of wound healing included the use of fine nylon thread sutures and of several types of adhesive.

For half-pearl production, a cyanoacrylate adhesive ('super glue') proved to be ideal. However, no satisfactory outcome was obtained for the other factors evaluated because of poor environmental conditions (water quality, nutrition and cold) for the oysters in the sea.

Only cyanoacrylate adhesives showed promise for wound healing in round pearl culture. Cyanoacrylate appeared to speed up the healing process, which occurred within a few days. However, the adhesive caused some reaction where it contacted the oyster tissue. The adhesive used was also inflexible, so that it tended to separate from the tissues when they contracted. A more flexible adhesive used in thinner strips is under evaluation.

Of the several relaxants evaluated, propylene phenoxetol used at 2–3 ml/l appeared to be satisfactory. It resulted in rapidly induced relaxation (less than 15 minutes), full relaxation for 10 minutes, rapid recovery (less than 30 minutes), 100 per cent recovery and 100 per cent survival after 7 days. It was simple to use and is non-toxic to the human operator if adequate precautions are taken.

It has been used on a pearl farm with satisfactory results. Of several antiseptics evaluated, a 1/50 dilution of 10 per cent Betadine (Povidone Iodine) caused no acute or chronic toxicity and reduced bacterial contamination. However, very few bacteria were found on the mantle and gonad surfaces of normal pearl oysters.

Attempts were made to prepare a pearl sac in the mantle of pearl oysters. One approach was to produce an infolding under the mantle; this was unsuccessful. Another approach was to thicken the mantle using chemical and physical agents (heat, cold, etc.). This was also unsuccessful.

Current attempts aim to restrict the flow of haemolymph from the mantle, while at the same time injecting sterile seawater into the mantle to thicken it in preparation for the later formation of a pearl sac. Limited attempts were made to culture the nacre-producing cells of the mantle using tissue-culture techniques. All attempts were unsuccessful.

## Training

A number of project participants received training during the course of the project. Staff from the Kiribati MNRD Fisheries Division and Fiji Fisheries Division received valuable practical experience in the methodology of marine surveys and scientific diving as well as oyster biology and hatchery techniques.

## Future research

The project was recently (April 1996) reviewed and continuation into a second phase has been recommended. A second phase is likely to begin in the first half of 1997 following an interim phase to maintain continuity of research.

The second phase is likely to focus on:

1) continued development of hatchery and grow-out technology for use in the atolls of Kiribati and other Pacific nations; and

2) the development of pearl-farming systems.

The inclusion of Fiji in the second phase of the project was also recommended by the project review. Research efforts in Fiji are likely to focus on spat collection and further stock survey work.

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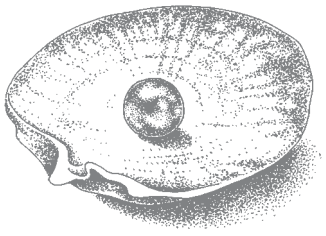

# Hatchery production of the blacklip pearl oyster

*by Paul Southgate & Andrew Beer*

**Source:** *Austasia Aquaculture*: 10(4), September / October 1996

Recent years have seen growing interest in hatchery production of pearl oysters and hatchery-cultured *P. margaritifera* spat are now produced commercially in French Polynesia, southern Japan and Hawaii. Hatchery culture offers many advantages over the collection of animals from the wild.

These include greater control over disease and genetic aspects, and reduced reliance on natural recruitment which can be unpredictable and unreliable. Hatchery production of blacklip pearl oyster spat is of particular significance in areas where natural stocks are depleted through over-fishing.

A previous article in this series outlined research with blacklip pearl oysters at James Cook University (Southgate, 1995). This research is funded by the Australian Centre for International Agricultural Research (ACIAR) and is investigating the development of simplified methods for hatchery and nursery culture of *P. margaritifera*, methods that are more appropriate for use in small Pacific Island countries and territories.

While this research is applicable to Pacific islands in general, the particular focus for this project is the Republic of Kiribati. This article reports on progress made with this research and the methods developed for hatchery and nursery culture of *P. margaritifera* at JCU and in Kiribati.

## Spawning induction and larval rearing

Approximately 300 broodstock are held adjacent to the JCU Orpheus Island Research Station (OIRS) in panel (pocket) nets at a depth of 3–4 m suspended from a floating longline.

Prior to spawning induction, broodstock are removed from the longline, cleaned of fouling organisms and washed in filtered sea water. Cleaned broodstock are held in a minimum volume of water in an air-conditioned room overnight at 21°C.

Spawning is induced by increasing water temperature to approximately 32°C and spawning individuals are placed in separate containers and allowed to spawn out. Fertilised eggs have a diameter of approximately 55–60 µ and are incubated at densities of between 30 and 50 per ml in lightly aerated 1 µ filtered sea water. After approximately 24 hours, D-stage veliger larvae are removed from the incubation tanks, washed and placed into 500 l larval rearing tanks at a density of 1–2 per ml.

Larvae are fed a diet of cultured micro-algae consisting of *Isochrysis* (T-ISO), *Pavlova salina* and *Chaetoceros simplex*. All three are tropical species and are tolerant of the high water temperature at which *P. margaritifera* larvae are reared (29–31°C). Previous studies have shown that temperate species of micro-algae, which are less tolerant of high water temperatures, are unsuitable as a food for pearl oyster larvae.

Umbo larvae (U) are usually seen around 8–9 days of age while 'eyed' larvae (E) are usually present at 15–18 days of age. Once large enough to be retained on a 150 µ sieve, larvae are removed from larval culture tanks and placed into 500 l settlement tanks which contain vigorously aerated 1 µ filtered sea water. Collector bags containing shade cloth are suspended in the tanks to provide a settlement substrate. Approximately 100 per cent of the water in settlement tanks is exchanged every 2 days using a flow-through water exchange system. Micro-algae are added at approximately 2.0–2.5 x $10^6$ cells / ml.

## Spat growth

After 2 weeks in the settlement tanks, collectors are removed, placed in plastic trays (with lids) and transferred to the ocean. Spat at this time measure approximately 3–5 mm. The trays are suspended at a depth of 3–4 m from a floating longline and are brushed free of fouling material when required. Regular inspection of the trays is required to check for the presence of crabs and other potential predators.

After 2–3 months, the trays are collected and spat are removed from the collectors. Spat are graded and counted. At this stage, the largest spat have a dorso-ventral shell height (DVH) of 25–28 mm; however, the majority have DVH of between 10–20 mm. Once graded, spat are returned to trays or placed in pearl (lantern) nets for subsequent grow-out. The growth of *P. margaritifera* spat under these conditions at OIRS is rapid and mean DVH is around 35 mm at 8 months of age, with the largest spat of this age having a DVH in the range 60–70 mm.

Research has shown that stocking density has a significant effect on growth and survival of *P. margaritifera* juveniles held in either trays or pearl nets. For example, juveniles held in pearl nets at a density of 20 per net for 4 months had a mean shell height, hinge length and wet weight of 39.2 mm, 34.5 mm and 6.8 g respectively, while those held for the same period at a density of 200 per net had dimensions of 29.8 mm, 26.2 mm and 3.3 g, respectively. Once large enough, juveniles are transferred into panel or pocket nets for subsequent grow-out, with the objective of producing abundant, healthy juveniles.

Further research is required to optimise the stocking density during grow-out. Although biological considerations such as growth rates and the frequency of shell deformity are major considerations when developing methods for grow-out, economic considerations are also important.

Clearly, the method used should optimise growth rate, but minimise the labour required for maintenance. Current research is assessing the growth rates of larger *P. margaritifera* juveniles held in plastic trays, pearl nets, panel nets and by ear hanging. Ongoing research will also assess growth rates of *P. margaritifera* spat at various locations on the North Queensland coast.

No major problems have arisen during nursery culture of *P. margaritifera* at OIRS. However, portunid crabs can cause major mortality of spat, and regular inspection of trays for crabs is required to minimise this. Older juveniles are attacked by leatherjackets (*Paramonacanthus japonicus*) which take up residence within trays. These fish continually trim the growing margin of the juvenile shell and, presumably, mantle tissue, and effectively cause stunting. Again, regular inspection of grow-out apparatus is required to minimise damage.

## Spat production in Kiribati

A small pilot hatchery was completed on the island of Tarawa in Kiribati in August 1995. It was equipped with a small algal culture laboratory and 500 and 1,200 l larval rearing tanks. The first larval run was conducted in October 1995 and 6,000–10,000 3–5 mm spat were transferred to the neighbouring atoll of Abaiang for grow-out.

A second hatchery run, completed in February 1996, resulted in 2,000–6,000 more spat being transferred to Abaiang. While the growth rates of *P. margaritifera* spat at Abaiang have been promising, survival has been disappointing.

Spat mortality is thought to result from fouling of the containers housing the spat, infrequent inspection and irregular maintenance. The results of subsequent research at OIRS, which has developed more suitable methods for holding pearl oyster spat after transfer from hatchery tanks, will hopefully alleviate these problems.

Research in Kiribati has demonstrated that significant numbers of pearl oyster spat can be produced in a relatively simple and inexpensive hatchery in a developing Pacific Island nation. Equally important, in terms of the eventual development of a cultured black pearl industry in Kiribati, is that there are now trained Fisheries staff in Kiribati with experience in hatchery management, larval rearing and pearl oyster culture methods.

Future research in Kiribati will continue to develop hatchery and nursery techniques suitable for Kiribati (and other developing Pacific Island countries and territories), and will also assess various sites within Kiribati for grow-out of *P. margaritifera* juveniles. The results of hatchery and nursery research at OIRS and the Tarawa hatchery improve the likelihood of successful cultured black pearl industries being established in developing Pacific countries and territories which otherwise have limited export opportunities.

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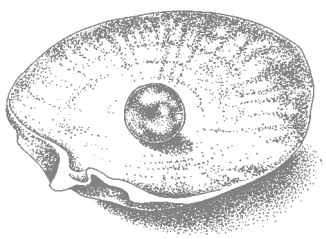

# Darwin pearl hatchery continues to improve techniques

*by Dos O'Sullivan & Amelle Tlili*

**Source:** *Austasia Aquaculture*: 10(5); Summer 1996/1997

*In 1991, Pearl Oyster Propagators established a commercial pearl oyster hatchery in the Northern Territory of Australia. Located in Darwin, the hatchery is capable of producing more than five million spat per year. The technology is also being used to establish hatcheries interstate and overseas.*

The golden-lipped (also known as silver-lipped) pearl oyster, *Pinctada maxima*, has been the centre of Dr Bob Rose's life for more than 14 years. Bob has been developing hatchery rearing techniques for pearl oyster since 1982. He first worked in Perth on a pearl oyster research project and then in Broome, where he built possibly the world's first non-tropical *Pinctada maxima* hatchery as a pilot project for the West Australian Fisheries Department. In 1991, he moved to Darwin and established a commercial hatchery at the Wharf.

The success of his work led to the establishment of the Darwin Hatchery Project (DHP) for which Bob's company, Pearl Oyster Propagators Pty Ltd (POP), has the design and operating contract. The project has a leased facility at the Stokes Hill Power Station as part of the Darwin Aquaculture Centre. The hatchery is operated by Tom Barker, Michael Mannian, Bob Shaw and Mike Wing. It is currently funded by a joint venture of two pearling companies: Arrow Pearls Pty Ltd and Toombridge Pearls Pty Ltd.

According to Mike Wing, the joint venturers rotate the work as needed. 'We change around a fair bit,' he says. 'Part of our success is that we are multi-skilled, so we can help out in all parts of the hatchery and the grow-out. We have increased our efficiency by 81 per cent over four years.'

The Darwin Hatchery Project is the largest producer among Australia's four hatcheries. The others are owned by Dick Morgan at Carnavon, Maxima Pearling Company at Cone Bay (an operation managed by POP) and Broome Pearls at Exmouth. A fifth hatchery is currently being built at Broome by the Paspaley Group.

Water is drawn from Darwin Harbour by the Darwin Aquaculture Centre. Due to the high silt load from tropical seasonal monsoons, this water is screened through 35 µ cartridge filter elements before being held in a header tank for 48 hours so that fine silt can settle out.

Five or six production runs are undertaken each season. The brood stock are collected from joint-venture farms located in Western Australia and the Northern Territory. They are extensively conditioned while held on longlines at the farms.

## Spawning pearl oysters

Pearl oysters are sequential protandrous hermaphrodites (first male, then female). They may reach sexual maturity as males after 12 months and then change to either sex, according to environmental conditions. Males can be recognised by their creamy-white gonads, while those of the females are canary yellow.

Using a gonad condition (maturity) index for *Pinctada maxima* modified by Bob in 1990 from techniques developed by D.J. Tranter in 1958 for *P. albina*, the readiness of the pearl oysters to spawn is quantified by visual observation. Gonads are indexed from zero to three. Those indexed as zero have no sex differentiation or have already spawned, while those indexed as three are fully mature and ready to spawn. Oysters which are ranked two or three are chosen for spawning. Pearl oyster broodstock are brought into the hatchery and cleaned.

'The males are spawned initially and then are introduced to the females,' Wing explains. 'The ova are about 60 µ when released and they are soon fertilised by the sperm. There is usually a 98 per cent fertilisation rate and a 20–35 µ screen is used to collect the eggs, which soon develop into free-swimming larvae.'

To meet requirements for translocation into Western Australia, the larvae are held at ambient temperature in aerated, 1 µ filtered, UV-treated seawater until settlement. They are fed a mixed microalgae diet every day. The algal culture room is maintained at 25°C.

Carboys (20 l) are used to culture several microalgal species, including Tahitian *Isochrysis*, *Pavlova lutheri*,

*Chaetoceros calcitrans, C. muelleri* and *Skeletonema costatum*. Larger volumes of algae can be bloomed in 500 l bags and shaded 1,000 l outdoor fibreglass tanks.

'We have a flexible formula to feed the pearl oyster larvae,' said Mike. 'We pre-mix the algal species, according to the size and age of the larvae. We do batch settlement of the larvae in two-tonne and four-tonne fibreglass tanks. We prepare the collectors (lengths of plastic strips hung like Venetian blinds) with an acid wash and then a blast of high-pressure water. The tanks are filled with filtered and UV-treated seawater at ambient temperature. When we see around 80 per cent of the pediveligers with a developed foot, we add them to the tanks. Over the next three to four days, they will settle out onto the collectors, attached by their byssal thread. At this stage, they are 350 to 450 µ in hinge length'.

After settlement, daily water exchange is made and during the rest of the day two to three feeds are undertaken. With the high water exchange, the level of nitrogenous wastes is kept low. As with other bivalve hatcheries, high larval mortalities sometimes occur. According to Michael Mannion, the causes of the mortalities are often unknown.

## Spat sales

Most of the spat are grown out by the joint-venture partners, although any surplus may be sold to other farms. The cost of the spat is determined by the average hinge length. The spat are sized and graded before they are sent out on collectors to the farms. Collectors are placed in plastic bags to prevent rubbing and avoid disturbance and stress. POP have 100 per cent survival rates during transport. Nevertheless, Ruth Leslie-Rose, a POP director, says transport of the spat is expensive. 'It takes a fair bit of management expertise to get our spat through to our customers, who are as far away as Dampier in Western Australia,' she says.

To help protect the wild stocks, a translocation protocol has been developed by Western Australian fisheries. Before any translocation, spat have to be checked by the Northern Territory Department of Primary Industry and Fisheries at its Berrimah laboratory and by the West Australian Agriculture Department laboratory at South Perth. Even when a health certificate is approved by both organisations, the newly translocated spat have to be quarantined in an area at least five nautical miles from the nearest farm. The spat are held for six weeks, during which they must be re-tested and independently certified before they can be transferred to the grow-out farms.

The remote location of the quarantine sites and the delays in access to the spat create difficulties for the farmers but so far, no specialist quarantine facility has been established to overcome these problems. Sometimes farms prefer to take larger spat, which may be held in the hatchery on the collectors for up to 20 weeks.

## Steep learning curve

The staff at POP know they have a long way to go before all the questions on pearl oyster hatchery production are solved. Mike Wing believes they are at a level similar to the Tasmanian Pacific oyster industry in the mid-1980s. 'We were at the bottom of a huge learning curve when the hatchery started in July 1991. By November, we had our first spawning and we have successfully spawned pearl oysters ever year since then. The main spawning season is September to March. We do our spawning according to seasons and farmers' demand, to fit with the environmental conditions on the farms (such as fresh-water inflow, water temperatures and turbidity), their work schedule or anything else.'

The farms usually prefer to stock the spat during neap tides, which occur every 14 days, when the currents are not too strong. Once on the farm, the spat are hung on the collectors from the longlines for about six weeks, until they average at least 1.0 cm. They are then sorted and placed in net panels for further on-growing.

Michael Mannion observes that there is wide variation in the growth rates of the spat. 'We believe this is genetically based,' he says. 'We are currently looking into it.'

Ruth adds that the hatchery is getting feedback from the farms which suggests that the 'runts' may catch up in growth when stocking densities are lowered. This corroborates observations made in the hatchery. 'There is plenty of scope for more research into this,' she says. 'Mike Mannion is currently involved in a joint research project with POP, DHP, CRC (Cooperative Research Centre) for Aquaculture and the NT University. The aim is to determine the best tropical algal diets to enhance spat growth. Quality of the gonad has also been examined as part of a research project by PhD student David Mills. Four members of POP staff are currently undertaking post-graduate studies.'

'Improved management at the farm nursery will result in increased survival rates,' says Michael Mannion. 'The industry is still not used to handling small stock, although some of the farmers now have a dedicated team for their nursery.'

Mike Wing says, 'Some of the DHP-produced spat has already been seeded. We have been told by farm managers that the ratio of successful nucleus

retention was higher for cultivated shell than for wild caught shell. This is probably due to the more uniform size of the hatchery stock and that they are grown using aquaculture techniques and have higher tolerance to stress during handling.'

Now five years old, the Darwin Hatchery Project is the first co-operative pearl oyster hatchery in Australia. The dedicated management and staff continue to improve their techniques to produce quality spat for the expanding pearl oyster industry.

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# Notes on 'pipi' pearl oyster, *Pinctada maculata*, fishing in Tongareva, Cook Islands, 1995

*by Kelvin Passfield*

Tongareva Atoll, also known as Penryhn, is situated in the northern Cook Islands, 9°S and 158°W. Two species of pearl oyster are common in the lagoon, the 'parau' or black-lip pearl oyster, *Pinctada margaritifera*, and the much smaller 'pipi', *Pinctada maculata*. Cultured black-pearl farming using black-lip pearl oysters (*Pinctada margaritifera*) has recently been initiated in Tongareva. Over 60 farmers participated in the first harvest in 1995. There is also a pearl oyster hatchery situated on Tongareva, built with assistance from USAID in 1994–95.

This note, however, deals with the lesser-known pipi. Pipi (*Pinctada maculata*) is gathered by both sexes, and is one of the few fisheries in Tongareva which involves women. The pipi are collected from the tops of the patch reef within the lagoon. Mask, snorkel and gloves are the necessary items, and the shells are simply plucked from the reef, to which they are attached by their byssus. Pipi are collected primarily for the natural pearls which are sometimes found inside. Some of the meat is also eaten, though a considerable amount is wasted.

Fishing activity was closely observed on one occasion. Two women collecting for 50 minutes collected 21 kg of pipi. This equates to what is commonly referred to as a 'bag', i.e. approximately one full 25 kg rice sack. This is the common unit of measurement used by pipi collectors.

Seven kg of pipi were counted out, for a total of 355 pipi. Therefore approximately 1000 pipi would constitute a bag. It took 3 ladies approximately 2 hours to open the 7 kg of pipi. 50 pipi were weighed (852 g), and the shucked meat was also weighed (121 g), giving a recovery weight of around 14 per cent. The meat can be eaten raw or cooked, and is very tasty, though a little gritty. On this occasion, in the 7 kg sample, only one saleable pearl was found, as well as 3 others of no commercial value. The number of pearls found in a full bag of pipi varies greatly, with sometimes no valuable ones found at all, and sometimes as many as 20 of various qualities.

Pipi pearls are a significant source of income for Tongarevans. As they are found, they are stored in small jars. They are then often used as a cash reserve. When a major purchase is required, for example a TV or video, new freezer, etc., the jar can be sold to buyers in Rarotonga. Although exact figures are difficult to obtain, jars containing an unknown number of pearls are sold for several thousands of dollars.

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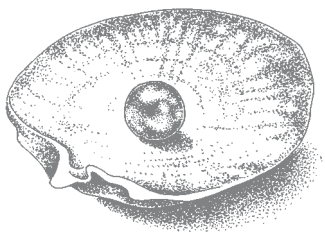


# Recent developments in pearl oyster culture and pearl production at Bahia de La Paz, Mexico

*by Mario Monteforte* [1]

A research programme for the technological development of pearl oyster culture and pearl production in the Mexican (Calafia) Mother-of-pearl, *Pinctada mazatlanica* and the Rainbow Mabe, *Pteria sterna*, has been conducted by the Pearl Oyster Research Group of CIBNOR, SC for nearly 11 years at Bahia de La Paz, South Baja California, Mexico.

By 1991, the techniques for spat collection, extensive culture and repopulation of natural beds for both species were considered fully determined. These achievements represented the second success in the history of our native species; the second, because the honour of having been the first belongs to Don Gaston Vives, who managed the Compañía Criadora de Concha y Perla between 1903 and 1915 at San Gabriel Bay, Bahía de La Paz.

A harvest of high-quality mabe was achieved in *Pteria sterna* by September 1993, and in *Pinctada mazatlanica* in February 1994. These events represent the first success in America in cultivating marine pearls. It should be mentioned that the abundant production of pearls that Don Gaston Vives attained in his enterprise was all of natural incidence (8 to 12%, on 10 million *Pinctada mazatlanica* yearly, from 1907 until the destruction of the installations in June 1915 during the social disturbances of the Mexican Revolution).

Since our research programme still operates out of a government institution, CIBNOR, the scale of our production remains at an experimental stage. Many specific studies are being carried out on both species; consequently, not all of them are used for pearl induction, and a certain number undergo sacrifice for anatomic and histologic studies, or monitoring pearl formation.

Nevertheless, an enterprise was founded in 1995. Perlamar de La Paz, formed by members of the Pearl Oysters Research Group, has acquired legal status and owns a territorial concesion of coastal land and a protected bay with excellent water quality. Although investment is still lacking to start a serious commercial activity, some solid interests have been expressed in joint ventures. We expect an interesting situation soon.

In our research programme at CIBNOR, we are conducting experiments aimed at the production of round pearls and keshi from both species, spat production of the Mexican (Calafia) Mother-of-pearl in the laboratory, and genetic studies in both species.

Round pearls (8 to 10 mm) and keshi (as large as 10 mm in the longer axis) have recently started to appear in *Pinctada mazatlanica.* The incidence is still inconsistent but quality seems to be satisfactory. The anatomy of this species favors the insertion and a good percentage of nuclei retention. *Pteria sterna*, on the contrary, presents anatomical difficulties for round pearl production, because the pearl sac is very wide at its base and the graft moves freely. The nucleus and the graft tissue are easily separated by the movements and contractions of the oyster, and the nucleus is either expelled through the wound, or lost somewhere into the gonad. However, X-rays seem to reveal the presence of keshi in some individuals.

As for experiments on nursery culture, a group of wild and cultivated adults of *Pinctada mazatlanica* is currently in the laboratory, under maturation induction. So far, the oysters are behaving perfectly, with zero mortality, and the gonads are nearly ripe. We will attempt spawning in the next few days.

The genetic studies aim at defining variability and polymorphism on populations of *Pinctada mazatlanica* and *Pteria sterna*, compared to other species of the genus. This study is being carried in cooperation with Professor Françoise Blanc, from the Laboratory of Zoogeography and Genetics at Paul Valery University, Montpellier, France. Aside from the focus of Madame Blanc in studying the genetic structure of the genus *Pinctada* in the world, we intend to reveal several unknowns about the distribution of *P. mazatlanica* and *P. sterna* populations on the Mexican Pacific coast and the Gulf of California.

As part of these studies, the identification of genetic 'signatures' comparing wild populations and cultivated specimens could be useful to determine the origin of collected spat. If we consider that the larval stage of our species is 25 to 30 days, we can suppose that the distance the larvae drift with the

[1] Pearl Oyster Research Group, CIBNOR, S.C., Mexico

coastal currents may be quite far, so we would be receiving larvae settling on collectors at Bahía de La Paz from as far as 300 km or more north over the eastern coast of the Southern Peninsula. Through the comparison of these genetic 'signatures' we would be able to identify the best sites for repopulation along the south-east peninsula coast and enhance spat collection at Bahía de La Paz.

Another important subject under study is the comparison of the genetic structure between the populations of *Pteria sterna*. This species is present on both sides of the southern Peninsula, at Bahía Magdalena on the Pacific coast, as an isolated population, and along the Gulf of California over both the continental and the Peninsula coasts, as far as Ecuador. However, we have observed conspicuous differences among the Baja California populations, not only morphological but also related to zonation and the reproductive periods.

The aim of this study is to determine the possibility of transferring spat from Bahía Magdalena, Loreto and/or Mulegé (where spat incidence is usually high, especially at Bahía Magdalena) to Bahía de La Paz (where spat incidence is lower). Nevertheless, we suspect we are dealing with different populations, at least to the level of variety or sub-species. *Pteria sterna* from Bahía Magdalena is larger than the La Paz species, but its shell is very thin, the wing is short or absent, and it lacks the beautiful colours that show in the specimens from the eastern coast, especially those from La Paz and Mulegé. The results of these genetic studies will help to define a transfer programme, or avoid it in case of differences.

This is a general glance at our programme. Extensive culture, repopulation and mabe production have been determined in both species. The elements still lacking for a complete and efficient technology are quite few.

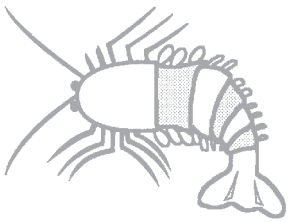
The results already achieved after all these years of work are satisfactory and allow us to establish a productive and conservationist management programme for both species, to be applied as a model in Bahía de La Paz, and, through this, to extend pearl culture farms on the Mexican Pacific coast, where both species occur along the thousands of protected bays and inlets existing there.

The future is in fact promising, but there is still much work to do, not only in the context of scientific research, but also on the social and political aspects.

# *Pinctada margaritifera* hatchery trials in Iran

**Source:** *Iran Fisheries Research and Training Organization Newsletter* no.11, Winter 1996

During the research project on larval rearing and production of blacklip pearl oyster, *Pinctada margaritifera* (Linnaeus), in the Persian Gulf Mollusc Research Centre, breeding and larval rearing of this pearl oyster were investigated in the laboratory during the spawning season on September and October 1995. Warm shock technique was used for induced spawning of the mature oyster. Oyster larvae were fed with *Isochrysis galbana* and with mixtures of *Isochrysis galbana* and *Chaetoceros calcitrans*. We succeeded in rearing larvae from fertilised eggs up to pediveliger during 34 days. Maximum size of pediveliger larvae reached 470 µ on the 34th day. Many of the larvae died at this stage and settlement was not achieved, mainly because the water was not of adequate quality.



# NEWS AND VIEWS

## Japanese pearl oyster voluntary import ban

**Source:** Kyodo via Foreign Broadcast Information Service

On 13 January 1997, officials of Japan's Fisheries Agency called for a voluntary limit on import of pearl oyster from China, until the source and cause of widespread deaths among cultivated pearl oysters in five Prefectures is better understood.

## *Pearl World* news updates

**Source:** *Pearl World , the International Pearling Journal*; R. Torrey, editor; fax: (602) 246 1688

### Australia

The 1995 pearl production of Australia is reported to have totalled some 300 kan (an ancient Japanese unit of weight; 1 kan = 1,000 momme), up from 280 kan the year before. Predictions for the 1996 crop range between 290 kan and 310 kan, with the Paspaley Group still accounting for approximately 70 per cent of the country's total production. The annual quota for total wild shell collection remains in 1996 at 550,000—reduced by 50,000 from 1994. Hatchery production quotas remain at 350,000, although this figure is not expected to be reached for several years due to conservative management practices resulting from the high cost and risk factors involved.

Demand for Australian South Sea Pearls (SSPs) continues strong in many markets. Prices had stabilised towards the end of 1995 after Paspaley Pearling withheld market supplies due to sell-off by Japanese importers trying to restructure after the Kobe earthquake. Prices then increased at the Shima Shokai auctions in November of that year due to shortages in some sizes and several qualities.

The South Sea Pearl Consortium (SSPC) has made many changes early in its second fiscal year, among which is the appointment of Ms Chryss Carr as Executive Officer of the Group.

The SSPC has decided to sponsor a GIA pearl course, about which Ms Carr wrote '[this] relationship between the two bodies will, in my modest opinion, move mountains for the industry.' Unsubstantiated reports have the budget for this project set at US$ 600,000 over a two-year span.

### Indonesia

Production of cultured pearls within Indonesia is reported to have fallen to half of last year's 300 kan output. Mortalities among farms in certain areas (the islands of Dobo and Maluku in particular) have been high. Of the total production, only about 60 kan is estimated to be of good quality, with the remainder being of lower quality (but saleable). With this reduced supply, prices are generally expected to rise across the board. *Jewellery News Asia* reports that 1995 prices for Indonesian goods

averaged US$ 200 a gram in 1995, up from US$ 100 a gram the previous year.

## Cook Islands

In early April 1996, the staff and board members of the Rarotonga-based Cook Islands Pearl Authority (CIPA) were terminated as part of an industry-led restructuring of the office. Manager Paka Worthington and assistant Doreen Boggs were among those let go. 'With the board appointed by the Prime Minister and CIPA employees on government tenure, the office has not endeared itself to its critics and has been viewed with criticism by those living in the isolated northern islands where the pearl industry is based,' the *Cook Island News* reported with quite some candour.

Other CIPA board members Joan Rolls, Unakea Kauvai, Peter William and David Wright are involved in the switchover to a new regime . '. . it was obvious that the private sector of the Cook Islands black pearl industry—not a government-appointed agency—ought to be determining [its] future,' Rolls said.

## Japan

The World Cultured Pearl Organization (WPO) meeting held in Kobe on 17 and 18 May 1996 drew mixed marks by attendees. Many reported that attendance and enthusiasm seemed down, and that further erosion was virtually a certainty. It seems that schisms exist within the Japanese cultured pearl industry itself, as well as without. 'The WPO will certainly continue to exist,' reported one member, 'but to what degree we're not sure.'

Plans also continue for the establishment of a lavish World Pearl Center (which many delegates feel is a totally unnecessary extravagance). Progress continues, despite voiced opposition, on integrating a pearl information centre, pearl assessment station, international pearl auction centre, pearl college and pearl museum within a costly structure to be erected in the Fashing District of Port Island in Kobe.

## Tahiti

Reports from Tahiti indicate a continuing upward trend for black SSPs. The April auction in Papeete held by the Tahiti Pearl Producers GIE, sold all but 7 of their 106 lots of 58,090 pearls weighing 102,821.9 g. At a total of US$ 3,9 million, each pearl sold at approximately $ 70 (or nearly $ 39 a gram). The largest buyer was Asia Gem & Pearl of South Korea, paying $ 927 per pearl (37.5% over reserve) for the most expensive lot put up for bids. This event—whose results were termed by its sponsors as 'better than expected'—is to be scheduled annually in April, meshing with the GIE Poe Rava Nui auction in October and the International Tahiti Pearl Festival held every June.

## Europe

Concerns mount among certain European dealers about the quality of more and more Akoya goods coming out of Japan. It is widely felt that 'demand for white, round, spotless goods with just enough nacre cover to hold their processing treatment' is taking over in many major European markets. Thus worries abound that this market direction, in turn, will pave the way for a tremendous influx of cheap Chinese Akoya goods, and that regard for better-quality cultured pearls will erode. As in the US, unit prices seem to be dropping and producers are conforming to this trend by lowering the quality in a greater percentage of exports. 'Is this wise?' many long-time Akoya dealers are asking among themselves. 'Are we selling a true jewellery product, or has it become a poor look-alike to what was once a reputable product which gave a fair value for the money to our customers?' Another concern being expressed is about the type and amount of processing that is being applied to Chinese and Japanese goods. Diamond, platinum and silver dust are quite widely held to be what many cultured pearls are currently being tumbled in to give them an unusual shine . . . along with the old stand-bys of beeswax and eucalyptus shavings.

## Tahiti

The French Polynesian Social, Economic and Cultural Council has approved plans to double pearl production and income from tourism by the year 2005 to make up for a cash shortfall arising from the loss of military investments following the final series of atomic tests beneath the Moruroa and Fangataufa atolls, which ended in January.

The plan would presumably raise annual sales of Tahitian black pearls to 1.1 billion francs in the year 2005 from the 550 million franc sales figure reported in 1995.

Several industry experts have expressed dismay at 'this arbitrary and artificial increase dictated by some bean-counter in Paris,' as one person grumbled. 'They obviously don't have a clue as to what negative effect this will have on the industry,' he went on to say.

# *Tahiti Pearl News* updates

**Source:** Excerpts from *Tahiti Pearl News, The GIE Perles de Tahiti Bi-Monthly International Journal*. Vol.1, No. 6, November 1996

## Pearl price keeps going up

A banner year of promotion, combined with increasingly successful quality control efforts and successful auctions, has made 1996 the year of recovery for the black Tahitian cultured pearl.

And with an increasing worldwide awareness of the Tahitian pearl, the demand for Tahiti's magnificent gem has reached an all-time high across the board—from the biggest names in jewellery creations to the biggest wholesalers.

All of this historic attention has made Tahitian pearl jewellery one of the top attractions at one international salon after another. It has also made Tahitian pearl producers more active than ever in offering only the best-possible-quality pearls from their yearly harvests.

The inevitable result has been a constant recovery.

## 19th Poe Rava Nui Auction

### *138 lots sold for US$ 4.9m, confirming price recovery*

Fifty buyers paid nearly US$ 5m for 65,154 Tahiti cultured pearls divided up into 138 lots at the 19th International Poe Rava Nui Auction, 18–19 October 1996, confirming the price recovery of recent months.

The 138 sold lots represented 90.8 per cent of the 152 lots put up for sale. And the collective value was 71.8 per cent above the reserve price. That produced an average purchase price of 7,123 CFP (about $ 76) per pearl and, most importantly, an average price of 3,257 CFP ($ 35) per gram for the total 142,492 grams sold.

This was the second international Tahiti pearl auction in five months to indicate that the Tahitian black pearl's value in the international market has returned to a normal price that had not existed since the beginning of 1995. The first was the April auction held by the newly created Tahiti Pearl Producers. That auction had an average price of $ 70 per pearl.

But the latest Poe Rava Nui auction contained other important messages. One of the most dramatic was the diversification of the buyers.

The 18 Japanese buyers once again dominated the purchases. But the value of their collective purchase was smaller than a year ago.

Competing strongly with the Japanese buyers this year were four Hong Kong buyers, 13 buyers from Tahiti, two Italian buyers and one German buyer. The result was that there were only five Japanese among the top 10 buyers, compared with eight last year.

The most expensive average price per pearl was 73,705 CFP ($ 788.29), paid by Vaima Perles of Tahiti for the very first lot—98 drop and round pearls with a diameter ranging from 10 to 13.5 mm. The lot sold for 7.2m CFP ($ 77,252), or 161.7 per cent higher than its reserve price.

**Buying shares by country at the 19th Poe Rava Nui Auction**

| Rank | Country | Total paid | Equivalent in US$* | % of total |
|---|---|---|---|---|
| 1 | Japan | 167.8m CFP | $1,795,027 | 36.2 |
| 2 | Hong Kong | 103.7m CFP | $1,109,486 | 22.4 |
| 3 | Tahiti | 70.8m CFP | $756,852 | 15.2 |
| 4 | Italy | 33.8m CFP | $61,441 | 7.3 |
| 5 | Germany | 30.5m CFP | $326,101 | 6.6 |
| 6 | Australia | 18.0m CFP | $193,039 | 3.9 |
| 7 | South Korea | 12.0m CFP | $129,005 | 2.6 |
| 8 | Philippines | 10.4m CFP | $110,706 | 2.2 |
| 9 | USA | 6.3m CFP | $66,929 | 1.3 |
| 10 | France | 5.5m CFP | $58,929 | 1.2 |
| 11 | New Zealand | 3.3m CFP | $35,497 | 0.7 |
| 12 | New Caledonia | 2.0m CFP | $21,401 | 0.4 |

* At time of auction, US$ 1.00 ≈ 93 CFP

## Reported 400 per cent increase in Tahiti pearl demand in USA

Demand in the US for Tahiti black pearls has increased 400 per cent as a result of a banner year in advertising and promotion, said Salvador Assaël, president of the New York-based Tahitian Pearl Association, during a July visit to Tahiti.

He told the local press he was optimistic about the development of Tahiti's pearls overseas.

'Our policy is quality first. We must continue to fight to stabilise the market. For the first time in 20 years we are seeing daylight after the storm,' Assaël said.

The launching of Elizabeth Taylor's black pearl perfume, with an extensive US promotion that included the actress' cameo appearance in four television sitcoms in one evening, was seen by Assaël as one of the key factors in the increased demand for Tahitian pearls.

Another factor, he said, was a 'Tahitian Black Tie and Pearls' ball at New York's American Museum of Natural History for some 750 invited members of the 'jet set'.

He also reported a success in creating scholarships for pearl studies of two months a year at the Gemological Institute of America.

### Tahiti pearl exports, 1995

| Rank | Country of buyers | Weight (grams) | Value (French Pacific Francs (CFP)) | Average price/gram (CFP) | Market share in weight (%) | Market share in value (%) |
|---|---|---|---|---|---|---|
| 1 | Japan | 1,156,052 | 2,392,663,000 | 2,069.68 | 69.9 | 67.9 |
| 2 | USA | 170,063 | 369,364,904 | 2,171.93 | 10.3 | 10.5 |
| 3 | Philippines | 124,637 | 211,000,000 | 1,692.92 | 7.5 | 6.0 |
| 4 | Hong Kong | 90,375 | 210,184,240 | 2,325.69 | 5.5 | 6.0 |
| 5 | Australia | 36,463 | 87,292,280 | 2,394.00 | 2.2 | 2.5 |
| 6 | South Korea | 11,121 | 73,839,800 | 6,639.67 | 0.7 | 2.1 |
| 7 | Singapore | 21,703 | 53,711,480 | 2,474.84 | 1.3 | 1.5 |
| 8 | Germany | 4,770 | 31,843,650 | 6,675.82 | 0.3 | 0.9 |
| 9 | France | 11,833 | 28,396,410 | 2,399.76 | 0.7 | 0.8 |
| 10 | New Zealand | 6,432 | 22,049,900 | 3,428.16 | 0.4 | 0.6 |
| 11 | Switzerland | 3,340 | 12,209,900 | 3,655.66 | 0.2 | 0.3 |
| 12 | Taiwan | 5,498 | 11,019,260 | 2,004.23 | 0.3 | 0.3 |
| 13 | New Caledonia | 5,361 | 8,234,380 | 1,535.98 | 0.3 | 0.2 |
| 14 | Italy | 3,813 | 5,979,550 | 1,568.20 | 0.2 | 0.2 |
| **Total*** | | **1,653,000** | **3,522,549,526** | **2,131.00** | **100.0** | **100.0** |

* including all other countries

### Tahiti pearl exports, January – June 1996

| Rank | Country of buyers | Weight (grams) | Value (French Pacific Francs (CFP)) | Average price/gram (CFP) | Market share in weight (%) | Market share in value (%) |
|---|---|---|---|---|---|---|
| 1 | Japan | 2,455,306 | 6,753,488,361 | 2,750.57 | 75.79 | 71.89 |
| 2 | USA | 325,187 | 1,160,442,059 | 3,568.54 | 10.04 | 12.35 |
| 3 | Hong Kong | 287,734 | 809,766,277 | 2,814.29 | 8.88 | 8.62 |
| 4 | South Korea | 18,582 | 136,577,420 | 7,349.98 | 0.57 | 1.45 |
| 5 | Australia | 42,137 | 130,567,880 | 3,098.65 | 1.30 | 1.39 |
| 6 | France | 34,218 | 127,977,450 | 3,740.06 | 1.06 | 1.36 |
| 7 | Singapore | 27,232 | 106,799,890 | 3,921.85 | 0.84 | 1.14 |
| 8 | Germany | 16,655 | 44,263,819 | 2,657.69 | 0.51 | 0.47 |
| 9 | Thailand | 5,437 | 27,126,820 | 4,989.30 | 0.17 | 0.29 |
| 10 | New Zealand | 4,373 | 26,610,960 | 6,085.29 | 0.13 | 0.28 |
| 11 | New Caledonia | 9,436 | 21,117,400 | 2,237.96 | 0.29 | 0.22 |
| 12 | Switzerland | 3,466 | 12,773,050 | 3,685.24 | 0.11 | 0.14 |
| 13 | Taiwan | 2,087 | 9,121,600 | 4,370.68 | 0.06 | 0.10 |
| 14 | Philippines | 1,031 | 6,312,630 | 6,122.82 | 0.03 | 0.07 |
| 15 | US Oceania | 2,106 | 5,500,000 | 2,611.59 | 0.07 | 0.06 |
| 16 | Italy | 378 | 3,360,777 | 8,890.94 | 0.01 | 0.04 |
| 17 | Malaysia | 1,331 | 3,358,520 | 2,523.31 | 0.04 | 0.04 |
| 18 | Belgium | 1,209 | 2,370,850 | 1,961.00 | 0.04 | 0.03 |
| 19 | Others | 986 | 2,238,720 | 2,270.51 | 0.03 | 0.02 |
| 20 | Czech Republic | 141 | 1,008,780 | 7,154.47 | 0.004 | 0.01 |
| 21 | Austria | 61 | 727.874 | 11,932.36 | 0.002 | 0.01 |
| 22 | Canada | 344 | 679.626 | 1,975.66 | 0.01 | 0.01 |
| 23 | Baleares | 33 | 534,720 | 16,203.64 | 0.001 | 0.01 |
| 24 | U.A. Emirates | 43 | 393,210 | 9,144.42 | 0.001 | 0.004 |
| 25 | Aruba | 54 | 280,000 | 5,185.19 | 0.002 | 0.003 |
| 26 | Dutch W. Indies | 23 | 141,800 | 6,165.22 | 0.001 | 0.002 |
| 27 | China | 80 | 140,000 | 1,750.00 | 0.002 | 0.001 |
| 28 | Bahrain | 68 | 16,100 | 236.76 | 0.002 | 0.0002 |
| 29 | Chile | 7 | 15,250 | 2,178.57 | 0.0002 | 0.0002 |
| **Total** | | **3,239,745** | **9,393,711,843** | **2,899.52** | **100.00** | **100.00** |

## World South Sea pearl sales up

Strong demand coupled with competitive prices lifted world sales of South Sea pearls during the second half of 1995 and the first quarter of 1996, according to producers and wholesalers.

World production of South Sea pearls in 1995 was estimated at 2,025 kg. Increased Australian production in 1995 was estimated at 1,125 kg, compared with 1,050 kg in 1994. 1996 Australian production is expected to be 1087–1,162.5 kg, with quality being similar to that of 1995.

1995 Indonesian production was an estimated 562.5 kg, or 50 per cent less than in 1994. The Philippines' production in 1995 was an estimated 300–375 kg, similar to 1994. Myanmar and Thailand's production in 1995 was an estimated 37.5 kg.

Production of Chinese Akoya pearls increased 30 per cent in 1995 to 20–25 t, with prices of unprocessed pearls dropping 36.8 per cent to US$ 1,200/kg at the end of 1995 from $ 1,900 at the start of the year. Producers in China said about 50 per cent of the 1995 production (10–12.5 t) is saleable. Chinese seawater pearls increased in size from 5–5.5 mm in 1992 to 7 mm in 1996.

But the increased production of Chinese fresh water pearls resulted in prices dropping for most categories last year. This year, however, there are signs of a price recovery, according to Hong Kong suppliers.

# Warning signs unheeded in South Pacific invertebrate trade

*by Bobbie J. Kelso*

**Source:** *Naga*, the ICLARM Fisheries Journal, January 1996. 9–12.

Nearshore marine resources play a significant role in the lives of South Pacific islanders and can be critical to the economies of countries and territories in the region. However, few have adequate management controls in place to ensure that harvests remain at sustainable levels, and determining current levels of utilisation is far from easy.

A lack of information about the volume of both domestic and international trade in marine invertebrates in high demand is a growing concern. Further hindering management and conservation efforts is the little background biological information available to allow for population assessments, according to this new study on the global trade in South Pacific marine invertebrates.

Pearl oysters have traditionally been used in the production of fishing lures. Globally, however, they are best known as the source of cultured pearls and for their shell in the mother-of-pearl trade. The two main commercially significant species of pearl oyster in the South Pacific are the black-lip pearl oyster *Pinctada margaritifera* and the gold-lip or silver-lip pearl oyster *P. maxima*. In Solomon Islands, the brown-lip pearl oyster *Pteria penguin* is also used. Black-lip pearl oysters are cultured for black pearls in Fiji, French Polynesia, the Cook Islands, the Philippines and Japan. The gold-lip pearl oyster is cultured for white pearls in Australia and Southeast Asia and at varying times in Palau and Papua New Guinea.

While the global demand for pearl oysters has led to extreme pressure on wild stocks, most countries have yet to set quota levels for pearl oysters harvested in the wild. In addition, more data are needed on the volume of wild stock collected for pearl farms and the impact on wild populations.

In Fiji, there is a minimum size limit of 10 cm, but there are few black-lip pearl oysters remaining in the wild and the gold-lip pearl oyster is now extinct. Exports from Fiji during 1980–1992 peaked at 57.5 t in 1988, declined to a minimum of 9.9 t in 1991 and stood at only 10.9 t in 1992, the most recent year for which data were available. The decreased supply is indicative of dwindling stocks. Stock declines in black-lip and gold-lip pearl oysters also led Solomon Islands to ban exports indefinitely in 1994. In addition to Fiji, South Pacific exporters include the Cook Islands, French Polynesia, the Philippines and Papua New Guinea.

Japan, with overall annual imports of 500–600 t, increased its imports of South Pacific black-lip and gold-lip pearl oyster from about 30 per cent in 1990–1992 to 52 per cent in 1993. In 1989, the value of pearl imported into Japan from French Polynesia alone topped US$ 40 million.

OPINION

# Setting the record straight

*by Neil A. Sims*

## Pearl culture as a conservation tool

Bobby Kelso's article summarizing the TRAFFIC report on trade in marine invertebrates in the South Pacific (*Naga*, January 1996; see facing page) does a disservice to the pearl culture industry. Certainly, a case can be made for improving management of wild stocks, given the history of overfishing for pearl shell, and the past practices of collection of wild oysters for pearl farming. But Kelso and Glenn Sant (the TRAFFIC report's author) might have made a more constructive argument by highlighting the increasing reliance in the industry on hatchery or spat-collected oysters, and the other economic and environmental benefits that can be brought by pearl farming. Rather than exhorting political and bureaucratic authorities to pursue more research into wild stock dynamics, and a more preservationist stance to these resources, a more objective analysis might have encouraged the managers of these resources to incorporate pearl-culture development into their management plans for these species, and for the reef ecosystems as a whole.

A clear distinction needs to be drawn between the past practices of collection of wild oysters for pearl shell or for farm stock, and current trends. Nowadays, collection of wild oysters for sale as pearl shell is widely viewed as a waste of valuable broodstock or farm resources.

Collection of wild oysters for farm stocks is sometimes an economic necessity, providing cash flow until the hatchery comes on line. Continued dependence on a supply of wild oysters for farm stocks, however, is considered by most to be as sustainable and stable as slash-and-burn agriculture. As pearl farmers crave stability, so they are inherently compelled to accept only that which is sustainable in the long term.

In French Polynesia, for example, pearl farms are stocked entirely from spat-collected oysters. Wild oyster collection is banned outright, but more tellingly, any pearl farmer worth his salt knows that oysters reared from spat collectors produce better pearls, and produce more of them (the nucleus retention rate is greater than in wild oysters). The wild oyster populations have since rebounded from the scarcities of the old pearl shell fishery days to a level of profusion unkown in this century. Similarly, in Manihiki Atoll, in the Cook Islands, wild stocks have increased dramatically with the shift from collection of oysters for shell to farming of spat-collected animals.

The growing use of hatchery-produced stocks in *Pinctada maxima* pearl farms in Australia and South East Asia is also reducing pressures on wild stocks. This allows expansion of the cultured pearl industry to areas where stocks have been depleted in the past, and permits new, start-up farmers in established pearl-growing areas such as Australia, where growth was long stifled by a rigid wild-stock quota system.

The pearl farms themselves then become agents of repopulation. Where once the oysters were isolated on the reefs, perhaps hundreds of metres from their nearest neighbour, a farm holds large numbers of mature, well-tended oysters in close proximity. This increases reproductive efficiency by better synchronisation of spawning epidemics, and maximising the fertilization rates of eggs, resulting ultimately in more recruitment.

Kelso and Sant might also have given more credit to the diverse spin-off benefits of pearl farm developments in the South Pacific and South East Asia. The returns offered by this lucrative industry—and the development of support industries—can reduce the economic imperative that drives artisanal fishermen to overexploit their marine resources. Pearl farming—and other culture of marine bivalves—turns the past hunter-gatherers into farmers, with a keen interest and economic reliance on the health of their lagoons. In Manihiki, it is the pearl farmers themselves who are the strongest advocates for increased research targeted towards better environmental management.

Pearl farmers and other aquaculturists also have strong incentives to establish tenure over their farm area—either by re-asserting traditional rights or by establishing new claims. In some areas of the Philippines where fish poisoning and dynamite fishing are rampant, pearl-farm lease areas usually harbour the few remnants of unspoilt reef.

Conservation organisations that are working in the Pacific Islands and South East Asia might consider these widely-accruing benefits from pearl culture when establishing marine resource management goals or setting up protected areas. The motivations for establishing, maintaining and policing a fishing reserve can be difficult for traditional communities to fully accept, where rewards are often based on common access to delayed or dispersed returns.

TRAFFIC, and similar well-meaning organisations, might do well to consider this approach. As a first step, some detailed study of the wider ecological benefits of pearl farms, and further documentation of their diverse socio-economic impacts, might be appropriate. While some folk might need to see solid data before they become bold enough to build a pearl farm in the middle of their marine reserve, it is difficult to see any real detriment from native, over-exploited filter feeders suspended from sub-surface long-lines. And it does make a marine reserve an eminently 'saleable' notion.

## Dispelling the pearl market myths

I am always surprised by the dismissive tone expressed towards pearl farming by a disconcerting proportion of the senior consultants, fisheries managers and development advisers that I run across. Whilst these attitudes have little impact on the established pearl-culture industry, they represent a constant countercurrent of opinion against which we—those of us working to expand pearls beyond their present geographical boundaries—must swim.

The most basic misunderstanding is the unfounded belief—and unfathomable concept—that pearls are an inappropriate product for rural and island communities. An august national body of agricultural researchers once dismissed the whole notion of pearl farming because 'they are a luxury commodity'. Development aid folk often highlight the disruption of socio-cultural traditions on atoll islands, and ignore or downplay the myriad attendant benefits. Certainly, pearl culture produces rapid—almost revolutionary—shifts in island communities, and there are inevitably tensions: lagoon tenure disputes, conflicts over political jurisdictions, the triumph of capitalism over traditional communalism, and the eager embracing of some of the tackier excesses of consumerism.

But there are wide and varied benefits of new-found affluence from pearl culture. The more measurable improvements include reversal of rural–urban drift, reassertion of faded lagoon tenure rights, and improved communications, transport links and public services to isolated communities that were essentially dead in the water. There are also the equally important intangible benefits: the gleam in the eye and the squaring of the shoulders of those who produce the pearls, who build the farms, who further the industry. There is economic independence, there is pride of ownership, and there is recognition of environmental stewardship. Is this not what development is about?

The other, more galling attitudes concern the pearl market. These might be either the innocent repeating of often-recited myths, or a more insidious attempt to take the wind out of the sails—or downright dismast—any potential competition from new pearling areas. Some of the established pearl producers continue to predict gloom and doom for any new ventures—the perils of overproduction are spun like a prayer wheel—despite the fact that they themselves have continued a virtually unrestrained expansion.

Production in French Polynesia has almost doubled every year since the mid-1980s, and the black-pearl price has fluctuated to the beat of its own drum (or more precisely, to the beat of the promotional drum). Any perceived ceiling of market saturation was quickly recognised as a mirage that one could walk through hand in hand with a couple of women bedecked in black pearls. It certainly helped that the 'couple of women' were Liz Taylor and Miss Tahiti. Black pearls now play well in Peoria, Illinois, as well as Paris, France.

Yet the myths continue, recited by higher-level fisheries and development personnel from all areas. The highest-ranking aquaculture expert from one of the world's largest development agencies believes black pearls are already sunk by the dual salvo of Chinese freshwater pearls and Brazilian hematite. This is as plausible as saying that the sashimi tuna market is under pressure from the massive expansion of tilapia culture and the technological breakthroughs in surimi manufacture.

There doesn't seem to be much that can be done in the face of such ill-informed attitudes. Perhaps a serious marketing study might help, but then it would probably be conducted by the perpetuators of the present problem. It might be hard for them to leave their preconceptions at home. One might hope that some demonstrated successes might turn some heads, but if the Tuamotus and the Cook Islands aren't example enough of what pearls and pearling can do for Pacific Islands, it is hard to imagine what further proof is needed.


# World class black pearls:
## *Pearl World* highlights the achievements of the Cook Islands black pearl industry

I thought it was extremely important for us to see the industry at Penrhyn. It is virtually brand new—its first harvest was late 1995—and it is a key to the Cook Islands' rapid production growth. While I knew there would not be much to see above the water, I believed we could get some sense of how active the new industry is and what its attitudes toward quality and quantity might be.

Penrhyn houses the US$ 3 million Tongareva Marine Research Centre, which was established in 1995 and manages more extensive environmental management tasks than does the smaller facility on Manihiki. The two facilities do operate co-operatively, but the Tongareva Centre has broader capabilities, as it has both good laboratory facilities and a hatchery capably managed by Cook Islanders with advanced education and a lot of innovative ideas. Dr Rick Braley, a US consultant, will be at the facility for about a year helping Marine Resources extend their programmes.

Both the Cook Islands Government and its pearl industry deserve recognition for having a strong determination first to establish the scientific resources to support pearl farming on Penrhyn, then to build the pearl cultivation infrastructure itself. Once again, this is proof positive of the 'let's-take-care-of-our-lagoon' approach that we encountered everywhere on our trip. It was yet another clue for us that the Cook Islanders are thinking managers of their ecology, and that in as much as human care can affect what happens with an animal as delicate as the oyster, quality production is likely to be a constant from the Cooks for some time to come.

The Tongareva Centre estimates that about 40 per cent of the lagoon is farmable, and that the natural black-lip oyster shell population there is between two to three million. Although we heard other industry estimates ranging up to five or six million, the consensus of opinion is to go with the more conservative total for now.

Penrhyn itself has a total population of approximately 600 people. There are two villages—Omoka and Te Tautua—which are located on opposite sides of the lagoon. All pearl farming operations are conducted from the two villages. There are no farms situated on coral heads out in the lagoon, as on Manihiki. We were told that the Penrhyn islanders rejected the Manihiki concept from the very beginning, as they had had ample time to witness the Manihiki way in actual practice prior to starting their own.

There are currently more than 100,000 seeded shells on Penrhyn, and there is a goal of having 200,000 seeded shells by the end of 1997. Each village has a communal seeding facility. We visited the Te Tautua seeding *motu* which was patiently awaiting the arrival of John Lyons, their next technician.

Right now, Penrhyn's industry is comprised solely of small farmers: 1,000 shells or less per farmer for the most part. You must be a Penrhyn Islander to get a farming licence. And while we were there, there was an Island Council cap on the number of allowable seeded shells per farmer (3,000). . . although it has recently been upped to 5,000 seeded shells per farmer.

The ability to collect spat (juvenile oysters) effectively is probably going to be important to the dynamic growth of the industry of Penrhyn. Lagoon characteristics have limited natural spat collection to date, but Raymond Newnham of Marine Resources does not see it as a long-term problem. The hatchery shows signs of being able to produce 100,000 spat per year when fully operational. Ongoing studies are being conducted which will show the most favourable natural spat collection sites and patterns. From what I saw, I suspect that Penrhyn has nothing but steady growth in front of it.

The reports of the first Penrhyn crop varied from Raymond Newnham's conservative 'Penrhyn shows some really fine colours,' to Peter William's 'It was pretty much what you would have expected , but a good first show,' to Joan Rolls' 'I was really excited by what I saw.' Joan—a respected Rarotongan jewellery designer and retailer—was not only enthusiastic about the pearls, but has been really happy with the quality of the mother-of-pearl shells that she sees coming down from Penrhyn to Rarotonga.

It is so early in the development of their industry that the Penrhyn farmers did not seem to have such fixed opinions as the Manihikians, but they seem to believe similarly in that the care of their lagoon will be their key to success. I feel certain that the development of the Pearl Federation of the Cook Islands will help these farmers communicate across island boundaries to the benefit of all.

I did not see the first crop from Penrhyn; it was sold entirely to a wholesaler in Australia long before we got there. But the Cook Islands' product and their approaches to perliculture reassure me that the international industry can look for consistent quality and increasing production from this region. This must be why more and more buyers are flying in these days to buy Cook Islands pearls. Comparable sizes and qualities from Tahiti and the Cook Islands are virtually indistinguishable. One buyer told me : 'You may have to search a little wider here, but it's certainly worth the effort.'

Over the past years I've been privileged to see for myself the great forward strides that pearl producers around the globe have been taking. Nowhere has improvement been so dramatic as here in the Cook Islands.

**Source:** *Pearl World* Vol. 5, Nos. 4 & 5; R. Torrey, Editor, fax: (602) 246 1688

# Pearl-culture history and developments in the US-affiliated Pacific

This paper reviews some recent developments in Hawaii and Micronesia that suggest artificial rearing may provide an alternative leading to the re-establishment of pristine population levels and a viable culture industry. Specifically this report details some history of the culture and exploitation of black-lip oysters in Hawaii and Micronesia.

We review recent attempts to develop pearl culture in the Federated States of Micronesia (FSM) and the Republic of the Marshall Islands (RMI). Additionally, we provide an update on recent activities related to the re-establishment of black-lip oyster populations and explore the potential of a commercial industry in the vicinity of the Hawaiian archipelago. In doing so, we span the spectrum of opportunities and constraints which may be of general interest to others in the insular Pacific looking to engage in this potentially lucrative industry. Much of the information presented here, unless referred to otherwise in the traditional manner, is from unpublished progress and final project reports; and some results are preliminary in nature.

## History—Micronesian culture activities : 1920 to 1980

Smith (1949) reported *P. margaritifera* as widely distributed throughout Japanese-mandate Micronesia. He refers to oyster shell being used by local populations for fishing lures: trolling jigs (lures) found at Kapingamarangi Atoll (FSM). Even then, these were considered collector items.

Japanese production figures from Palau show 2,500 t of pearl shell landed in 1939. Smith (1949) reported pearl oyster culture in the 1930s in Palau and at Ebon Atoll in the Republic of Marshall Islands (RMI). Prior to World War II there were four pearl culture companies in Palau and one in Ebon in the RMI. Japanese statistics show 17,783 pearls valued at 77,046 yen shipped for the year 1939 from Palau (Smith, 1949).

It is unclear what duration of time this production represented and what was the relative quality of the pearls. Assuming the four Yen to one US dollar exchange rate noted in the report, the net present value of the 1939 production figure represents approximately US$ 225,000 in 1995 dollars.

This low figure draws into doubt the reported production figure in that it represents around $ 12 per pearl. It is also unclear if this figure includes production of the gold-lip pearl oyster *Pinctada maxima* which was reportedly imported to Palau from outside Micronesia. Other sources (Nichols, 1991) indicate that pearl farming in Palau started in 1935 with *P. maxima* and that between 1937 and 1941 3,736 kg of pearl were produced , but no value is reported. Between 1935 and 1942, Shinju Kabushiki Kaisha of Tokyo attempted pearl culture experiments on Ebon Atoll, RMI, but activities were disrupted because of World War II and never continued (Smith, 1992b).

Beyond an additional reference in Smith (1949), there appears to be little information in western literature regarding activities at Ebon Atoll. It is reported that adult shells were transported live from Namdrik Atoll to Ebon for presumed implantation (Dashwood, 1991). Discussion with individuals involved in Ebon pearl farming indicate it was a subsidised operation (government-supported), in joint venture with a private firm, and that several Marshallese were hired to maintain the oysters in Ebon lagoon (T. Loeak, pers. comm., 1994).

In the mid-1980s, a pearl farm operation was established in Koror, Palau, as a joint venture between a Japanese company and the Palau National and Koror State Governments. The operation focused on the culture of *P. fucata* and *P. maxima* with shells imported from Japan and Indonesia. A reported 25,000, 150,000 and 110,000 shells were imported in 1985, 1986, and 1987, respectively, because of the lack of wild stock. The operation reportedly had a number of problems (high mortalities, security) and ceased operations in 1994. No production figures are publicly available.

## Federated States of Micronesia

Beyond the reference to the occurrence of the black-lip oyster in what are now the atolls of the FSM by Smith (1949), there are few quantitative data on landings. The only recent reported landings of black-lip oysters in the FSM are those reported by Smith (1992a) from Chuuk State. In 1979, 12,001 kg were reported harvested, with another 7,804 kg reported for 1986. The 1986 landings had a reported export value of US$ 23,207. These landings are assumed to be all wild stock of *P. margaritifera*; however it is not clear whether the statistics may also include some trochus (*Trochus niloticus*) landings.

In 1987, the Pacific Fisheries Development Foundation (PFDF) and the Pohnpei Marine Resources Division (PMRD), began investigating the possibility of establishing a cultured oyster pearl industry in the FSM. The goal was the establishment of a low-technology pearl/shell industry in FSM providing employment and export-earning opportunities for outer atoll inhabitants. A project supported by the US National Marine Fisheries Service, Saltonstall-Kennedy Program (NMFS S-K) was established to provide training and testing of spat collection techniques for black-lip pearl shell on three outer atolls of FSM: Nukuoro, Kapingamarangi and Ant. Support was also provided by the local atolls to compensate local workers.

Actual project activities began in July 1988 with the installation and monitoring of spat collectors on Nukuoro and Ant Atolls and later Kapingamarangi Atoll (April 1989).

On Nukuoro, 17 dive surveys were conducted for wild oysters with a mean catch per diver-hour (CPUE) of 5.01 (s.d. 4.35, range 0–15.07). Two surveys were performed using scuba, with 2.5 pearl oysters shell per man-hour found between 18 and 25 m and 13 shells per man-hour between 12 and 18 m. Spat collectors were deployed on five longlines at different locations in the atoll. At Nukuoro wild stock were collected and strung on standard longlines in an attempt to provide the rudiments of a small farm.

On Kapingamarangi, 47 surveys were conducted and no black-lip oysters were encountered. Activities there appear to have terminated quickly due to lack of adult oysters.

Activities on Ant Atoll were run by the PMRD office due to its proximity to Pohnpei. Two project workers were hired to establish longlines and search for wild oysters, and an unknown number of spat-collector bags and lantern nets were deployed. A small shed was built to house the workers, and a platform was installed in the lagoon. Five spat-collector longlines were established in a water depth between 8 and 14 m. Efforts at collecting wild stock were marginally successful: by June 1990 no more than a total 200 oysters were deployed in lantern baskets. Spat settlement was reported as ‘sparse’ but no quantitative data were obtained from any of the sites at the three atolls (although 2–3 cm spat were observed at the site established on Ant Atoll in 1992).

In the second year the project was to expand to acquire enough mature oysters so that an implanta-

tion expert could initiate pearl production. However, a variety of problems hindered project progress; the field ship that normally visits the outer atolls was continually out of service, constraining transportation of needed supplies; natural materials needed for spat collection were unavailable on some atolls; and spat settlement was sparse. Efforts at establishing demonstration farms were unsuccessful at two of the three sites. In addition, vital local participation (in-kind services) was sporadic.

The project ran for 36 months, with work on the second portion of the project expected to begin in mid-1991. However, these pearl-oyster development activities terminated in June 1991 as a result of the abrupt closure of the PFDF. There is little documentation on the project beyond project progress reports. Despite the relatively poor results of the project, there appears to be some positive aspects. In 1994, individuals on Nukuoro Atoll re-initiated pearl-oyster-rearing activities (described below). Additionally the lessons learned from the Pohnpei project were used to some degree in planning later activities in the Marshall Islands.

### *Nukuoro Atoll*

Nukuoro Atoll is located 275 km south-west of Pohnpei in the Federated States of Micronesia. It is a relatively small atoll, approximately 7 km in diameter. It is composed of a series of islets amounting to 1.66 $km^2$ which ring an interior lagoon of 27.25 $km^2$. There is no publicly held land on Nukuoro (Anon., 1992). The depth of the lagoon varies, with an estimated maximum depth of 100 m. The circular lagoon has one small pass, with the south-western portion of the atoll being open to the sea across the reef flat.

The width of the reef is reduced on the eastern portion of the atoll. Inside the lagoon there are coral out-croppings which extend from the generally sandy or coral rubble floor of the lagoon. The atoll has a total population of approximately 550 in 80 households, and is serviced roughly every month by an outer-island trip ship. There is no air transport to the island at present.

During pre-western-contact times, locals report that seafarers from Yap, more than 1,000 miles away, sailed to Nukuoro to trade for pearl oyster shell which was taken home and used as a currency. In the 1800s German divers 'plundered' 50 t of oysters from the lagoon (Martin, 1996).

In 1994, interest was revived in pearl oyster culture at Nukuoro Atoll by individuals actually living in Pohnpei. With Australian and Pohnpei State Government support, these private citizens travelled to Namdrik Atoll in the RMI and received training on the rudiments of pearl oyster mariculture from the Marshall Islands Marine Resources Authority (MIMRA) and its technical advisor Black Pearls Inc. of Kailua-Kona, Hawaii.

This training provided the Nukuorans with 'hands-on' experience in developing a small farm. These individuals then decided to return to Nukuoro to re-start activities initiated in 1987. After receiving SCUBA diving training, those trained returned to Nukuoro and began to re-establish pearl oyster cultivation activities (Lindsey, 1996).

Toward the end of 1995, a pilot spat-collection programme was established to determine relative rates of settlement. At total of approximately 3,000 adult oysters were collected from the lagoon and strung on lines suspended from spare longline floats, and a small hut was constructed for use by a pearl implantation technician.

The oysters were collected from the wild, from approximately one-third of the lagoon accessible to skin or SCUBA diving (Lindsey, 1996). At that time the farm had a staff of five. In late 1995, a pearl oyster technician from the Cook Islands, along with representatives from the RMI MIMRA and an US supported regional aquaculture extension agent travelled to Nukuoro to begin implantation activities and provide technical assistance as requested.

A total of 3,000 shells were implanted with round nuclei and 100 with half (mabe) nuclei. Initial retention rates were hoped to be 75–80 per cent but the implantation attempt appears to have been less successful, with a rejection rate in excess of 61 per cent—only 1,168 retaining the nuclei after the first month. The low retention rate was hypothesised to be a result of the poor condition of the oysters, the rudimentary working conditions, and the relative inexperience of the local staff (Lindsey, 1996). No quantitative data are available on the spatfall rates, nor are any data provided on the number of spat lines / bags deployed so far.

The farm manager reportedly was to travel to the Cook Islands for additional training. Future plans call for the collection of at least 4,000 additional pearl oysters from the remaining two-thirds of the atoll, with an ultimate goal of between 10,000 and 15,000 oysters (Martin, 1996). The implantation technician planned to return in the third quarter of 1996 (Lindsey, 1996). The spat collection programme is expected to be expanded, as is farm infrastructure. Under the assumption that facilities will continue on Nukuoro, the first harvest of round pearls was expected to be in the third quarter of 1996. Despite the logistical impediments, given the private-sector initiative, the prospects appear promising at Nukuoro.

## Conclusions

Micronesia has a long history of black-lip pearl-oyster exploitation and culture. Exploitation of natural stocks appears not to have been sustainable during initial western contact periods. Stocks in most locations were reduced to 'background levels', though brood stock remain in selected locations in the FSM and RMI (no information exists on Palau).

Culture activities in the Pacific originated in Micronesia but proved unsustainable for reasons that appear, in part, to be related to lack of natural stocks and the advent of World War II.

Work in Palau, the FSM and RMI during the late 1980s and early 1990s attempted to emulate successes demonstrated in the Cook Islands and French Polynesia.

Recent efforts in all locations have been constrained by lack of natural stocks. Additionally, for those locations which have brood stock available, logistic and human resource capital provide both constraints and opportunities.

While the activities described above cannot be viewed as an accurate indicator of the potential for pearl oyster development in the FSM, several valuable lessons are provided. Transportation and communication links to remote settings must be established and dependable. The availability of technical advice is crucial for success, as is the need for quantified data collection and reporting.

The remote hatchery technique provides a promising alternative to those areas in which natural spatfall proves deficient. There is a need to increase survivorship of spat both in the hatchery and once the young oysters are placed in the lagoons of Micronesia. Growth to sizes above 10 mm appears promising in the RMI, and mortalities are significantly reduced by placing young spat in protective devices still under development.

However, even this technology is not without logistic considerations; air shipment of the spat can be problematic, if, for example, freight space cannot be guaranteed. There are now at least four black-lip pearl culture farms developing in the RMI and the FSM, three of which are mainly supported by private capital.

There is considerable, growing interest in the topic in the region in general. These findings suggest that the outlook for black-lip pearl oyster development in Micronesia is optimistic. As is the case with any marine resource development initiative, its relative success will ultimately depend on economic and social considerations.

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## Source:

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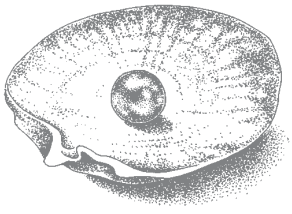


# Search for lost Hawaiian pearls

If people would harvest enough pearls of wisdom, there might be more of the real pearls growing in Hawaiian waters today. Instead, environmental pressures and over-fishing combined to winnow the population of pearl-producing oysters in Hawaii to a fraction of its former numbers. The local pearl industry, which enjoyed its last boom in the late 1920s, has been dead since 1930.

And among the lesser casualties of this situation is Michael Walther—or, more precisely, the Lucoral Museum that he manages. As a result, the Waikiki museum has launched The Great Hawaiian Pearl Hunt, and has offered a reward.

'The reason for the hunt is we have a display about Hawaiian pearls, with no pearls from Hawaii,' said Walther, who also has researched the subject preparation for a book on Hawaiian pearls to be released later this year. What the museum's new exhibit does include is a number of archival photographs and shell specimens from the species that once thrived here. A stand-in for the Hawaiian jewel is a tiny pearl from Christmas Island, on loan from John Naughton of the National Marine Fisheries Service.

## Don't look in the ocean

Walther emphasised that the museum does not want people to scour the ocean and uproot any oysters that may still be clinging to the rocks (there are tiny remnant populations in spots around the Islands, he said). The aim is to find and photograph some of the pearls harvested in the late 1920s from an atoll called Pearl and Hermes Reef, about 1,100 miles northwest of Oahu in the Hawaiian archipelago, that may be languishing in someone's jewel box. The chances are slimmer that any would be found from Pearl Harbor, since those oyster colonies died off in the mid 19th century.

Walther checked first with the Bishop Museum (which confirmed for the Advertiser that no Hawaiian pearls exist in its collection). He said calls to the Smithsonian, the US National History Museum and others have failed to uncover anything either. (*Editor's note : The Lucoral Museum's search eventually yielded several pearls, with verifiable lineages tracing them back to around the time of the Pearl and Hermes harvest*).

## Native Hawaiian uses

The Bishop Museum does have ample examples of how mother-of-pearl, the iridescent lining of the shell, was used in traditional artistry and fishing hooks. The Hawaiians were less ardent seekers of the pearls themselves, Walther said, because they did not possess the tools required to drill holes in them for ornamental use.

When Westerners arrived and declared a desire for the pearl oysters being harvested from Pearl Harbor, Kamehameha I developed a fishery. But increased siltation of the harbour, produced by runoff from soil denuded by cattle herds, killed off most of the colonies by 1840.

Historian and zoologists believe the Pearl Harbor species was the *Pinctada radiata*. Earlier this century, an enormous population of a larger oyster, *Pinctada margaritifera*, was found in the pristine atoll waters of Pearl and Hermes Reef. A company called Hawaiian Sea Products harvested more than 100,000 oysters from 1927 to 1930, to the point where the population could no longer recover.

Pearl oysters need to be closely packed in a colony to foster reproduction. Females need to be near enough to sense the males have spawned before releasing their eggs, and there need to be enough juveniles produced to survive feeding by natural predators, said Neil Sims, one of the principals in a company seeking to culture oysters in Hawaii. Subsequent surveys have found that the Pearl Harbor population never recovered, either. The Bishop Museum recently finished a study in which eight months of sampling found exactly two living specimens of *Pincatada margaritifera* and one empty *Pinctada radiata* shell in the harbour, said museum zoologist Steve Coles.

## The culture of the pearl has attracted a following

Someday it won't take a contest to turn up a pearl grown in Hawaii. Pearl culturing has sparked interest among several entrepreneurs here—including the former governor of the state.

C. Richard Fassier, an economic development specialist for the state's aquaculture programme, said there are maybe a half-dozen or so businesses demonstrating everything from 'a gleam in their eye' to real research. Among the more serious projects he cited :

- Former governor George Ariyoshi is president and chief executive officer of Hawaii Cultured Pearls Inc.;

- Black Pearl Inc. is a company headed by Dale Sarver and Neil Sims. Both they and the Ariyoshi group are doing research at the State's Natural Energy Laboratory on the Big Island;
- Jaw-Kai Wang, a biosystems engineering researcher at the University of Hawaii, is doing experimental work at Anuenue Fisheries Research Center, Sand Island.

**Source:** 'The lost pearls of the Islands', by Vicki Viotti, *The Honolulu Advertiser*, 14 January 1997, C1–C3.

# Cook Islands offers Small Island States co-operative efforts

At a recent Forum Small Island States meeting in Nauru, Cook Island Prime Minister Sir Geoffrey Henry reaffirmed his Government's interest in assisting its small brothers in the development of pearl farming, one of the Cook's major money earners.

Sir Geoffrey first mentioned this at an earlier Small Island States summit meetings, and one of the small countries to respond was Kiribati. After that meeting, President Teburoro Tito, aligned a group of selected would-be farmers and fisheries officers to take the opportunity and visit the Cook Islands.

The trip, however, never materialised, as there were strong opposition and rejections from pearl farmers, mostly from Manihiki Atoll. Farmers there condemned their Prime Minister for not consulting them before initiating his regional assistance.

At the recent Sixth Summit in Nauru, President Tito indicated that he would not like the same episode to happen again and after consideration, it was agreed that the consensus of Cook Islands farmers must be sought before a move is made. Pearl farming trials have taken place on different islands in Kiribati, but all proved unsuccessful. The most promising trial was carried out in the lagoon of Abaiang Island, once a commercial centre for seaweed export.

But experts found that the experiments were carried out in the wrong spots, at the wrong depth with the wrong currents. Beside, the equipment used in the experiment was vandalised, probably by poaching fishermen. Government then stopped experiments on Abaiang, Butaritari and a few other islands, but the determination to get pearl farming off the ground is still there.

According to government officials, Kiritimati island in the Linnix and even the remote islands in the Phoenix Islands are potential farming areas and government is interested to seek opportunities there. The pearl farming project is still very much active, not merely shelved on paper. The Fisheries Division in Tanaea continues to conduct experiments, not just in the sea but in huge tanks on land. During debates in Parliament, politicians often claimed that their islands too have suitable sites for pearl farming and would like the authorities concerned to investigate.

**Source:** 'Getting help for pearl farmers; Cooks reaffirm its interest to spread pearl farming knowledge' by Laura Kessleman, *Marshall Islands Journal*, Vol. 27, No. 44, 1 November 1996. p 19.

# Assessment of the Marshall Islands pearl farming potential

There is good long-term business potential for breeding black-lip pearl oysters in the Marshall Islands. But after almost four years of research in the Marshall Islands, the representative of a Hawaii-based company says raising pearl oysters is definitively not a get-rich scheme.

Because the Marshalls Islands does not have a large natural supply of pearl oysters, establishing a hatchery is essential to building a pearl oyster industry in the Marshall Islands, said Dale Sarver, president of Black Pearls, Inc. in Hawaii, which is working with the Marshall Islands Marine Resources Authority (MIMRA) to develop pearl-oyster farming here. In French Polynesia and the Cook Islands, which have both established major pearl export industries, hatcheries are not needed because there is a huge natural supply of oysters, he said.

Slowing the development of pearl farming in the Marshalls has been the difficulty of getting investment funding to establish a hatchery-based farm locally, Sarver said. Up to now, all spawning has been done at Black Pearls' Hawaii research facility, and brought back to the Marshalls to grow, an inefficient way to develop a local industry. But after several years of work here, Sarver says, 'It'll happen. It may take longer to develop, because of the lack of funding for a hatchery, but it will happen. We're patient.'

To date, most research has been supported by US federal grants through the National Marine Fisheries Service and support from MIMRA. 'Conditions for growing oysters are generally good in the Marshalls Islands,' is what the research has shown. Sarver observes that to make pearl oyster farming sustainable from a business perspective, 'you can't do it small'. He foresees development of a large, industrial-size hatchery with a farm as the best way to foster an industry. Once a major farm is established, local people can be trained to farm oysters in smaller numbers, so that the spin-off financial benefits reach many people. 'In addition, a large farm can bring in equipment and supplies at lower prices than an individual farmer could, thus saving everyone money,' he added.

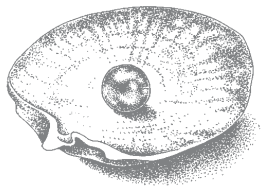
'Once the nucleus is there, we can support other farms with stock, seeding and equipment,' he said. 'A big hatchery will be an advantage for everyone. You must have a minimum number to be profitable.' He believes that more pearl oyster farming here is better than less, and doesn't see competition as a problem. He comments that growing oysters is like farming. 'People think of this as a high-tech, razzle-dazzle industry, but it's not,' he said. 'It's like growing potatoes. It takes a lot of labour to clean and properly care for oysters,' he said.

The quality of the pearls—which determines the price that will be paid—is directly proportional to the care that is given to them. From the start to sale, it can take four years: two years for the oyster to reach maturity, when it can be seeded, and two years to complete its growth cycle before it can be harvested and sold.

Sarver said that they are just now starting to produce the second generation of pearl oysters grown in Marshall Islands waters. He describes Black Pearls, Inc. as 'probably the only private company that is doing research to take pearl-oyster-growing into the next century.' The Hawaii company's research is investigating ways to genetically speed up growth time and to select for better colours and quality that will increase the value of the pearls.

Several investors are now seriously considering financing their farm in the Marshall Islands. 'There could be a significant industry here in 10 years,' Sarver said.

**Source:** 'Marshalls has fertile waters for pearl oyster industry' by Giff Johnson, *The Marshall Islands Journal*, Vol. 28, No. 5, 31 January 1997. p. 19.



# Tenure regimes and their impact on pearl-farm development and management in the 'Pearl Islands'

In French Polynesia, pearl farming is regulated by the Department of Sea and Aquaculture (SMA), a branch of the autonomous territorial government based in Papeete, Tahiti. Pearl farming has proved difficult to regulate. The interests of the French and Chinese–Tahitian entrepreneurs who played a major role in the early trials, production technology, and market development have often been at odds with the interests of the Tuamotuan people. The position of the administration is that lagoons are part of the public domain and that all residents of French Polynesia are eligible to apply for concessions in any lagoon, providing they prove their ability to farm pearls and pay the required annual fees for the concession area. Tuamotuans, however, find themselves increasingly displaced from high-value shorefront land and lagoon space.

At the heart of the problem is a tenure code imposed over a century ago by the French colonial administration and never completely accepted by the local people. This article, based on archival research and fieldwork conducted in 1990 and 1991, shows how land and lagoon tenure codes imposed by the French and sanctioned more recently by the emerging 'post-colonial' Tahitian administration compare with *de facto* tenure arrangements in the Tuamotu Archipelago.

It shows that Tuamotuans have attempted, with varying degrees of success, to hold on to their ancestral territorial resources by tenuously balancing between 'old' and 'new' legal systems, and that tenure regimes provide an important arena for political contestation.

**Source:** 'Between two laws : Tenure regimes in the Tuamotu Archipelago', article by Moshe Rappaport in *The Contemporary Pacific*, 1996, 8(1): 33–49.

*Moshe also provided references to two other articles stemming from his PhD research in the Tuamotus :*

'Pearl farming in the Tuamotus: Atoll development and its consequences'. *Pacific Studies* 1995, 18(3): 1–25.

'Oysterlust: islanders, entrepreneurs and colonial policy over Tuamotu lagoons'. *Journal of Pacific History* 1995, 30(1): 39–52.

# Pearl farming looms large in Australian aquaculture reviews

For the financial year 1994–1995, data on aquaculture (both hatchery–nursery and growout) production and the value of this production have been collated from a number of government and industry sources. In order of value, the major sectors were pearl oysters (AU$ 252.2 million), salmonids (AU$ 73.3 million), edible oysters (AU$ 47.5 million), southern bluefin tuna (AU$ 37.9 million) and prawns (AU$ 27.7 million).

## Pearl oysters

The overall value of *Pinctada maxima* production increased significantly to over AU$ 252 million on the strength of firm market prices and increased farm production.

While more than 30 operations were farming pearl oysters, the bulk of Australian production, valued at around AU$ 196.0 million, comes from Western Australia. Production from the Northern Territory was AU$ 46.2 million and for Queensland the industry is thought to be worth approximately AU$ 10 million.

For a number of years, pearl oysters have been Australian's most valuable aquaculture industry and the 'South Seas' pearls are reputed to be of the finest quality in the world. While the market outlook is uncertain due to increased competition from several overseas countries, especially Indonesia, prices are expected to remain high for quality product.

Industry development has been restricted by an annual quota system designed to protect the low stocks of wild-caught shell available for seeding. However the work undertaken in hatchery production should mean increased stocks on the farms. Innovations in longline and bottom-culture methods and an expansion in the number of farms will also allow further production increases.

**Source:** 'Status of Australian Aquaculture in 1994/95' by David 'DOS' O'Sullivan and Tania Kiley, *Austasia Aquaculture Trade Directory*, 1996; and Australia, Country Statement No. 13, SPC 26th Regional Technical Meeting on Fisheries, Noumea, 5–9 August 1996.

### Aquaculture production of molluscs for 1994–1995

| Species | Farm (tonnes) | Hatchery* | Value (AU$ ,000) |
|---|---|---|---|
| Sydney rock oysters | 5,272.2 | 0 | 28,015.8 |
| Pacific oysters | 4,005.7 | 0 | 19,543.4 |
| Native oysters | 0.5 | 0 | 6.1 |
| Northern oysters | 24.7 | 0 | 87.3 |
| Pearl oysters (*P. maxima* ) | <0.1 | 0 | 252,200.0 |
| Other pearl oysters | <0.1 | 0 | 2.0 |
| Mussels | 992.0 | 0 | 2,723.0 |
| Freshwater mussels | 0.2 | 0 | 0.7 |
| Scallops | 170.0 | 0 | 980.0 |
| Abalone | 1.3 | 0 | 39.9 |
| **Subtotal** | 10,296.8 | 0 | 302,618.2 |
| **Australian total for all species** | 40,363.3 | 13,883 | 464,582.5 |

* Hatchery production not for sale to commercial farms

# Pearl plans pending

Two proposed pearl culture operations have been submitted to the Great Barrier Reef Marine Park Authority, and are waiting for approval from various government departments. The projects are the idea of Michael Crimp, of Zen Pearls Ltd. He proposed a shallow-culture operation at Juno Bay, and a deep-culture operation near Yank's Jetty. Several applications in the past five years have been knocked back, but he gives the two current applications a 50/50 chance success. The operations would grow the pearl oysters on submersible longlines and racks. Michael welcomes the State Government's introduction of 15-year licences, saying his operations would take at least five years to get a positive cash flow, and eight years to reach full development. 'The new, longer licences mean aquaculturists can confidently maximise the potential of an area', he said.

**Source:** 'Pearl plans waiting', article in *Herbert River Express*, Ingham, 4 July 1996, excerpted in *Austasia Aquaculture Magazine.*

# Western Australian pearl farming perspectives: market, production practices, history, and current status

## A king's ransom

Know you perchance, how that poor formless wretch,
The oyster,
Gems his shallow moonlit chalice,
Where the shell irks him
Or the sea sand frets?
He sheds this lovely lustre on his grief . . .'

*Sir Edwin Arnold*

*The sea's loveliest treasure, pearls, is the basis for one of Western Australia's most valuable fisheries. Cathy Anderson report on how the best pearls in the world—Australia's South Sea pearls—go from humble oyster to glittering limelight.*

Occupying the luxury end of the market, South Sea pearls earned the industry about AU$ 190 million last year and, although their price is high, the international spread of well-heeled folk who buy them is expanding.

One man ideally placed to comment on the growth in interest in pearls and pearl jewellery worldwide is David Norman. David's involvement in the industry started when he was quite young. He was born into a pearling family with connections in Japan and Thursday Island and, as he grew up, was determined to stay in the industry; today he is pearl-marketing consultant at Broome Pearls Pty Ltd.

For many years the Japanese dominated the pearling industry, but times are changing. 'The Australians will get better at selling all around the world and the Japanese will completely lose the stranglehold they previously held,' David predicts. 'They used to buy 100 per cent of the production, now only about half gets sold to Japan direct, and maybe another 10 per cent indirectly.'

Today he is confident South America, where there is no indigenous pearl production, will prove a huge market for Australian pearls. 'The market in Europe likes a creamy, rosy colour and America likes silver white and pink, as does the Australian market.'

David Norman thinks the Australian South Sea pearl industry, young though it is, is very well placed to increase its markets. 'There was a World Pearl Conference in May 1994 and it was amazing to see how disorganised some of the other producers were,' he said. 'Last year the South Sea Pearl Consortium was set up, which is basically a group of all the Australian pearl producers with Nick Paspaley as chairman. Two of the largest Japanese companies, one from Hong Kong and one from the USA, are also members.'

'Everyone in the Group has to give an amount of money, about US$ 200,000 a year, into a fund to promote Australian pearls and to educate people who sell them.'

## Typical work schedule for a pearl farm

### *January*
Prepare for wild shell collection, organise dive crews, fishing gear, paper work and licence fees.

### *February*
Fishing for 20,000 wild shells begins, linked to tide patterns. (Note: tides in the area can vary by 10 m per day).

### *March*
Collected shell is 'dumped' on the seabed or site leased by the company and allowed to rest. Maintenance of dumped shells, turning and cleaning them. X-ray shells seeded in previous year checked to see if implanted nuclei have been rejected. Oysters which reject nuclei are usually re-seeded.

### *April*
Water temperature begins to drop as winter approaches; rest period for the shells.

### *May*
Ongoing farm work, turning and cleaning previous two years' seeded oysters kept suspended in wire panels in the water column.

### *June*
Prepare for operating on oysters to implant nuclei. (Note: some technicians may come from overseas, and some companies have boats fitted as mobile laboratories so that seeding can be done on the pearling grounds). Seeding and harvesting begin.

### *July*
Normal operating time for pearls, seeding new oysters, re-seeding those which have rejected nuclei. Oysters which produce acceptable pearls are also re-seeded.

### *August*
Harvest of previous year's seeded shells continues; a two-month turning programme follows operations. The oysters are turned over to encourage production of round pearls.

### *September*
Turning operated shell.

### *October*
Turning, cleaning and change of areas.

### *November*
Transportation of operated shell to grow-out areas.

### *December*
Oysters into longline system. Clean gear.

(Courtesy Maxima Pearls)

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## Pearling — The early history

Pearling began in Western Australia in the 1850s at Shark Bay, where natural pearls were found in the *Pinctada albina* oyster.

When the larger *P. maxima* oyster, which produced superb pearls (called South Sea pearls) and top-quality mother-of-pearl (MOP) shell, was discovered in areas north of Nickol Bay, the industry spread along the north-west coast during the 1880s.

By 1910, nearly 400 luggers and more than 3500 people were fishing for shell in waters around Broome, the biggest pearling centre in the world. The divers were mostly Japanese from the Taiji province. Their diving ritual would often begin by downing a bottle of port, before donning their cumbersome vulcanised canvas suits and massive bronze helmets, after which they would be lowered over the lugger's side to spend hours underwater.

On the bottom they struggled about in lead-weighted boots, often almost horizontal as they peered through inch-thick faceplates into murky waters, frantically scooping oysters into bags because divers were paid by the amount of shell they collected. The early luggers were sail-powered and only catered for one diver's apparatus, but by the 1930s, most vessels were motorised and mechanical air pumps allowed two divers per boat. The death toll in the early industry was horrific, from the 'bends', cyclones and sharks.

Pity the diver on the bottom when his lugger was smashed by one of the four cyclones to catch the pearling fleet at sea between 1908 and 1935. The death toll for these is only approximate but it is known that more than 100 boats and nearly 300 men perished. They are commemorated at the Japanese cemetery in Broome.

As a frontier town full of trading, thieving, racial mixes, booms and busts, Broome has a rich store of legends which make histories of the place good reading. However, around the time of the First World War the price of the MOP shell which sustained the industry plummeted as new plastics were used for buttons, buckles and other shell products.

By 1939 only 73 luggers and 565 people were left in the industry and during the Second World War, pearling virtually stopped. Japanese divers discreetly went home or were interned and Broome was bombed, destroying many of the remaining luggers.

After the war, anyone who had known Broome in its roaring days would hardly have known the place, and a mere 15 boats on average worked the fishery, employing around 200 people.

Little of early days remains—a couple of luggers, a few historic buildings on new sites, rotting jetties, the Japanese cemetery of gracefully calligraphed stones, the modest but absorbing museum, and a few helmets, now valuable artefacts and integral parts of pearl-shop displays.

The advent of cultured pearls pumped the industry up again and a Kuri Bay pearl culture farm, Pearls Proprietary Ltd., was established in 1956 as a three-way venture between Japanese, Australian and American interests.

One of the industry founders, G.S. Streeter, had actually tried culturing pearls in the 1890s by drilling tiny holes in the shell and inserting MOP beads, but such was the alarm about possible effects on the local industry that the State government banned artificial pearl cultivation until 1949. Meanwhile, back in Japan, Mr Mikimoto pursuing his dream of having every woman in the world wearing a pearl necklace, continued to sell shining mountains of cultured pearls internationally while developing culturing techniques and production to a fine art.

## Pearling today

*Less than 100 years ago, commercial pearling in the north-west of Western Australia was a wild, unregulated industry, filled with larger-than-life characters and peppered with high adventure, fabulous wealth and ferocious weather. Massive tides, crocodiles, strong currents and unheralded tropical cyclones made it a tough way to make a living. However all things come to an end, and the introduction of synthetic buttons before the Second World War effectively spelled the end of an era for NW pearling.*

*Technology ended one facet of the industry, but it was also technology and modern scientific practices that opened the door to another, hopefully more enduring, aspect of the business—pearl farming. Cathy Anderson looks at that modern industry through the eyes of some of the major players, and finds that, although there's not so much high excitement, today's industry offers its own rewards to these who get caught by the lure of pearls.*

Today's modern pearling industry, with its high-tech labs, boats and safety-efficient farming regimes, is a fairly young creature. Fierce and dangerous competition has been replaced by an industry which is regulated, professional in its cooperation, safe, efficient and profitable—but not boring.

Bill Reed has been involved in pearling for nearly 40 years, as a marine biologist, pearl farmer and retailer. Much of that time has been spent in Western Australia, although he has worked in the Middle East and the South Seas as well.

During his involvement with the local industry, Bill has seen some dramatic changes. 'When I first came here in the mid-1970s, I couldn't believe how moribund the industry was, it was extraordinary,' he said. 'It was largely indentured labourers, with Malays from Singapore paid AU$ 30–40 a week and locked up in camps like the Foreign Legion. It wasn't until Australian divers came onto the scene that pay rates improved.'

'We weren't allowed echo-sounders on the boats, or automatic pilots, because the crew might learn where the shell beds were and set up in opposition to the boss. We still threw a lead with tallow on it to find the bottom where the shell might be. It was partly through my involvement that we put the first echo-sounder, auto-pilot and radar on a lugger.'

During the 1970s and 80s, there was a shakeout in the industry; demand for pearl seesawed with the value of the yen and dollar and some small farms sold their quotas and facilities to bigger concerns. In 1986, the Fisheries Department commissioned the Pearl Industry Review to set out management guidelines for the industry, establish a legislative process and move toward the upgrading of the antique Pearling Act.

Pearling licences are administered by the Fisheries Department and these days a quota of wild shell is allocated to each licensed company. In 1994–95, 572,000 pearl shells were collected from WA waters. However the tight controls that exist today are relatively recent.

'I was probably partly responsible for having pearl quotas imposed about 15 years ago' said Bill. 'As a biologist I couldn't believe there was no restriction, it was just open slather, as much as could be caught . . . We were totally raping the environment, so we began to keep logbooks and tried to get a picture of what was happening. At that stage you could kill as much shell as you wanted if you had a mother-of-pearl farm and one company killed 100 t of the most beautiful shell.'

Oyster stocks have since recovered to the point where divers no longer need to descend to dangerous depths to find shell and take hours to surface safely. Although the process is much improved from the industry's early days, there is still some danger for divers. A fatal shark attack last year reminded everyone that not all risk can be reduced by human cleverness. The industry is remarkable for its complement of cheerful longtimers, and it now offers a definite career path to newcomers—a vital necessity if the industry is to attract good staff and continue to develop into the future. And, according to Broome Pearls administrator, John Wheadley, pearling is no longer seen as a 'man's game' only.

'Families in Broome have been involved in pearling for perhaps 60 or 80 years and are still here making a living out of it,' John said. 'But it's a growing industry and our employee numbers have gone from 40 to 120 in five years . . . There's a mixture of people on our top farm, which has a permanent crew of about 28 on a rotation basis (two weeks on, one week off). There are some older experienced people, young, new starters, and even some women—we are an equal opportunity employer—involved in the operations which include shell-cleaning, driving boats and so on.'

'We encourage the young ones to get their sea-time up, get their coxswain's certificates so they can drive the boats, and then they might progress to the larger boats or wherever they have talent. Good training makes for a stable long-term industry.'

With pearling getting its act together, activity has exploded in recent years. 'When I first got here five years ago, boats were working about nine months of the year and crews were under contract so they'd go out and fish for shell, seed it, look after it, X-ray it and that would be it,' John said. 'Now they are battling to get holidays and the boats are working 12 months of the year flat out trying to get everything done.'

'The increase is due to the volume of production, handling and tending the shell, and the travel time to pearl farms, which are usually quite a distance away from the grounds. We have two major large vessels operating from Broome, which stay at sea as multi-use vessels—operating rooms, X-raying, transporting and fishing all from the same boats. There is a smaller fishing vessel for Exmouth and an accommodation vessel in Yampi Sound.'

Add to this basic fleet the many little boats which carry cleaning machines and six to eight crew, plying their way up and down the rows of shell panels at the farms, and you begin to understand the size of some these operations.

The Paspaley Pearling company pioneered the development of the purpose-built boats which revolutionised the industry, transporting live shell, allowing seeding at the farms and making life far more comfortable for the many workers. The company differs from other Broome pearlers because its grow-out farms are near Darwin, so shell transport is a critical issue.

Paspaley's Broome manager, Russell Hanigan, said the company had based its first purpose-built vessel on a tuna boat. 'In 1974, Nick Paspaley (Jnr, following his father into the industry) went to Japan and built *Paspaley 1*, the first fibreglass state-of-the-art fishing vessel that went away from a lugger design,' Russel said. 'It was based on a tuna boat but was still a radical design and our competitors used to call it 'the gumboot' because it was plastic, but it was the biggest fibreglass boat in the southern hemisphere at the time.' The company now has seven boats in its fleet and every new *Paspaley* is state-of-the-art.

Most of the basic techniques for pearl growing are established, but research and development continue, either within company laboratories, funded by the Pearl Producer's Association (PPA), or at the Fisheries Department.

'In the 1970s, we all suffered problems with shell mortality,' said Russel Hanigan. 'It was thought to be disease, and shells died during all stages through the process—in the holding tanks during transport and at the pearl farm. We were losing 50 per cent of the oysters and sometimes more and of course the industry couldn't sustain that, so a lot of the smaller operators suffered badly.

'We tried different ways of getting the shell to Darwin and one winter we even hired an F-28 (Fokker jet) and took the shells to Darwin sitting on the seats! We found out that the reason oysters were dying was that there was a bacteria build-up in the shell due to being kept in the tanks too long without filtering, so a combination of antiseptic conditions, making sure everything is scrupulously clean when handling and fishing the pearl shell, and not keeping them in tanks too long, fixed the problem.'

'Now we fish them, then dump them back on the bottom and don't give the bacteria a chance to build up. It's a very staccato process.'

Fisheries Department research concentrates on continuous monitoring of the oyster stocks (using logbooks kept by fishers, as well as surveys), but a recent survey by Dr Lindsay Joll of the efficiency of pearl divers concluded that the human diver, equipped as he is now, is working at maximum efficiency.

'As far as new technology goes, it goes hand in hand with improved methods of pearl farming, though you can't go far off the beaten track as to how you get your shell, treat your shell, seed it, look after it and harvest,' John Wheadley said. 'We have an R & D section in Fremantle, and release a lot of information through the PPA, and this is where the organisation helps all its members by sharing information.'

Today, the Pearl Producers' Association (PPA) represents all 16 pearling companies in negotiations with bodies such as the Fisheries and Immigration Departments and local authorities.

While the two biggest players are Paspaley Pearls and Broome Pearls (the Kailis group), smaller producers benefit from the facilities, research and negotiations of the large companies through membership of the PPA. The PPA is currently investing in the aquaculture park planned for Broome, which will involve hatchery facilities and research.

'It was very difficult in the early days, when quotas were imposed, because everyone was sitting down together and licking their wounds,' said Russell Hanigan, who is also the current chairman of the PPA. 'We had to work very carefully through that because they divided pearling into zones and some people were allowed to fish in different zones and that meant you needed either an A or B Class licence, but those problems are being solved.'

The production of hatchery spat (baby oysters) will present the next challenge for the industry. There is considerable debate about whether there should be quotas—at present each company is licensed to use 20,000 spat.

'In this industry you are pitted against other pearl farmers, but we co-operate in the management of the natural resources and everything else,' John Wheadley said. 'It's up to each company to get the best out of that and sell its product on the market, but we all love the highest price and that's what it comes down to, the profits.'

Bill Reed believes the production of South Sea pearls will treble over the next 10, certainly 20 years and that there shouldn't be hatchery quotas. 'There's certainly no way you are going to limit production in every country in the world where *Pinctada maxima* occurs, no way,' he said.

The oyster is found in such places as French Polynesia, the Cook Islands, and Indonesia. 'The question is, will that result in a reduction of prices? Probably a bit, but that takes pearls into another income level able to buy them,' Bill continued.

'I think we'll only have big hatchery production for about ten years, because with less predation, stocks will build up in the wild. Then it will be easier and more economical to collect wild shell instead of breeding them, and round it goes. Some producers may fall by the wayside, but generally our knowledge of the industry and pearl-growing and our expertise is very good, good enough to sustain us.'

**Source :** '... a king's ransom', 'The creation of a pearl', 'Pearling – The early history' and 'Pearling today', series of articles in *Western Fisheries*, Autumn 1996, 36–48.

# The Indonesian industry: increased co-operation

*While pearl farming on a commercial scale began in Indonesia in the 1970s, details on the industry are few, mainly because of a lack of organisation on a national scale and most producers preferring to keep a low profile.*

*To rectify this situation, increase cooperation among producers in Indonesia and help them sell directly to overseas buyers, the Indonesian Pearl Culture Association was formed in Jakarta in 1995. In this report, President of the association, Nani Soedarsono, and members of the trade and government spoke to* Jewellery News Asia *about developments in the pearl industry in Indonesia.*

'With better organisation within the trade in Indonesia, we now have responsibility for some functions of the government in the industry, such as marketing and regulation,' said Mrs Soedarsono. 'The association plans to hold auctions of South Sea pearls in Indonesia and increase direct sales between the pearl farmers and overseas buyers; publish information on the pearl industry in Indonesia; and establish branches and chapters of the association in the provinces.'

'We plan to exhibit in trade fairs overseas to promote the industry as this will have more impact than companies exhibiting individually.'

'Thirty-eight companies are members of the association,' Mrs Soedarsono said. 'Those eligible to join are

pearl producers and companies in related industries, such as pearl jewellery manufacturers and cosmetic and pharmaceutical companies which use by-products of oysters. A convention will be held every five years to elect the president and office bearers.'

## Fifty-eight licensed producers

'The total number of pearl producers issued licences by the Government of Indonesia to culture South Sea pearls increased by 87 per cent to 58 in 1995 from 31 in 1991,' Mrs Soedarsono said. Of the 58 companies, 21 are joint ventures with overseas companies; 21 with investment from Indonesia; and 16, private companies.

'Most farms are in Maluku, or Moluccas, west Nusa Tenggara, east Nusa Tenggara, central, south-east, south-west and north Sulawesi, and East Timor and some in Lampung, Bali and Java,' she said. 'Around 25 companies are active pearl producers and the average output of a company is 40 kg a year.'

Director-general of fisheries at the Ministry of Agriculture in Jakarta, Muchtar Abdullah, said joint ventures are with companies in Japan as well as one in Australia. 'The government is encouraging investment in pearl farming in eastern Indonesia. Licences are issued to companies with financial resources, suitable areas for cultivation and the technology to produce good quality,' Mr Abdullah said.

Mrs Soedarsono said South Sea pearls from Indonesia are from 10 mm to 13 mm, with good lustre, and are harvested in April and September each year. 'Most South Sea pearls from Indonesia are usually not processed or bleached.'

President of Kogen Trading Co Ltd in Tokyo, Japan and president of PT Kendari Mutiara Indonesia in Jakarta, which owns five farms in Indonesia, Shuho Osawa, said oysters used for production in the company's farms in Indonesia are gold-lipped, resulting in more pearls with a cream colour and fewer whites. Sizes are below 13 mm and most are 9 mm.

'Thirty per cent of oysters are estimated to be natural and 70 per cent cultured,' he said. 'The abnormal weather conditions that began in 1991 killed many workers and oysters. Output is not expected to increase for the next three years.' (See *Jewellery News Asia*, January 1995, page 86).

The industry in Indonesia was severely affected by an earthquake and tidal waves in December 1991 which resulted in decreased production in the following years.

Mrs Soedarsono said another problem facing the industry is dependence on wild stocks of oysters and lack of breeding programmes; this would lead to decrease in production and fluctuation of prices if there was a shortage of wild stock.

'There is a lack of hatcheries and not many companies breed oysters.' Survival of oysters depends on the quality of the water and plankton in the area, she said.

## Sales mainly to Japan

Indonesia's pearl exports in 1994 increased in value by 19.1 per cent to US$ 20.88 million from US$ 17.52 million in 1993 and increased in weight by 466.4 per cent to 103,495 kg from 18,270 kg, statistics from the Central Bureau of Statistics in Jakarta show. In 1994, the largest importing country was Japan, second, Hong Kong, and third Singapore.

Mrs Soedarsono said price per gram is set by the Government of Indonesia at US$ 40. Mr Osawa said Japanese companies used to control operations, production and distribution and all pearls were exported to Japan where they were distributed or re-exported.

In the past few years, operations with Indonesian capital have increased, he said. 'Buyers from Taiwan, South Korea, Japan, Brazil, Italy and other countries in Europe purchase directly from these operations or through bidding.'

**Indonesia's export of pearls, 1993 and 1994**

| Category | 1993 | | 1994 | | Per cent trend | |
|---|---|---|---|---|---|---|
| | Value (US$) | Weight (kg) | Value (US$) | Weight (kg) | Value (US$) | Weight (kg) |
| Natural pearls | 2,633,645 | 972 | 3,325,649 | 218 | +26.2 | –77.5 |
| Unworked cultured pearls | 12,736,033 | 17,076 | 14,896,497 | 99,197 | +16.9 | +480.9 |
| Worked cultured pearls | 2,151,798 | 222 | 2,660,602 | 4,080 | +23.6 | +1,737.8 |
| **Total** | 17,521,476 | 18,270 | 20,882,748 | 103,495 | +19,1 | +466.4 |

### Pearl auctions in Indonesia

Auctions of South Sea pearls in Indonesia may help increase direct sales to buyers and raise prices for pearls, Mrs Soedarsono said. 'For these reasons, the association is planning to hold an auction with companies participating from all over Indonesia,' she said. 'Auctions of pearls have been held in Jakarta by a private company and the price per pearl at auctions has gone up to US$ 100 per gram.'

**Source:** 'How new trade goup plans to develop South Sea pearl industry'. Article in *Jewellery News Asia*, February 1996. 52–54.

# New Zealand company produces abalone mabes

A producer in New Zealand, Empress Abalone Ltd in Christchurch, has cultivated an abalone native to New Zealand and harvested 1,000 mabe pearls. 'Pearls are large with good lustre and colour-play from greenish-pink to magenta and greenish-blue to deep sky-blue,' Liz McKenzie, partner in the company, said.

'Abalone cultivated were *Haliotis iris* and of the 4,000 operated on, only 25 per cent produced pearls . . . We are trying to produce 4,000 pearls in the next crop, mainly because of an increase in abalone and improved production technique . . . Empress Abalone has breeding tanks in the George Knox Research Laboratory in the University of Canterbury in Kaikoura and on-shore facilities in Stewart Island in New Zealand,' Michael McKenzie, partner in the company, said.

**Source:** 'Success with abalone mabes'. Article in *Jewellery News Asia*, February 1996, p. 54.

# A review of investment opportunities in pearl farming

*by Richard Fassler* [1]

### Introduction

Although the raising of pearls is a billion-dollar-a-year business, and one of the world's largest aquaculture activities, until recently, opportunities to invest in pearl farming were extremely limited. If you weren't Japanese, Australian or French Polynesian, you had little chance of getting involved in this industry.

This is because, from the early days of this century, the Japanese have dominated every facet of pearl farming, with the Australians joining their ranks in the 1950s (with Japanese assistance) and the French Polynesians coming in a decade later (again, with Japanese assistance). From time to time, a new member would apply for membership in the exclusive pearl club, but the cost of membership was most often the forfeiture of control over the operation to the Japanese who not only supplied the technology, but the personnel and the equipment as well. And when it came to marketing the product, it was often the Japanese who were the only buyers.

The pearl world was basically divided into three oysters: the Japanese and Indians farmed their Akoya (*Pinctada fucata*) for pearls in the 4 mm to 8 mm range; the Australians concentrated on the species native to their country, *Pinctada maxima*, the gold-lipped oyster, which produced the large (12 mm to 18 mm) gold, white or silver pearls; and the French Polynesians cultured *Pinctada margaritifera*, which occurred in abundance in the Tuamotu archipelago, and produced black, grey or greenish pearls in the 10 mm to 14 mm range.

### The positive side

This situation changed dramatically in the early 1990s with the explosion onto the scene of Chinese

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freshwater pearl farming. The Chinese have an abundance of lakes and rivers, inexpensive labour, a perfect climate and a sufficient supply of freshwater mussels to produce pearls by the tonne.

The effect was to force the Japanese out into the world in search of opportunities to sell their considerable technical and marketing skills. Thus, 'joint venture' is now the word of the day in pearl farming, as the Japanese are teaming up with Indonesians, Thais, Filipinos, Vietnamese and others.

Most fortunately for the potential pearl investor, the Japanese no longer hold a monopoly on technical skills. The key to Japan's monopoly on technology was the grafter, the one indispensable person on the farm—the technician who held in his stainless steel instruments the success or failure of the venture. Tied to that technician were agreements on equipment and nuclei purchase, and often marketing contracts—with Japanese, of course. Today, however, there are Australian, Tahitian, Indian and even American grafters at work throughout the world.

An additional positive factor has been advances in hatchery technology, which have made possible to start a farm in a location with a depleted oyster resource. If the proper biological conditions exist, then a hatchery—located on-site or even thousands of miles away—can provide a supply of oysters for producing pearls. Indonesia, for example, which lacks a significant oyster resource, has, nevertheless, emerged as a major pearl producer.

The Chinese onslaught has had another important effect on industry. Their rock-bottom price 'has driven Japan to all but abandon domestic production of 4, 5 and 6 mm pearls'. The lady who purchased a fine strand of saltwater, medium-sized, Mikimoto pearls in the 1970s for more than a thousand dollars can now purchase a freshwater necklace of comparable quality from China for less than $ 200.

With the Chinese 'crisis' has come the realisation on the part of the Japanese (and the Australians and French Polynesians) that 1) large-pearl farming is the only option remaining; and 2) happily, the technology for the raising of one pearl oyster is generally transferable to the raising of another. Thus, Akoya skills can be used to raise *maxima* and *margaritifera*, or *margaritifera* skills can be used to raise *maxima*. A grafter used to operating on *fucata* can make the transition to *maxima* or *margaritifera* without much difficulty.

There is a significant exception to this large-pearl scenario: the many countries that are concentrating on their own unique product for a 'niche' market—Indian freshwater pearls or Mexican mabes, for example. To choose another example close to home, Hawaii's tourist industry, with six million visitors a year, presents an enormous marketing opportunity for a locally produced black pearl utilising the native *margaritifera* species. A final example would be the development of conch pearls, or Mexican mabes or abalone pearls, to sell to passengers on cruise ships in the Caribbean.

## The negative side

Weighed against the numerous opportunities that now exist to get started in pearls is the fact that, in most places, the industry remains a highly expensive and risky proposition.

### *Consider this:*

**1.** ***Pearls still take a long time to produce***—without a cent of revenue coming in. With a natural source of oysters nearby, the time involved could be two or three years. With hatchery-supplied oysters, the time span could equal four years, or more.

**2.** ***The expense is considerable.*** Certainly, 'mom and pop' farms, requiring a few thousand dollars, or possibly less, can still be found throughout the Pacific. But pearl farming remains a 'rich man's'—or 'rich company's'—game. Labour in Southeast Asia is in the 'dollar-a-day' category, but there is often pressure by local governments to hire many more workers than the farm needs. Grafters come from many nations now, but the best are still costly—so costly, in fact, that they often take a share of the crop in addition to a salary. And Japan still has the most talented technicians. Because of security and a desire to find the most optimum sites, farm locations are still remote, requiring considerable transportation expense. Finally, the cost of setting up a hatchery is high. If no hatchery is needed, the cost of purchasing oysters can be great. In the Philippines or Thailand, for example, a single mother *maxima* may run at $ 6.00 to $ 11.50.

**3.** ***The supply of nuclei is uncertain.*** American mussels provided a source of nuclei for the vast majority of the world's cultured pearls. Now, an alarming environmental crisis exists: exploding populations of exotic zebra mussels are smothering the native molluscs. Some species are close to extinction; others are threatened. Pearl farmers throughout the world are considering substitutes, but, to date, none has equalled the performance of the American product. A decrease in supply could lead to higher prices or pearls of lesser quality, if the substitutes prove inadequate.

**4.** ***Storms can be disastrous.*** While South-east Asia and part of the South Pacific are opening up to pearl culture, typhoons that can destroy a farm in a day tend to prowl the optimum areas. A well-

protected location, outside regular 'typhoon alleys', is a must.

**5. *Security concerns are high.*** Theft, by employees or others, is always a possibility. In some areas of South-east Asia, government protection is minimal or non existent. The prime oyster-buying area of the Philippines—the Sulu Sea—is considered 'lawless' territory, notorious for pirate activity.

**6. *Disease and predators are a possibility.*** As with any aquaculture venture, there is the possibility of the oysters contracting a disease. Placing the oysters well off the ocean bottom in an area of strong current will prevent this problem. To control predation, the oyster shells must be cleaned on a regular basis.

## Starting or investing in a pearl farm

As we have seen, a great deal of caution needs to be exercised in starting, or investing in, a pearl venture. Before taking a country-by-country look, here's a list of the most important factors to keep in mind:

### *1. Which pearl?*

With the exception of pearls for local niche markets, you will most likely choose *Pinctada maxima*, *Pinctada margaritifera* and *Pinctada fucata*. *Maxima* is concentrated in Southeast Asia and Australia. *Margaritifera* is grown in French Polynesia, the Cook Islands and Micronesia. *Fucata* occurs in the Gulf of Mannar and the Gulf of Kutch in India. There are *maxima* with white mantles (lips) which produce pearls. If you would like to raise golden pearls, which are currently in high demand, you will need to know the location of the *maxima* that will produce this product. Reportedly the Philippines, Papua New Guinea and Myanmar have numerous 'gold-lip' oysters, while Australia, Indonesia and Thailand tend to have the silver-lip variety. *Fucata* produces a smaller, 4 mm to 8 mm, silver pearl.

### *2. Biological characteristics of site*

Important considerations would include: cleanliness of the water, amount of nutrients; water depth; salinity; nature of the seabottom; water flow and temperature. Sheltered areas with calm waters of sufficient depth are best for pearl farming.

### *3. Access to site*

For security concerns, a remote location may be best, but a site that requires many days travel by airplane and boat may end up with considerable transportation expenses.

### *4. Oyster supply*

Ideally, there will be an abundant oyster resource within a day's journey from the farm. If this is not the case, but all the biological characteristics of the site are exceptional, then a hatchery should be considered. A combination hatchery–wild resource could work well. For *margaritifera*, there should be a sufficient supply of mother oysters so that the oyster spat can be collected.

### *5. Government support*

How eager is the government to see you get started, and how much support are is it willing to provide? Is the government a facilitator, with extension capabilities that can help you out with a problem, or is it a burden, with officials who need to be 'taken care of' to stay out of the way? Does government have an active and effective research programme, with capable facilities, or does it leave this to the private sector?

### *6. Business structure*

How much of the venture can you own? Will you be forced to team up with a 'silent partner' who will take 51 per cent and contribute nothing to the business, or are there local enterprises that could play a valuable role in your achieving profitability?

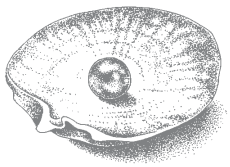
### *7. The market*

While the immediate market for large pearls is strong, the sudden increase in farm start-ups in the Pacific (particularly in Indonesia) should cause some concern for the situation in a decade or so.

## The search is on

The vast ocean areas of Southeast Asia and the South Pacific have been turned into hunting grounds for Japanese, Australian and Tahitian companies seeking new areas for pearl farming, with opportunities for the owners of these waters—and others—to get into the business. We have even heard of a large Chinese pearl farming company looking for a suitable site.

**Source:** 'Opportunities for investing in pearl farming' transcript of a paper presented by Richard Fassler at INFOFISH AQUATECH '96, Kuala Lumpur, Malaysia, 25–28 September 1996.



# The great debate: the cultured pearl polemic

Science and business came face to face when cultured pearls first entered the international market.

From 1920 to 1935, Paris—the world capital of pearl trading at that time—witnessed an intense polemic between those who defended the legitimacy of cultured pearls and those who thought they could not be compared in quality and value to the natural gem. This controversy involved a great number of jewellers, traders, scientists, journalists and men of law. It also attracted the attention of consumers and owners of pearls, who feared the value of their investment might be diminished.

Two groups, the proponents and opponents of the cultured pearl movement, each moved by combined commercial and scientific interests, confronted each other around a central question: whether the valuable natural-pearl sector would suffer if cultured pearls were recognised as gems.

## Proponents

Kokishi Mikimoto, who had succeeded in producing round pearls on a commercial scale through the successful application of the Mise / Nishikawa method, was the leader of this group. In 1899 he had opened a shop in Tokyo to sell his half-pearls and had proudly exhibited them at international fairs, but he only began promoting them internationally in the early 1920s.

The first years were contentious, as the great jewellers of the world were reluctant to accept cultured pearls as gems. To fight the nay-sayers, Mikimoto supplemented the promotion of his products by widely describing the scientific method used in culturing pearls. At museums and international fairs, he outlined his principles, demonstrating the similarities between cultured and natural pearls.

The first to be persuaded were members of the scientific community, where the topic had been researched for centuries. Their participation in the polemic, that began when the first spherical cultured pearls appeared on the Parisian market, was important, as their expert opinion was requested to mediate in civil and judicial debates. The commercial and scientific realms intertwined in subsequent exchanges between Lucien Pohl, Mikimoto's commercial representative in Paris, and the most important jewellers and pearl traders represented by the *Chambre Syndicale des Négociants en Diamants, Perles et Pierres Précieuses et des Lapidaires* (Syndicate of Traders in Diamonds, Pearls and Precious Stones, and Stone-cutters).

The scientist who most actively defended the legitimacy of cultured pearls was Professor Louis Boutan. In books and papers he explained how, from the chemical and biological point of view, both kinds of pearls could be considered equivalent. He argued that human intervention in no way devalued cultured pearls, since their worth derives from the external qualities of the gem.

Far from placating the Pohl–*Chambre Syndicale* with their scientific arguments, the scientists raised the tone of accusations, and became an element of the debate. Traders themselves argued against the scientists, urging them to let scientific truth prevail over commercial or other kinds of interests. Faced with foolishness and false arguments, the impartial tone of science began to yield to emotional responses.

Pohl's motives were not as pure. As Mikimoto's commercial representative in Paris, it was his role to promote the acceptance of cultured pearls in the wholesale and retail markets. This quest often led him to the courts of law, sometimes as plaintiff, sometimes as defendant. On several occasions, Pohl brought lawsuits against the *Chambre Syndicale* and its presidents for obstructing the importation of Japanese cultured pearls and for employing derogatory terms when referring to them. He also demanded compensation from journalists who began a propaganda campaign against cultured pearls. As a defendant, Pohl was accused of selling cultured pearls without specifying that they were cultured.

Pohl argued, with scientific support, that cultured pearls were as much gems as natural pearls, but to jewellers and traders it was unthinkable that cultured pearls should receive the same price as natural pearls (called 'gem pearls'). Thus one of the major concerns in the international pearl trade was that the origin of cultured pearls be clearly stated in any sale.

Pohl was further motivated in his promotion of cultured pearls by a desire to convince the French authorities of the potential for pearl culture in the colonial territories of Oceania. He wrote to colonial governors, scientists and ministers, and lectured on the subject in public forums thereby gaining the support and good will of a large number of important people. Pohl intended the centre of the cultured pearl trade to stay in Paris, whether the gems were of Javanese or French origin.

## Detractors

In contrast to Pohl's illusory goals, the 'Pearl King' of 'gem pearls' (Leonard Rosenthal) and his colleagues at the *Chambre Syndicale* were well aware that the sale of cultured pearls on the international market represented a commercial threat to their present and future interests.

In the years between both world wars, Paris—a metropolis that was home to rich exiles and great fortunes—was the centre of the market in luxury and decorative goods. This employed a great many people and let the great Parisian pearl traders control prices and quality. They bought pearls directly from the production centres and sometimes financed pearl-fishing fleets. The two companies headed by Bienenfeld and Rosenthal were the most important, although Paris also housed important Indian and Arab pearl traders.

The emergence of Paris as the seat of power in the pearl trade was a relatively recent event, since for centuries Bombay had been the centre from which the gems were distributed to London, Paris and Berlin. Indian businessmen ruled the market, directly acquiring pearls in the Gulf of Manaar and the Persian Gulf, where they were known as 'bunnias'. In exchange for financing the pearl-fishing fleets, they kept a third of the catch, but then bought most of the remaining production from fishermen or governments at prices that they themselves set.

The monopoly enjoyed by the Bombay magnates was broken at the beginning of the twentieth century by Leonard Rosenthal, who decided to buy pearls directly at Bahrein. After several years, through shrewdness and perseverance, Rosenthal managed to convince the Arabs to sell him their entire production, and thus brought to Paris pearls of a quality never seen before.

A few years later, Rosenthal himself was financing several pearl fishing fleets and had cornered the market, in the 'bunnia' manner. These events coincided with an increase in the public's spending power in the 1920s, which helped make Paris a competitor to Bombay.

Thus it is no surprise that Rosenthal was the first to oppose Pohl and his cultured pearls, and that he vigorously opposed the inclusion of cultured pearls in the international market. He could see the danger posed by a product whose price or production he could not control and which, because of its origin, might displace the centre of the market.

The latter was no doubt his most convincing argument before his colleagues at the *Chambre Syndicale*, whose fortune and livelihood depended on the Paris luxury trade. For this reason, they started a campaign of disparagement against cultured pearls. Using the press as one of their channels, they called cultured pearls 'shell pellets covered with nacre' and wrote that comparing them with 'gem pearls' was the equivalent of comparing a solid gold jewel with one that was only gold plated.

Fraud was not the only peril; cultured pearls fundamentally threatened the value of the market itself. It was feared that controlled breeding could flood the market, lowering prices and causing serious problems for both culture and fishing. Professors Boutan, Joubin and Jameson deemed this fear unfounded since 'operational costs, as well as the time necessary for the formation of a pearl, allow cultured pearls to acquire a high market value, so that prices in the pearl market were no more threatened than gold or diamonds would be if new mines were discovered.' The most adverse opinions announced the imminent disappearance of private and public fortunes and warned that an object prized since antiquity would lose its spell by becoming common and vulgar.

Speculations on the future were equally uncertain for defenders and detractors in the controversy. However, one real and immediate consequence was that a great number of jewellers, pearl traders and consumers lost confidence and reined in their commercial operations. Pearl demand dropped in favour of diamonds and the struggle of the jewellers' corporation intensified. Producing and consuming countries were asked to ban the import of cultured pearls as well as all culturing experiments, a request that was accepted in Venezuela, for instance. Legal proceedings were also initiated to compel traders and consumers to distinguish by name between the two kinds of pearls. This was achieved in 1931 when French tribunals forbade the use of the term *fine* (i.e. gemlike) when referring to cultured pearls.

Another measure was a recourse to science to demonstrate that it was possible to distinguish between a cultured and natural pearl since they neither had the same quality nor were, indeed, the same product. After several failed attempts to distinguish the two kinds visually, the investigators turned to optical, chemical and physical methods. However, the only truly effective method—to break a pearl in half and examine its nucleus—was overwhelmingly rejected.

With time, the polemic lost its heat. The Great Depression and World War II severely affected both the market and the production of both kinds of pearls. In the 1950s and 60s the standard of life in Western countries improved, and with this came a

renewed demand for pearls. This time, however, there was no antagonism between advocates of the natural and cultured gem; the pearl fisheries had been exhausted and natural pearls had disappeared from the market. Furthermore, pearl cultivation methods had so improved that cultured pearls were accepted by even the most demanding clients. These new conditions of supply and demand won over the scepticism of jewellers, and cultured pearls showed up in the windows of Tiffany's, Cartier, and Chaumet. Ultimately, Mikimoto became the new 'Pearl King' and Japan became the centre of the international pearl market.

**Source:** 'The cultured pearl polemic' by Micheline Cariño, *World Aquaculture* 27(1). March 1996. 42–44.

# Pearly shells

*by Beatrice L. Burch*

*Beatrice Burch, from the Bishop Museum, has published a series of articles in the* Hawaiian Shell News *on pearl oysters. Excerpts of the first four articles were published in the* SPC Pearl Oyster Bulletin #9*; we continue here with excerpts from the following three articles. See also Beatrice's contribution in the Abstracts Section, page 65.*

## Part 5. Transport by man of commercial pearl shells and their hitch-hikers

Pearl oysters and nacreous gastropods occur in commercial numbers abundantly in the Pacific and Atlantic tropical and subtropical regions. Since the last century, people have transported these species to areas where they did not occur naturally. Unfortunately, these transfers may have resulted in a spread of parasites and predators associated with these shellfish. It is only now that awareness and acceptance of the problems of 'hitch-hikers' have been addressed for these commercially significant species.

The South Pacific Commission, headquartered in Noumea, New Caledonia, has begun to examine this problem in the Pacific Islands, beginning with a study of the background of co-distribution of commercial invertebrates and marine algae. Pearl oysters, mussels, trochids and turbans are most important, but abalone are also included in the nacreous species being studied. Of course, non-nacreous bivalves, gastropods, and fish are also included in this study (Eldredge, 1994).

The Inshore Fisheries Research Project of the South Pacific Commission and the South Pacific Regional Environment Programme have collaborated in an attempt to address this vital study for the South Pacific area, beginning with viable, safe mariculture practices (Eldredge, 1994).

According to Gervis and Sims (1992) four species of the pearl oyster family (Pteriidae) in the Pacific have been transported for mother-of-pearl as well as for pearls. *Pinctada margaritifera* (Linnaeus, 1758) occurs from the Hawaiian Archipelago, throughout south-east Polynesia, to the Red Sea and the Persian Gulf. *Pinctada maxima* (Jameson, 1901) ranges from Australia to the Indo-Malayan region, from Burma east to the Solomon Islands, and northward to southern Japan and the Philippines. *P. fucata martensi* (Dunker, 1872) occurs naturally in Japan, while *P. fucata* Gould, 1857 occurs naturally in the Persian Gulf and Gulf of Manaar. *Pteria penguin* (currently known as *Magnavicula penguin* (Röding, 1798)) occurs naturally throughout the Eastern Indo-Pacific to Japan and Thailand.

The charts of Pteriidae (see Figure 1 on next page) and *Trochus* show the sites of repeated human attempts to establish new populations. The arrows, however, indicate only one of what may have been repeated introductions.

Eldredge (1994) includes also tropical Pacific nacreous gastropods such as the topshell, *Trochus niloticus* Linnaeus 1767 (family Trochidae) as occurring naturally from the Andaman Islands, Indian Ocean, to an amazingly spotty distribution in the Western Pacific. By the end of 1992, the Food and Agriculture Organization and the United Nations Development Programme had begun a successful Pan-Pacific transplant programme of more than a dozen plantings of nearly 16,000 seedlings and adult specimens transported to Tokelau, Tuvalu, the Cook Islands, Tonga and Niue. An early introduction to Hawaii was apparently unsuccessful (Eldredge, 1994).

The green snail (*Turbo marmoratus* Linnaeus, 1758) in the family Turbinidae, is another large nacreous gastropod transported to new sites where it was not formerly found. The green snail naturally lives on

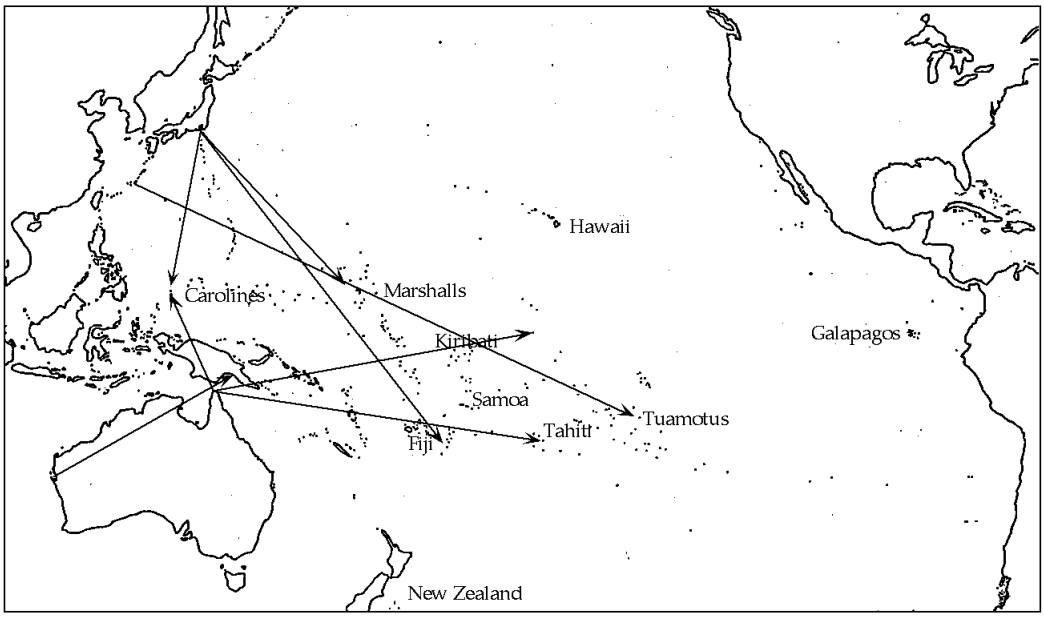



**Figure 1**

**Generalised map of pearl oyster transfers among the Pacific Islands, all species included; each direction of transfer is indicated only once, although numerous transfers may have occured in that direction. (From Eldredge, 1994)**

continental high islands such as Papua New Guinea, Solomon Islands and Vanuatu (but not New Caledonia) (Eldredge, 1994).

As with other molluscs, little is known about their tropical and semi-tropical parasites and predators. In each case, while specimens were transported with surface-cleaned shells, no attempt was made to determine whether or not shell borers, internal parasites, commensals, or predators were included with any of the plantings, even though the formation of pearls had been attributed to the presence of trematode adults and larvae by Herdman (1903a, 1903b, 1904) in the pearl fisheries of Ceylon.

Later workers on shellfish parasites have published voluminously on temperate marine predators, parasites and commensals as compiled by Cheng (1967). Mytilids, for example, contained as many as 22 species of sporozoans, ciliate protozoa worms (such as trematodes, nematodes and cestodes in juvenile stages or as adults) as parasites, copepods (small shrimp-like crustaceans) living as commensals, and crabs which were predators.

Adults of many of the cestode and trematode worms were found living in fishes associated with the nacreous molluscan species. There is a good probability that tropical fish species are the final host for many of the tropical species of parasites of nacreous bivalves and gastropods.

Many of the fish, bivalves, and gastropods are used for food by man. Undoubtedly more tropical parasites will be found in scattered literature by workers subsequent to the compilation by Cheng (1967).

The knowledge of parasites in marine animals is not new, since the role of molluscs as hosts for animal parasites has been known since 1737 when Swammerdam found the larval stage of trematodes in a snail (Cheng, 1967). Thus precautions are vital to avoid transporting pests to contaminate new areas and their already existing fauna.

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**Source:** *Hawaiian Shell News*, July 1995. 3–6.

## Part 6. North American freshwater bivalve biology, threats and dangers—no fish, no mussels

There are, according to Williams et al. (1992), 297 species and subspecies of freshwater unionid bivalves in North America north of Rio Grande River. This is about twice as many species as are found in the rest of the fresh waters of the world. These mussels are biological filters, indicators of water quality, serve as food for wildlife, and form the basis of a US$ 50,000,000 pearl mussel industry (Anon. 1994). These bivalves are commonly known as freshwater mussels, but they are neither mussels nor oysters. Geologically, they have been found abundantly all over the world since the Cretaceous. They form the super-family Unionacea (Burch, 1995).

Native freshwater pearl mussels of North America are dependent upon fish. The mussel's larval stage, known as a glochidium, is parasitic on fish gills or fins for 10 to 30 days. The glochidia metamorphose on the fish and fall to the river bottom, where they grow into free-living mussels (Lefevre & Curtis, 1912).

Reproduction of the Unionacea requires abundant fish hosts in order for the life cycle to be completed. While attached on migratory river fish, the mussels may be transported as much as 1000 miles before they drop off to begin a population in a new locale. In some species the male and female shells are different. Some species are known to live up to 80 years. If there are no fish for the larval mussel to utilise, then the adult parent mussel, although producing many larvae, will be 'terminal', living and dying with no succeeding generations. Watters (1994a, b) described the biology of these mussels more completely.

Currently, most species of freshwater mussels are increasingly stressed by business and farming pollution in their rivers and lakes. Neves and Williams (1994) studied 197 species and sub-species of freshwater mussels in the United States and reported that only 24 per cent were in stable condition. The rest were endangered (21%), threatened (14%), 'special cases' (24%), presumed extinct (7%), or were of undetermined status.

Also, they are being threatened further by introduced foreign species of bivalves. The Asian clam *Corbicula fluminea* (Müller, 1774) from the Columbia River in Washington State was first brought to scientific attention by Tom and his father, John Q. Burch (Burch, 1944, Hanna, 1966). The *Corbicul*a slowly dispersed through canals and rivers and 50 years after the initial report in Washington State, they reached the eastern seaboard rivers.

*Corbicula* utilise the food of the native freshwater mussels and larval fishes, grow and reproduce at a very rapid rate, and clog their environment with shell and sediment. Since the 1950s, industries and agencies have been involved constantly in emptying and cleaning irrigation canals (Eng, 1975), hydroelectric plant pipes, and industrial rivershore facilities due to the immense amount of *Corbicula* shells and sediment. Morton (1977) summarised the extent of their devastation in North America in his Preface to the First International Corbicula Conference.

An even more alarming danger to native mussels is the exotic freshwater zebra and quagga mussels, in the family Dreissenidae (superfamily Dreissenacea) (Ross, 1994). Larvae and / or adults were apparently introduced by cargo-ship into the Great Lakes from the St Lawrence River about 1983–1984. They have now spread throughout the Great Lakes and Mississippi watershed to the southern borders of the United States.

There are two species, *Dreissena polymorpha* Pallas, 1766, known as the zebra mussel, and *Dreissena bugensis* Andrusov, 1897, known as the quagga mussel (Carlton, 1995). There is, however, some doubt on the taxonomy of the latter species.

Neves (1994) reported that *Dreissena* were first seen in the Illinois River in 1991 and that by the summer of 1994 most of the native mussels were encrusted by zebra mussels preventing the native mussels from opening their valves sufficiently to feed. Neves predicts that, if something is not done soon, by the year 2000 all North American native mussels will be dead as the river bottoms are being carpeted by these invaders.

The life history of the zebra mussel in the USA has been studied by scientists from universities and federal agencies. *Dreissena polymorpha* is sexually mature when it is only 8–10 mm, although it reaches 50 mm at two years. Each individual is then able to produce 1,000,000 eggs per year. Free-living larvae are formed, which are carried by currents, or in the bait wells of small weekend boats to small streams, or by barges on larger navigable rivers.

Their byssal attachment to hard surfaces such as river debris and benthic bivalves and their enormous quantities have proved devastating to native freshwater molluscs, industry, hydroelectric plants and canals (Stolzenburg, 1992; Ross, 1994). Additionally they threaten the native fauna by consuming the same sizes of food as small fishes and native freshwater mussels.

While early in the last century freshwater-seed-pearl jewellery was popular, Lefevre & Curtis (1912) cited that from 1893 to 1910 use of native commercial-sized freshwater bivalves for the shell to produce mother-of-pearl buttons seriously affected many species.

The advent of plastic buttons in the 1920s and 1930s granted a reprieve to the exhausted populations of native mussels. By World War II, plastic buttons were common in America and little use was made of the native mussels, except locally by fishermen.

After World War II, a new industry was created using North American pearl mussel shell for beads to serve as nuclei for marine cultured pearls in Japan, Australia and Tahiti. Very recently pearl industries have been established in small Pacific Islands that also use US pearl mussel-shell nuclei for their cultured marine pearls (Lawson, personal comm., 1994).

As a result of the recent pressure from the zebra and quagga mussels on native North American freshwater mussels, private organisations such as The Nature Conservancy and the Isaac Walton League have begun 'people-to-people' programmes and are working to alert the general public of the danger presented by these invaders to the biodiversity and health of the rivers.

Scientists of state and federal agencies are also studying the life histories of host fishes—local and exotic—as well as zebra mussels and of tolerances of habitat conditions and sensitivities (Anon., 1994).

Even though industry and federal protective measures are working to slow and eliminate damage by zebra mussels, it may well be too late for this vital link in the life of healthy rivers and lakes in North America (Williams, 1994).

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**Source:** *Hawaiian Shell News*, July 1995. 4–5.

## Part 7. Pearling family in North America—Foragers, farmers, wholesale jewellers

After World War II, John Latendresse of Nashville, Tennessee began a post-war life by foraging along the eastern USA while purchasing available freshwater natural pearls. Realising that the supply was fast diminishing in the increasingly stressed rivers of the United States, he began in 1954 to farm river pearl mussels in a man-made Tennessee Valley Authority Lake near Lexington, Tennessee. Then in 1963, he began a lucrative pearl mussel nuclei industry with the help of his wife who learned Japanese methods of culturing pearls in the Japanese marine Akoya pearl oyster. After initially use of Japanese partnership and technicians from Japan, the Japanese were bought out and nimble-fingered young girls and women from Tennessee learned rapidly to do the precise methods of nuclei implantation in the Tennessee native pearl mussel. Thus was created the 'all-American pearl'.

The American Pearl Company can produce spherical pearls, but far more frequently beautiful baroque pearls of different shapes such as bars, marquise, navettes, tear drops, coin and the half pearl grown on the shell, called Domé, are also received well as jewellery. Naturally grown 'turkey-wing' pearls and the lovely enucleated pearls are also grown.

The long years of constant experimentation and care resulted in 1993 in bountiful crops of numerous nucleated, enucleated and natural pearls of bizarre and charming shapes. Now it is possible to implant multiple nuclei in shells, yielding even more pearls per shell. The company uses over 22 species of pearl mussels, each differing in shell thickness and colour. No dye is ever used. The many species of mussels with natural hues of rose, pink, lavender and white produce charming pearls of great beauty and durability.

Dangers and threats are ever present in any farming industry. This water farm is no different. Water acidity must be modified using crushed shell in the waters and fertilizers regularly applied for increase of the food of these filter feeders. Water quality, temperature, current strength and pH are monitored three times daily. Floating rafts of the suspended bivalves growing pearls for three to five years are raised and lowered according to need for optimum growth. This is an industry requiring constant attention.

Now the new dangers and threats of zebra mussels will be added challenges for this North American industry.

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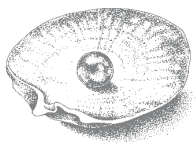

# PEARL MARKETING NEWS:
## PROMOTION, PRICES, PROFITS . . . AND PERILS

# South Sea perils: pearls to dye for ?

The people who gave you too-good-to-be-true black pearls in the 1960s and 70s are back again with beyond-belief white and golden South Sea pearls. But this time the gemological community has been placed on early full alert against these latest doctored beauties coming out of Japan and Hong Kong—thanks largely to the efforts of a dealer who led the fight against ersatz-colour black cultured pearls 20 years ago. He's South Sea pearl specialist Salvador Assael of Assael International, New York.

As soon as customers began raving about the fabulous strands of Australian white and Indonesian golden pearls they were being offered at giveaway prices in Asia earlier this year, instinct prompted him to borrow a few of these underpriced treasures. As he studied some of them, suspicion became conviction. 'I knew something was wrong,' Assael says, 'but I couldn't prove it'.

That's when he turned to the Gemological Institute of America (GIA). 'I told them I would supply them with all the treated pearls they needed if they would make detection of the methods used to enhance their colour a top priority,' Assael continues.

Realising the gravity of this threat to the stability of the global pearl market, GIA moved identification of these new pearl make-overs high on its rather extensive list of research projects, notes Tom Moses, GIA's vice president of Identification Services.

After only a few months on the project, GIA feels it is very near developing precise techniques to differentiate natural from treated golden South Sea pearls. White pearls, however, are another matter. 'The golden pearls, which we believe are transformed from light and medium greenish-yellow to fine golden colours using dyes, are the easier of the two to ferret out,' Moses says. 'The whites, which we believe are improved possibly using a bleaching process or heating, present more difficulty.'

Meanwhile, Assael has been alerting his best customers around the world about the epidemic of doctored pearls. And since the GIA is not yet issuing colour pedigrees for white and golden South Sea pearls in the way it long has for black South Sea pearls, Assael is urging jewellers to buy from trusted suppliers who will stand behind the integrity of their pearls.

### Déjà vu

Assael is no stranger to the threat of undisclosed doctored pearls. Indeed, selling pearls that show only their true colours has been a point of honour with Assael ever since he made colour-integrity guarantees the cornerstone of his historic marketing campaign for Tahitian black pearls in the late 1970s. And as soon as GIA gives the word that its Gem Trade labs will issue such papers for his white and golden pearls, he intends to make these documents the cornerstone of his South Sea pearl sales, too.

But the need for colour pedigrees isn't the only reason that Assael has become so involved with GIA. Just as pressing to him is the need for greater jeweller education about the relatively new product category of South Sea pearls. That's why the South Sea Pearl Consortium, of which Assael is the designated representative to North America, recently gave US$ 600,000 to GIA to write a comprehensive two-month residence course in pearls. 'When you see unsavoury practices in the market, it makes you realise the importance of education,' he says. 'It is the only real deterrent to deception.'

**Source:** 'South Sea Perils' article by David Federman in *Modern Jeweller*, p 16.

# Torrey's tour

*Richard (Bo) Torrey, publisher of* Pearl World – the International Pearling Journal *provided the following update on market movements in an article in* Jewellers' Circular-Keystone *in October 1996.*

South Sea pearls account for 17 per cent of cultured pearl sales worldwide by value but only 1 per cent by unit volume. Experts who track the US market say the average price of a single jewellery purchase is US$ 250, but rarely does a single South Sea jewellery item sell for less than US$ 2,000.

After some pricing and availability instability in the past two years, South Sea peals seem to have stabilised. Here's a look at the situation by country:

- Australia will produce somewhere in the region of 300 kan (an ancient Japanese unit of weight; 1 kan = 1,000 momme) in 1996.

- In Indonesia, wholesale prices should top US$ 200 per gram as the South Sea pearl industry recovers from several years of weather, water and oyster mortality problems. Look for continued improvement and a noticeable impact on the upper end of the Akoya market and the lower end of the white-lip South Sea pearl market within several years. Total 1996 Indonesian production will be about 150 kan, a considerable portion of it of lower quality.

- Philippine South Sea pearls are reported to be in somewhat short supply despite increased cultivation; 1996 production is estimated at 90 kan. Prices are expected to remain stable or even rise because of concerns about deteriorating environmental conditions. However, it's important to note that farmers and producers have used this reasoning before to keep their prices steady despite increased competition.

- Myanmar and Thailand are still bit players in the South Sea pearl game, together producing slightly over 10 kan. This is a regrettable condition because product from Myanmar (formerly Burma) was once the *nec plus ultra* of cultured pearls.

- Tahitian exports have dropped about 22 per cent in dollars-per-gram over the past two years, but have risen 15 per cent in weight. Business is returning to normal for French Polynesian producers as Japanese buyers recover from the disastrous 1995 Kobe earthquake.

- Production and sales of black South Sea pearls in the Cook Islands follow similar trends. Demand over the past year has been firm; prices have been stable. The upcoming increase in production is expected to be absorbed easily and may even boost demand because more (and better) pearls will be available. In the recent Manihiki harvest alone, some 75,000 pearls of saleable quality were expected. In 1997, the harvests in Manihiki and Penrhyn are expected to top 120,000 pearls. Not all of these will appear on the open market, however, because many are committed to existing buyers.

Many South Sea pearls are exported to the US through Japan. The Japanese retain tremendous buying power and a tradition of meticulous matching of South Sea pearls, something the producers themselves can't always duplicate. So any increases or decrease in exports through Japan are a generally good indicator of what's going on in the US. For 1996 (to October), exports of South Sea pearls from Japan rose 76 per cent in weight and 146 per cent in dollar value over the first half of last year.

Accordingly, importers and retailers expected a healthy Christmas 1996 selling season for South Sea pearls.

## Pearl promotion

Several organisations are pursuing the popularity of pearls with promotional campaigns.

The most active is the Japan Pearl Exporters' Association (JPEA), which pumps money into advertising, public relations and promotion efforts in the US via the Cultured Pearl Information Center in New York City.

JPEA tried to assess US importers a voluntary one per cent of the value of their shipments (matched by JPEA funding) to raise promotional funds in 1995. But the effort, the second of its kind in recent history, fell apart because of non-compliance. Funding continues on a reduced level.

Some Australian, Japanese and Hong Kong producers and a major US importer / marketer formed the South Sea Pearl Consortium in 1995. The organisation raised more than US$ 2 million to sponsor global marketing efforts in its first year. In 1996, the group switched to regional marketing,

specifying the US, Japan and Hong Kong as major opportunities. The Australian government and the Western Australia Pearl Producers Association have also helped to fund these efforts. Among the major projects was significant funding to create a course on cultured pearls at the Gemological Institute of America.

Tahitian pearl producers budgeted almost US$ 3 million for promotional efforts in 1996. This includes funding for the Japan Black Pearl Promotion Association and the New York City office of the Tahitian Pearl Association to cover promotion in the US, Canada and South America, plus ancillary funding for activities in Europe, Australia and Asia.

Tiffany & Co., meanwhile, budgeted for its own US$ 1 million promotion of Tahitian black pearls and will advertise them in *Town and Country*, *Women's Wear Daily*, *Architectural Digest* and the *New York Times*. Fortunoff will participate this year also.

The launch of Elizabeth Taylor's Black Pearls perfume in March spurred additional interest in cultured pearls. The promotion spanned four successive CBS sitcoms in one evening (the storyline centred on a very expensive missing black-pearl necklace) and was bolstered by a US$ 12 million advertising budget from the perfume's maker, Elizabeth Arden, along with in-store promotions in department stores such as Macy's, Marshall Field and Dayton.

**Source :** 'Touring the pearl world', by Richard D. Torrey, in *Jewellers' Circular-Keystone*, October 1996, 69–73.

# The politics of pearl grading . . .
## so you thought this was all done objectively?!?

*As Japan plans to end mandatory government inspections, industry factions debate a universal classification system.*

A perfect pearl's considerable value comes partly from its elusiveness, wooing consumers with the romantic prospect of owning an enigma of nature.

Mystery, however, means bad business for some members of the cultured pearl industry. Though most pearl dealers in the world use personalised grading systems, there is no internationally accepted standard to communicate quality between companies and countries. Some in the pearl world want a universal quality-classification system for cultured pearls.

The call came most adamantly at a meeting of the World Cultured Pearl Organisation directors in May in Kobe, Japan. Facing government deregulation and disbanding of their government-operated Pearl Export Inspection Officers in spring 1998, Japanese pearl exporters planned the international forum to discuss possibilities for privatised quality control and promotional funds once the government has given up the responsibility.

Currently, exporters are required to submit their goods to the government office, which applies a grade of 'H' (high quality) or 'L' (low quality) to each pearl. Only the H-quality pearls are eligible for export. At the time the pearls are graded, exporters pay an inspection fee, part of which goes to promote pearls overseas. Once the office is disbanded, exporters will be asked to participate in optional inspections. But some exporters fear too many won't participate, possibly sacrificing quality and hurting the stability of Japanese pearl promotion.

As a result, some delegates at the World Cultured Pearl Organisation meeting pushed for a universal classification system. 'If we don't take charge, somebody else will eventually do it,' says Pierre Akkelian of Gemme Canadienne P.A. in Montreal, Quebec, a WPO director from Canada. 'The world needs a common language. There is no internationally accepted terminology that would be meaningful to you in any way.'

Akkelian and other delegates in favour of the idea met strong opposition. The issue was dismissed without a vote, but it continues to arise throughout the pearl industry. 'There are two camps,' said another WPO delegate from Canada. Those who favour a universal classification system foresee better business relations and more confident customers, he says, while opponents fear complication and commoditisation. Regardless of opinion, some members of the industry believe consumers, especially those who are used to buying cultured pearls with a certificate of quality from Japanese pearl-makers, will eventually demand a grading system that will provide them with confidence in the product.

Convenient, protective and fair: the concept of quality that's not quantified is a problem for many pearl dealers. 'If I get an order from Europe requesting a certain number of A-, B- and C-grade pearls, nobody understands exactly what that means' says Hiroshi Norioka, president of Daiichi Trading Co Ltd in Kobe.

This variance also confuses consumers. Most pearl makers and dealers use their own grading system when communicating quality to their retailer customers. The retailers, in turn, explain quality to consumers using the same system or a vague interpretation. But consumers have no way to compare pearls from one retailer with those from another who uses a different system.

Many people believe an educated customer is a comfortable customer. 'Whatever is good for the consumer is good for the industry,' Akkelian says.

Luigi Di Luca, a WPO delegate with Di Luca Bros in Torre del Greco, Italy, agrees that the more informed consumers are about a product, the more likely they are to buy it. Di Luca and others point out that with pearls now being produced in more countries, a common standard is important to ensure quality worldwide.

'A universal classification system would help to shield the industry from complaints about poor-quality pearls', says Di Luca. 'If the world demand shifts toward quality, sea-cultured pearls (pearls that have a lengthy cultivation period, regardless of shape, colour and size) can never be over-produced'.

*Complicated system*: instituting a universal classification system would be challenging. Most dealers evaluate pearls using at least six factors: lustre, orient, shape, size, colour and nacre thickness. Therefore, it would be hard to divide pearls into neat categories of quality. 'A classification system would be a major undertaking for pearls,' says Avi Raz of A & Z Pearls in Los Angeles, California. 'The challenge is finding a simple system. If it gets very complicated, people won't understand the technicalities.'

**Source:** 'The politics of pearl grading' by Stacey King, *Jewellers' Circular-Keystone*, October 1996, 74–75

# Pearl grading then, now and in the future

Diamonds are often described as a girl's best friend, and perhaps a consumer's as well when it comes to understanding how their value is graded. The general public seems sufficiently educated on the 4 Cs of a diamond—colour, clarity, cut and carat weight. But diamonds are a consistent product category which lends itself to a form of standardised grading. Other gems, like pearls, are a bit more problematic when it comes to establishing a common language to describe value.

'Pearl grading is much more complicated than diamond grading,' explains wholesaler Joseph Nakamura, president of the New York-based Shogun Trading. 'If you want to cover all the factors there are too many combinations, making it impractical.'

One of the reasons why a standard pearl grading system does not exist is the difference in opinions on the influence each factor has on value, notes Richard Drucker, editor/publisher of *The Guide* (gem sourcing/pricing guidebook) and president of Gemworld International in Northbrook, Illinois, USA. 'For example, some feel that colour is the most important factor. Others, including myself, feel that lustre and nacre are the most important'.

But how about rarity? Gina Latendresse, president of American Pearl CO. in Nashville Tennessee, agrees that lustre and orient rank supreme when it comes to cultured pearls. But she notes that some natural pearls which may have low lustre have value because Mother Nature may cease to produce these gifts of the earth some day.

How can you rank colour, shape and size in terms of what's better than another? Tastes in pearls vary by individuals and nations, comments Hidenobu Ogawa of the Japan Pearl Exporter Association in Kobe, Japan.

Ogawa says the most important factor to consider is nacre thickness. Coating creates lustre and orient colour, he explains. Thick-coated pearls have durability and better lustre. This element is vital to grading, but difficult to quantify. Words like thick coated, medium coated, thin coated or young are used.

For lustre, words like very high, high, medium, low and very low describe the reflection of light radiating from the pearl. Regarding cleanliness, terms such as flawless, lightly spotted, spotted and heavily spotted describe surface blemishes which can easily be seen.

In addition to identifying all these elements, is the fact that there is such a variety of products within this category. 'There has been such a change in the pearl market in the last decade,' explains Richard Liddicoat, chairman of the Board of Governors for the Gemological Institute of America in Santa Monica, California. 'There are more producers bringing different kinds of pearls to the market than ever before. We have Japanese Akoya, South Sea, black pearls, Chinese tissue-nucleated pearls, which are almost all nacre, and many more. Then there's the different products within each of these categories.'

Certainly it would be difficult to lump all the varieties of pearls into one system. Each type of pearl has its own characteristics, notes Latendresse. 'If a grading system is developed it must be specific for each type of pearl in order to be fair and complete. Even so, it would be hard to get the whole world pearl community to agree upon such evaluations.'

Even the Federal Trade Commission in its Guides to the Jewellery Industry does not offer a complete and comprehensive list of pearl terminology. 'They do not define "Mabe pearl", blister pearl, or tissue-nucleated pearl,' she says. 'These terms are always very confusing for consumers, retailers and dealers.'

## Present industry practices

There are a number of comparison charts with photographs and master comparison sets for pearls on the market which give trade professionals, especially retail jewellers, some point of reference to communicate quality/value to their customers. Basically, most of the systems available focus on the Japanese Akoya cultured pearl, although there is a chart for black pearls and one for South Sea which make effective sales tools at the counter level.

## Currently no standardised grading system

Because there is no industry-wide standard grading system, communication can get complicated and confusing on all levels of the trade, says Nakamura. 'Having some system is definitely better for the stores to sell pearls than not to have one at all.'

## Education and development

GIA began researching the Japanese Akoya pearl in 1968, creating a pearl-grading course which is still offered at the institute today, but needs updating, Liddicoat notes. 'Just like coloured stones, the challenge with pearls is developing a system that addresses all variables,' says Liddicoat. 'The teaching side has been effective; grading is more problematic. GIA's present course combines product knowledge with a grading system that addresses five major parameters multiplied against each other. But this is geared toward the Japanese Akoya and does need to be updated. Additionally, there have been so many more players entering the market bringing products that need to be discussed. It's been difficult to build a course that incorporates all these new things, with limited funding and demand'. According to GIA president William Boyajian, GIA is in the process of raising funds for pearl course development. New York-importer Salvador Assael has been instrumental in working toward this goal. The South Sea Pearl Consortium (SSPC), as well as the Perles de Tahiti, are supporting efforts to upgrade GIA's educational programming in this area. 'We're looking at quite a few years of development,' notes Boyajian.

About US$ 200,000 will go to GIA from the SSPC, Assael recently reported. Funding will be applied to research the development of a scientific system to grade South Sea cultured pearls and a training course to be included in its curriculum.

## What will the future bring?

According to Hiroshi Norioka, president of Daiichi Trading CO. in Kobe, Japan, researchers there are working to create a new system that will use computers to judge the quality of pearls, perhaps resulting in the development of a universal grading system for pearls. 'Researchers in Kobe have just started working on developing machines to analyse the quality of pearls optically, measuring size and lustre,' explains Norioka. 'We are trying to develop a system on a practical level.' Norioka could not report details at this time and was not certain if this would be something available on all levels of the industry.

'The Japan Pearl Promotion Society (JPPS) is considering developing a pearl grading standard,' explains Shigeru Akamatsu of K. Mikimoto & Co. in Kobe, Japan. 'JPPS proposed the need for a world pearl grading system at the World Cultured Pearl Organisation Conference held in May.'

## Mixed reactions

There appears to be a mixed feeling in the industry as to whether a world-wide standard system should be developed or not. While there are definitely differences of opinion on how to describe pearls in terms of value, all agree that showing and telling customers about the many characteristics of pearls—however one decides to do it—is needed to build consumer confidence in this product category.

**Source:** 'The future of standardised pearl grading system' by Deborah Catalano Yonick, *Europa Star*, September 1996. 76–80.

# Reality check!

'Your bosom can be fake, your smile can be fake, and your hair colour can be fake, but your pearls must always be real.'—a South Carolina grandmother as quoted in *Chic Simple Accessories*

## Pearls are back

Even before Jacqueline Kennedy Onassis' faux pearl necklace made auction history earlier this year, pearl jewellery was staging a comeback. When her triple-strand necklace sold at Sotheby's in April for about 10 times the price of a real cultured pearl necklace, costume jewellery designers scrambled to bring Camelot to the masses while fine jewellers cringed.

There's a positive side of this frenzy. Really. It's building desire for pearls in general, helping to bring back substantial-sized jewellery and sending the 'Y'-necklace to fashion Siberia. Because fake pearls, no matter how cleverly designed, are still, well, fake.

The Franklin Mint, which paid US$ 211,500 for Jackie's triple strand, makes its $ 195 copies from a mould of the original.

For those who can't abide faux in any form (and bless them!), JCK researched the cost of the real thing. A quick poll of leading pearl suppliers found an 8.5 mm to 9 mm triple-strand pearl necklace, collarbone length, with a simple 18k gold clasp retails from US$ 12,000 to US$ 35,000, depending on the quality of pearls. Still a bargain compared to Jackie's fakes.

**Source:** 'It's the real thing!' by Hedda T. Schupak, Fashion Editor, in *Jewellers' Circular-Keystone*, October 1996, p 76.

# GIE Perles de Tahiti: supplies sink, prices rise

Promotional successes earlier in the year have led to an increased demand for Tahiti pearls, with the volume and value of pearl exports rising in the first two quarters of this year. However, since the harvest for 1997 is forecasted to be smaller than that of 1996, and prices are expected to increase, many Japanese wholesalers have been encouraged to stock up and purchase larger quantities now in anticipation of a future shortage of supplies.

## GIE Perles de Tahiti outline

The GIE Perles de Tahiti is a special non-profit economic-interest group founded in 1993 by the French Polynesia Territorial Government and three local producer's organisations to promote Tahiti's cultured black pearls and by-products on the overseas markets. There are local promotional offices in Tokyo, New York, San Marino and Pirae, Tahiti. The general manager at the head office in Papeete, Martin Coeroli, is assisted by Gérald Adams and Cathy Allgaier.

With the aim of helping overseas jewellery wholesalers establish contacts with local pearl producers, the GIE Perles de Tahiti maintains a regular presence at several international jewellery trade shows and promotes two annual pearl auctions held in Tahiti, as well as the Tahiti Pearl Jewellery Festival held each June.

The organisation has also produced a wide range of promotional materials, including full-colour brochures published in seven languages, a 'Pearl of Tahiti' 17-minute video cassette also available in several languages, a pearl quality document, an A–Z guide to Tahiti pearls in English and French and an 88-page book on jewellery designs featuring Tahiti pearls.

For further information contact:

GIE Perles de Tahiti
BP 20470
Papeete, Tahiti
French Polynesia
Tel: 689 45 03 03
Fax: 689 45 04 50

**Source:** 'GIE Perles de Tahiti outline' and 'Supplies sink, prices rise', in *Asia Precious*, October 1996, p 31.

# Chinese Akoya pearls incomparable

It was reported in the *Retail Jeweller* that cultured pearls produced recently in China are of good commercial quality and compare well to Japanese cultured pearls. The pearls are mostly less than 7 mm in size, and it was stated that 'expertise is now required to distinguish between the Chinese Akoya and the Japanese Akoya'. Prices for the Chinese pearls were quoted as being around 40 per cent lower than those of similar-quality pearls from Japan.

**Source:** 'Chinese Akoya compare well', in *Asia Precious*, October, 1996, p 31.

# *Europa Star* reporting

## Tahitian pearl debuts on Internet

The Tahitian pearl made its first full-day debut on the Internet on the opening day of the 3rd Annual International Pearl Jewellery Festival in Tahiti.

The opening of an Internet Website by the GIE Perles de Tahiti, an organisation created in 1993 to promote Tahitian pearls and their by-products in world markets, is viewed by GIE as the biggest development ever in the overseas promotion of Tahiti's black cultured pearls. The 96-page Website, htt//www.tahitiblackpearls.com, treats every aspect of Tahiti's black cultured pearls. It has been designed with easy access in mind for Internet users and there is even a quiz to win a Tahitian pearl.

As for the Pearl Festival, an Italian theme was chosen, since Italy produces more than 70 per cent of Europe's jewellery and 20 per cent of all jewellery in the world. French Polynesia's Government Vice-President and Minister of the Sea, Edouard Fritch said during the opening of the festival that 1996 is turning into a banner promotion year for Tahiti's pearls. Mr Fritch noted two things which have occurred. First, there has been 'a very clear diversification of our clientele, notably among the new economic powers in South-East Asia—South Korea, Taiwan, Thailand, and Hong Kong. Finally we are observing a strong growth in our sales to the United States, France, Germany and . . . Italy.' Mr Fritch also noted that the first international auction held by the newly created GIE Tahiti Pearl Producers Association in April demonstrated that foreign pearl wholesalers have once again become interested in Tahiti's pearls.

Mr Fritch noted that this year's budget for the GIE is the equivalent of US$ 3.1 million, which represents a significant increase over last year's budget of US$ 2.3 million; 90 per cent of this year's budget is for overseas promotion of Tahiti's pearls, mainly in partnership with overseas associations and wholesalers.

**Source:** *Europa Star*, No. 217, April 1996

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## Bahrain Society for Pearls and Oysters

Due to growing interest and support of Bahrain's jewellery and pearling industries, the Bahrain Society for Pearls and Oysters (BSPO) has been established. Members will come from both the public and private sectors and their main objective will be to educate the Bahraini community and the international sector as to the present value and importance of pearls as one of Bahrain's main industries. The society will also be responsible for conducting scientific research and studies related to pearls and plans to establish a specialised library on the subject of pearls.

**Source:** *Europa Star*, No. 217, April 1996

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## Australia's South Sea pearl stamped

The South Sea Pearl Consortium, of Australia, has announced that the Australia post is to release a collector's stamp featuring the South Sea pearl. Two stamps celebrating the beauty of Australian South Sea Pearls and diamonds will be issued on 5 September 1996. The South Sea Pearl Consortium has welcomed this stamp as a fitting tribute to pearling and Australia's leading role.

**Source:** *Europa Star*, No. 219, January 1997

## GIE Poe Rava Nui Auction: emphasising quality

Poe Rava Nui, organisers of the Tahiti pearl auction, chose 75,000 Tahiti Pearls from 159 of its pearl farms for its international auction held on 18–19 October 1996. This compares with the 112,798 pearls which were divided up into 184 lots for last year's sale. Since then, Poe Rava Nui state that they have made a considerable effort to improve the quality rather than the quantity for the auction this year. Already 53 potential overseas buyers have confirmed their presence for the auction. As usual the majority of potential buyers come from Japan but amongst other there will also be buyers from USA, Australia, Hong Kong, Italy and Germany. Pierre Lehartel, Poe Rava Nui's chairman, said during a press conference that every effort had been made to separate the best-quality pearls for auction. This year they harvested 495,832 mother-of-pearl shells and submitted 110,714 pearls for auction consideration. Of these 75,000 were chosen for the auction and the remaining pearls will be sold on a daily basis at the Poe Rava Nui's new showroom at its Papeete headquarters.

**Source:** *Europa Star*, No. 219, January 1997

## Philippines' National Gem declared

The president of the Philippines proclaimed the Philippine South Sea pearl the country's National Gem by presidential decree at the opening of a new exhibit 'Pandanan Wreck – 1414: Centuries of Regional Interchange'. The Pandanan wreck was discovered by a pearl diver looking for his lost oyster basket and revealed the remarkably preserved remains of a mid-15th century merchant ship and an astounding treasure of some 5,000 pieces of priceless Chinese, Vietnamese and Thai porcelain.

**Source:** *Europa Star*, No. 219, January 1997

## Recovery in Tahitian pearl exports

Exports of unmounted Tahitian pearls were up 81.6 per cent in volume during the first eight months of 1996, with an average price per gram higher than in July and August of 1995 and higher than the average for all of 1995, according to figures released by GIE Perles de Tahiti. These results show that Tahiti is catching up with the 1994 average price per gram of 4,183 francs for pearl exports. This progress created a favourable setting for the pearl auction, which was held in October. Perles de Tahiti stated that exports were up 200 per cent in volume and 93 per cent in value during the first four months of 1996, compared with the same period a year earlier. However the price per gram dropped 37.8 per cent from the same period in 1995. Overall January – August export value in 1996 was nearly 2.8m grams, compared with nearly 1.5m grams for the same period in 1995. This eight months' 1996 volume was worth nearly 7.2 billion French Pacific Francs (about US$ 78 million) nearly 51.5 per cent more than the 1995 value. The GIE Perles de Tahiti are hoping that this puts them on course for the best full year since 1993. Japan remains the biggest buyer of exported Tahiti pearls, in terms of both volume and price, followed by the USA and Hong Kong.

**Source:** *Europa Star*, No. 219, January 1997

## 1996 : The Year of the Pearl

1996 marked the grand return of the pearl. After 30 years in the doldrums, jewellers, the press and millions of women rediscovered the incomparable beauty of the pearl.

The fashion houses covered their models in pearls, Christian Dior launched his latest perfume 'Dolce Vita' at a presentation where the model also wore pearls. Les Galeries La Fayette celebrated their 100th Anniversary and covered the walls of their Paris shop with pearls. Chanel revealed their new jewellery collection and at the same time a book entitled 'Stars and Pearls'. Tiffany produced a collection devoted to pearls, the South Sea and the pearls of Tahiti in particular, entitled 'Fireworks' and the vice-president stated 'the charm, the style, and the legends and mystery which surrounds them makes them irresistible. The South Sea pearls and the pearls of Tahiti are particularly enchanting.'

Spring was the time of the pearl, with almost every celebrity seeming to be wearing pearl jewellery, and Elizabeth Taylor launched her new perfume 'Black Pearl'. Back in Paris, in September at the Bijorhca fair, the jewellers Torrente caused a sensation with their collection entitled 'A woman, a pearl'. Sharon Stone's photograph appeared in every paper and magazine wearing wonderful pearl jewellery at a celebration for Van Cleef & Arpels. The pearl has definitely been the jewel of the year, seducing jewellers, stars of show business, princesses, the media and the fashion houses. Even the record industry has been influenced, as Bryan Adams released a song on his new album entitled 'Black Pearls'.

**Source:** *Europa Star*, No. 219, January 1997

# New pearler from South Australian Ships

All the best features the owner had seen in other pearling vessels were incorporated in the design of *Joseph Conrad*, a 31 m vessel launched recently by South Australian Ships of Port Adelaide.

Managing director of Maxima Pearling of Broome in north-west Australia, David Jackson, worked with Robert Williams of International Maritime Consultants of Fremantle to evolve the design of what they describe as 'the most modern pearling vessel in Australia'.

Robert Williams said the vessel was designed with three roles in mind: to go out to the pearling grounding to catch shell; to transport that shell to the farm; and to provide onboard facilities for seeding the pearl shells with the nuclei around which the pearls will form.

This called for extensive accommodation, with 21 berths for the pearl-farming crew, the Japanese technicians who carry out the seeding, and the ship crew.

A six-berth cabin aft of the wheelhouse accommodates the technicians, who normally have a separate cabin which includes their own rice cooker. Other crew members' quarters and the seeding room are on the main deck.

*Joseph Conrad* has four shell tanks, which can carry a total of 10,000 live shells. Water circulates through the tanks, changing six times an hour.

When fishing, the vessel extends a boom from each quarter with three ropes to enable six divers to move along the bottom gathering shell. Each has an air line delivering filtered air. Should the compressor fail, air is automatically switched to air tanks which store air under pressure. Each diver also has an alarm button to warn of any problem.

The vessel will generally remain at sea fishing for periods of up to two weeks. Fuel capacity is 45 t and fresh water capacity is 65 t.

A Caterpillar 3508 main engine delivers 805 hp to the Heimdal controllable pitch propeller, giving a free-running speed of 11 knots.

At the naming and handing-over ceremony at South Australian Ships, David Jackson said he was delighted with the new vessel and he thanked the builders for their work.

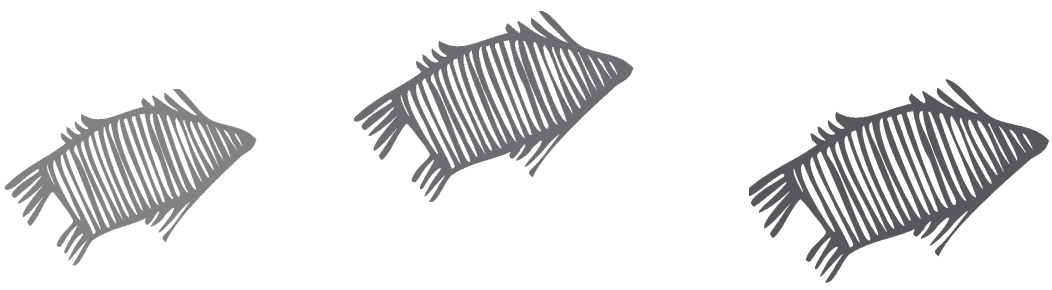
He said he went into pearling eight or nine years ago and his previous vessel was a 50 ft wooden lugger with a long bowsprit and maximum speed of 5.5 knots.

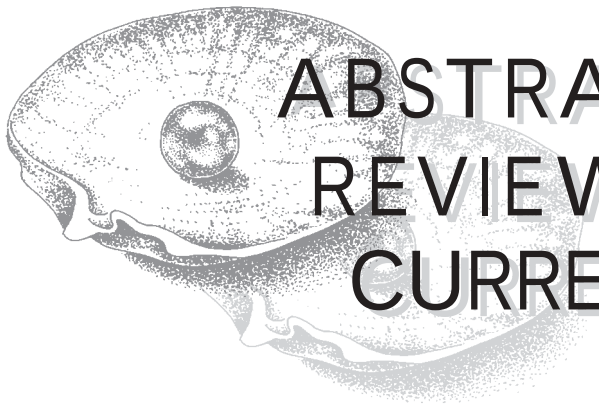
The new vessel would put his company into the professional league of pearling and make them more competitive.

For further details contact:

South Australian Ships
Ocean Steamers Road
P.O. Box 200
Port Adelaide 5015
Tel: (61) 8 341 3030
Fax: (61) 8 341 2218

**Source:** 'Three-fold capability for new pearler from South Australian Ships' in *Professional Fisherman*, July 1996, 30–31.





# ABSTRACTS, REVIEWS AND CURRENT CONTENTS

## Pearls, pearl oysters and pearl mussels in fiction

*by Beatrice L. Burch*

*Beatrice Burch perseveres on her prolific path, and offers us the following reviews of novels which focus on pearls or the bivalves which bear them. In light of Elizabeth Taylor's much-celebrated black pearl necklace series in American sitcoms last year, it is helpful to remember the powerful role pearls have always played in literature—and the role literature has played in fostering the alluring image of the pearl (Ed.).*

This is a series of essays united on the theme of pearls, pearl shells or pearls and the authors who wrote so eloquently on these subjects. The writings range from legends of American Indians, prophetic French science fiction, a modern orientalist from the Netherlands, Modern Americans who lived and wrote on Polynesians, a very modern grandmother writing of the Southern Tennessee poor during the Great Depression, a late Nobel prize winner relating a Mexican folktale and a contemporary teller of adventure tales. What these authors share is expression of pearls and pearl shells as symbols of beauty, hopes and dreams, the struggles towards these ideals and the impacts on the characters in those novels.

### The haunted journey

by Ruth Diddell, 1988, Anthenum, Macmillan Publishing Co., 866 Third Avenue, New York 10022, 215 pages.

To pay off the taxes on his late father's land, 14 year old Obediah Wilks, his dog Chaser and his brother's friend Bas, an older teenager, travelled to the haunted River country of Tennessee in 1931 during the Great Depression. Using Obie's great-grandfather's map, they locate the source of freshwater pearl mussels in an almost legendary land of strange shadows and eerie voices. Braving the lonely and wet Tennessee hardwood forests through rain and cold in exciting, although scarey experiences in fording swollen rivers, they have dreams of ancient hostile Cherokees guarding the pearl beds of giant pig-toe pearl mussels in long-protected mussel beds (which the author places hinge side up!).

Obie's fishing methods are explained, as told to him by his grand-daddy. Also explained is why the other Tennessee rivers had experienced the demise of their pearl beds.

Obie told tales of DeSoto and his men finding Indians with pearls, of pearl thieves and of the great-grand daddy's accounts of Cherokee ghosts haunting that area. This all increases the uncanny atmosphere for the two boys alone in that bleak forest. The difficulties in hunting for food increase, making the exhausting and thrilling trip realistic for teenager and adult.

This is a touching picture of the lives and anguish of southern poor folk during the Depression. With the faith of a good teacher at Obie's school, Obie's journey results in a satisfying conclusion for Obie and his family, although not in the way that Obie had anticipated.

## 20,000 leagues under the sea

by Jules Verne, 1869, edition newly translated and annotated by W. J. Miller and E. P. Walter. This edition also includes illustrations from the original publication in French. Naval Institute Press, Annapolis, Maryland. 392 pages.

## 20,000 leagues under the sea

1981, edition translated by Anthony Bonner, introduction by Ray Bradbury, Bantam Classics, New York, 1540 Broadway, New York, 371 pages.

Jules Verne (1828–1905) was a French pioneer in scientific fiction which stimulated hopes and dreams of people everywhere. He wrote many grand stories of imaginary voyages extending from the centre of the earth to voyages to the moon and back, to islands by balloons and across the Russian plains to Siberia. He never wrote more powerfully than in 1868 when his book *20,000 Leagues Under the Sea* was written to challenge thinking readers around the world.

Yes, you may have read his stories, including this one, but it affected people everywhere so much that almost 100 years later, Americans named their submarine that went under the North Pole *Nautilus* after Captain Nemo's vessel. Even Disney named his first submersible *Nautilus* in Disneyland.

There are fan clubs for many topics and items, but two Jules Verne admirers, Miller and Walter in the USA, shared their high esteem of his expert research by newly translating the original French edition into English, with numerous annotations for this modern audience explaining many terms commonly known to people of the late 1800s and not so familiar to our contemporary audience.

For the pearl reader, description of diving off the famous pearl beds in the Gulf of Manaar between Ceylon (now called Sri-Lanka) and India are impressive. Remember, these pearl beds had been utilised as long ago as Roman times. However, Jules Verne, avid sailor and experienced boatman, with long hours of study on geology, astronomy and engineering, wrote this book before these pearl beds were studied and reported upon by Herdman in 1903. The same dangers of pearl diving there or anywhere still exist.

Verne excelled in this great adventure story, but now that I've reminded you of this 'pearl' connection, may you have many happy hours also reading for the first time, or rereading, others of Jules Verne's inventive stories in the companion volumes of *Mysterious Island*, or *Voyage to the Center of the Earth*, *From the Earth to the Moon and Back* and two written in collaboration with Adolphe d'Ennery, *Michael Strogoff* (better read this one in summer, as the flight across Russia in winter is bleak) and (at any time) the joyous *Around the World in 80 Days*. All of these are great in videos, but absolutely glorious when reading them aloud to the family. 'Jules Verne's books look forward, not backward. Therefore they are still the books of youth', stated M. Allotte de la Fuye in the Encyclopedia Britannica (1947).

In *20,000 Leagues Under the Sea*, a part of the long voyage took the *Nautilus* and its scientific passengers to where a two million dollar pearl was shown, still in its gigantic oyster in the dark undersea cave. The rubber-suited, copperhelmeted Professor Aronnax and Captain Nemo and their companions walk on the ocean floor. While a coconut-sized pearl is still fantastic today, the story goes on with the submarine divers still under water observing an Indian diver and his methods of working beneath his rowboat overhead, with the surrounding dangers.

I present two editions of this story as both have their good points and few errors. The Naval Institute Press edition is newly translated from the original with its very informative annotations. The Bantam Classic in the 1981 edition contains an American philosophical comparison of thinking by Captain Nemo of this story and that expressed by Captain Ahab of 'Moby Dick' fame. The comparisons are by Ray Bradbury, a noted science fiction author of today.

Both editions express the hopes for the future that have enthralled readers for the last 125 years and in our times today, as Marshall Lyaultey wrote in the 1947 Encyclopedia Britannica : 'The advances of the people is merely living the novels of Jules Verne'.

## The song of Hiawatha

by Henry Wadsworth Longfellow, 1807–1882.

In 1885 Longfellow wrote *The Song of Hiawatha* in trochaic dimeter as best suited to American Indian dance repetitive dance rhythms. It attempts to weave together American themes and legends of the American Indian North East Onondaga tribe in 50 pages of glorious verse. It tells of Hiawatha's birth, childhood, wooing of Minnehaha, a Dakotah, his blessing of corn fields, his teaching of picture writing, his vengeance and departure. Our interests are in particular the part of the legend of how Hiawatha killed the Pearl-Feather Magician Megissogwan, bringer of disease and fever, mighty manitou of wealth and wampum. [*Wampum are the strings of shell beads, made from mussel shells, which were used as money and as ornaments by the American Indians (Ed.)*].

'Then he stripped the shirt of wampum
From the back of Megissogwan
As a trophy of the battle,
As a signal of his conquest,'

Skipping onwards we resume . . .

'From the wigwam Hiawatha
Bore the wealth of Megissogwan,
All his wealth of skin and wampum,
. . . .
All the trophies of the battle,
He divided with his people,
Shared out equally among them.'

The six nations Indian Museum of Onchitoa, New York holds 'The Hiawatha' Belt as an emblematic union of the Great Peace between the five Nations—the Mohawks, Oneida, Onondaga, Cayugas and Senaca. This is a dark strip or belt in sash form known as the Hiawatha Belt. It is dark wampum [*black or purple bead wampum were considered more valuable than white (Ed.)*] with a central white heart or pine representing the Onondagas, with the other tribes represented by white squares all joined by a white wampum row representing the unity of all the five Iroquois Nations.

This sacred belt rests in the State Museum at Albany, New York. It is said by the Nations that the first shell wampum was made from fresh-water mussel shells brought to the Onondagas by Hiawatha. Later the five Nations also included the Tuscarora as the sixth Iroquois group, which thus became the six Iroquois Nations. The Iroquois peoples came to regard wampum highly for official as well as for religious purposes. No Iroquois chief would listen to a messenger until he received official information through a runner who carried the proper wampum string or belt. No Iroquois, either individual or tribe, would think of breaking a word or treaty if the treaty was made over a sacred wampum belt.

Thus the importance of various wampum belts symbolises treaties between individuals, tribes or Nations. This is why in both New York and in Pennsylvania State capitols, these treaty belts still are held as agreements honoured by the six Nations, and hopefully by the Governments of those states, and by the federal government.

## The emperor's pearl

by Dr Robert Van Gulik, author and illustrator, University of Chicago Press, pocket-sized, soft cover, 184 pages.

The story opens in China of the Tang Dynasty on the night of the Poo-yang dragonboat races along the Grand Canal, with the leading boat's drummer collapsing and dying before the astonished audience.

Following the discovery that it was death by poison, Judge Dee, official magistrate of that area, found the body of a beautiful young woman in a nearby forest in a deserted mansion. These two deaths were linked to a 100-year-old tragedy and theft of the then Emperor's huge pearl. Tied to all this is a statue of a mysterious River Goddess and more murders. With the help of faithful Sergeant Hoong, Judge Dee brilliantly solved the cases, as well as the secret of the Emperor's pearl.

Judge Dee was an actual magistrate of the Tang Dynasty and is as well known as a master detective in China today as the far more recent fictional Sherlock Holmes is to modern western-world detective fans. Judge Dee (and his clever solutions to mysterious cases) has been well fictionalised over a period of years.

Gulik entered the Netherlands Foreign Service in 1935 and served in many oriental and western countries, as well as Egypt, Indian, Lebanon and the United States of America. In 1963 he became director of Research, Netherlands Foreign Ministry, the Hague, and died in 1967.

His work as a student of the Orient and his non-fiction works on Imperial China were well regarded, and are expressed admirably in his writing of fiction in Judge Dee stories, which illustrate the completely different ideas of life and justice in old China from western countries of today.

## Necklace and calabash

by Dr Robert van Gulik, 1992 ed., illustrated by author, University of Chicago Press, 144 pages.

Originally published in 1967, the year that the author died, this story is set in the Tan Dynasty and solved by the same famous Judge Dee as in the 'Emperor's pearl'.

This final mystery in the Judge Dee series returns the now Imperial magistrate and his assistants to near the scene of this first case in mythical Poo-yang. Judge Dee hoped to have a brief vacation of fishing and relaxation. Instead, he becomes involved with a fierce Taoist recluse and involved with two sudden murders. State secrets, a missing pearl necklace belonging to a beautiful Princess in a Water Palace nearby, the involvement and help by a charming young girl cousin of a nearby inn-keeper begin a fast reading mystery. Customs and government are vividly described and add to the amazing solution of the gorgeous missing necklace.

# World Aquaculture '97 abstracts

*The following seven abstracts were extracted from:* World Aquaculture Society, Book of Abstracts, World Aquaculture '97, Washington State Convention Centre, Seattle, Washington, USA, 19–23 February 1997

## Benzocaine (Ethyl p-Aminobenzoate) as anesthetic for surgical implantation of nucleus in the pearl oyster *Pteria sterna* (Gould, 1851)

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A basic activity in pearl production concerns the surgical implantation of a piece of mantle together with a nucleus. Success depends on many elements, the determinant being the ability to maintain at a very low rate the standard metabolism of the pearl oysters to be implanted. Japanese specialists succeed by culturing organisms into slotted cages, and by keeping them crowded just before implantation. In other countries menthol is used, but methods are not described.

With the aim of defining a simple and effective methodology to anesthetise pearl oysters *Pteria sterna* (concha nàcar) prior to implantation, several parameters and reagents (i.e. low temperature, low salinity, alcohol, chloroform, formalin, hydrogen peroxide and Benzocaine) were used in a series of experiments. Reagents were slowly added to paired groups of 10 oysters, placed in ten litre plastic containers filled with filtered sea water, and giving enough time to see reactions. Also, temperature and salinity were gradually lowered for another set of organisms.

Alcohol, chloroform, formalin and hydrogen peroxide stimulate secretion of mucus and then implantation becomes difficult; cold or low-salinity seawater pearl oysters strongly close their valves. Beyond a certain level, both kinds of method provoke death in organisms. Benzocaine (Ethyl p–Aminobenzoate) gave the best results, as it never harmed nor killed pearl oysters.

To determine the concentration giving best results in terms of longer sedation time, a total of 24 organisms, 15 months old, were paired and placed into two-litre beakers, at Benzocaine concentrations of 1, 5, 10, 100, 250 and 500 mg/l. The Benzocaine was first dissolved to saturation in Methyl alcohol (250 mg/ml), and added to seawater to reach the desired concentration. As Benzocaine cannot be dissolved by stirring, sea water must be warmed to 88–92°C in order to ensure melting.

Pearl oysters maintained in 1, 5 and 10 mg Benzocaine/litre seawater did not show any reaction; organisms maintained in 100 mg/l showed symptoms of low metabolism, as they stayed with valves open, but rapidly closed their shells when touched. After 5 minutes, oysters subjected to 250 and 500 mg Benzocaine/l opened their shells widely and stayed relaxed, even when taken out of water or when internal organs were touched or punctured.

Organisms stay immovable for 45–60 min.; after that they recover and react normally, closing their valves. Before this time, if they are placed in an open seawater system, they recuperate in 10 min. As pearl oysters subjected to the 500 mg Benzocaine treatment secrete an abnormal quantity of mucus, surgical interventions become difficult. Benzocaine acts as a good stimulus to spawn pearl oysters; when mature organisms are subjected to this procedure, they liberate gametes when recovering in clean seawater. Normal spat has been hatchery-produced this way.

## Breeding cycle of *Pteria sterna*, in wild and cultured conditions, and wild *Pinctada mazatlanica*, in Guaymas, Gulf of Califonia, Mexico.

Enrique Arizmendi, Sergio Farell y Rocio Covarrubias

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Pearl oysters, *Pinctada mazatlanica* and *Pteria sterna*, have been an attractive resource for centuries in the Gulf of California but natural beds were depleted to a point where populations became endangered and

a fishing ban was imposed. Any further use of this resource will be linked to aquaculture operations, and for this purpose, it is relevant to know the breeding cycles.

Wild pearl oysters of both species from different points, and cultured organisms from the ITESM long-line system, were sampled monthly for a one-year period. Both qualitative (gonad histology) and quantitative (condition index) approaches were taken to find the seasonal cycle of gonad activity. For *Pinctada mazatlanica*, gonad width was also measured.

Both species have asynchronous cycles. Cultured *Pteria sterna* has peaks of maturity (histologically determined) and of condition index in November and April. Wild *Pteria sterna* has two maturity peaks (histologically determined), one in October – November – December and the other in April; its condition index peaks are in December, February and May.

*Pinctada mazatlanica* has maturity peaks (histologically determined) in June and September, a condition index peak in February and peaks of gonad width in June and August. *Pteria sterna* passes through an inactivity stage during the summer that is more pronounced in culture conditions than in the wild.

## Installation of the first commercial marine pearl farm from the pearl oysters *Pteria sterna* and *Pinctada mazatlanica* in all the American continent

Sergio Farell, Enrique Arizmendi, Douglas Mc Laurin and Manuel Nava

Proyecto 'ITESM-Perlas de Guaymas', Instituto Tecnologico y de Estudios Superiores de Monterey-Campus Guaymas, A.P. 484 Guaymas, Sonora 85400, Mexico

For more than four centuries, and until the 1930s natural pearls were one of the main products from the Gulf of California. This resource was overexploited to the point that the government enlisted it for special protection. Now, aquaculture is the only way to recover and enhance this resource.

ITESM-Perlas de Guaymas' farm is located in Bacochibampo Bay, at the Central Gulf of California, Guaymas, Mexico. The experimental project started back in 1993, and by 1995 the pilot production was of 2,000 half-pearls; in 1996, the first commercial harvest was 5,000 half-pearls. The estimated production for 1997 is 50,000 half-pearls, and 100,000 for 1998.

Since the pearl oyster populations are limited, we begin our process by cultivating the oysters themselves. The seed is collected inside onion bags arranged in vertical lines, located in the same bay as the culture. In other words, we don't remove the seed; it is relocated in the same water body with special care and protection. The culture system is suspended in longlines, using Japanese pearl nets for nursery and lantern nets for grow-out.

After a year of culture, at an average height of 70 mm, the 'Western Winged Pearl Oyster', *Pteria sterna*, is ready to be implanted. There's a 64 per cent success rate for mabe pearls and a promising success for round pearls. For the 'Panamic Pearl Oyster', *Pinctada mazatlanica*, two years are necessary for the implant operation, when they have reached an average size of 100 mm. After implant, the oysters are returned to the culture area where they spend from six to ten months in the pearl formation process. The harvested half pearls are classified, cut from the shell, processed into mabes and some of them are mounted in jewellery, to be sold.

This is an example of a low-impact, high-return aquaculture project. It can be the beginning of an important industry in the Gulf of California. The pearls are returning to this region.

## The status of black-lip pearl oyster, *Pinctada margaritifera*, culture in the US-affiliated Pacific Islands

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Culture of black-lip pearl oysters (*Pinctada margaritifera*) has been established in the US-affiliated Pacific Islands in recent years, spurred by the success demonstrated by South Pacific island nations. Production of black pearls offers an economic development alternative for remote areas where exploitation of marine resources is hampered by lack of infrastructure. The demand for high-quality

black pearls appears to be expanding in the US and Europe, although consistent production of sufficiently high-quality pearls remains problematic.

The Federated States of Micronesia (FSM) and the Marshall Islands contain over 60 atolls representing potential pearl oyster culture sites. *P. margaritifera* occurs in varying numbers on some of the mostly unsurveyed atolls. Despite great interest and potential, development of the industry has been slow due to low stock densities, generally poor spat collection results, lack of technical assistance, a paucity of available biological and culture data, and few funds for basic research and development. The overall atmosphere of secrecy pervading the pearl industry has adversely affected the dissemination of information and limits cooperation between workers in the field.

There is currently one commercial-scale farm in Nukuoro, FSM and three in the Marshall Islands. Ownership arrangements and marine tenure vary and may be contentious. With the exception of one privately owned farm, start-up funds have largely been through public monies.

Longline culture predominates and is used in combination with lantern baskets, pocket panels and ear-hanging on chaplets. An estimated 30,000 adult pearl oysters are cultured and approximately 10,000 of these have been implanted with nuclei. An unknown number of spat is also under cultivation. Four bouts of nucleus implantation (seeding) have been performed by two technicians. Only a few sample pearls have been harvested to date in the region, with the first commercial harvest projected for early 1997.

What little is known of the biology and ecology of *P. margaritifera* is derived from research conducted principally in the South Pacific. The applicability of these results to *P. margaritifera* populations in other regions is speculative. Reproductive behaviour and recruitment dynamics are of particular relevance to the industry, given the reliance on spat collection to supply farming purposes, but little research in these areas has been conducted in the Western Pacific region. Consequently, key data, such as timing of spawning, larval transport mechanisms, and optimal design and deployment of spat collectors, are not available for the Western Pacific region. Until the requisite basic research is conducted, it is unlikely that spat collection and other culture methods will improve. Hatchery technology offers an alternative method of supplying juveniles, but remains under-utilised in the region.

For future expansion and development of the industry to occur, the obstacles presented by limited numbers of wild stock, poor spat-collection results and inadequate technical assistance must be overcome. In response to these needs, CTSA is providing extension assistance in the form of funding a Regional Aquaculture Extension Agent position in the FSM, public workshops, and production of a training manual and video on pearl oyster culture methods.

Further basic research is needed, with an emphasis on reproductive biology and recruitment. Improvements in culture methods and implantation technology, accompanied by increased technical assistance, will further enhance development of the pearl industry in the US-affiliated Pacific Islands and Hawaii.

## Growth and mortality of the pearl oysters, *Pinctada mazatlanica* and *Pteria sterna*, at different stocking densities

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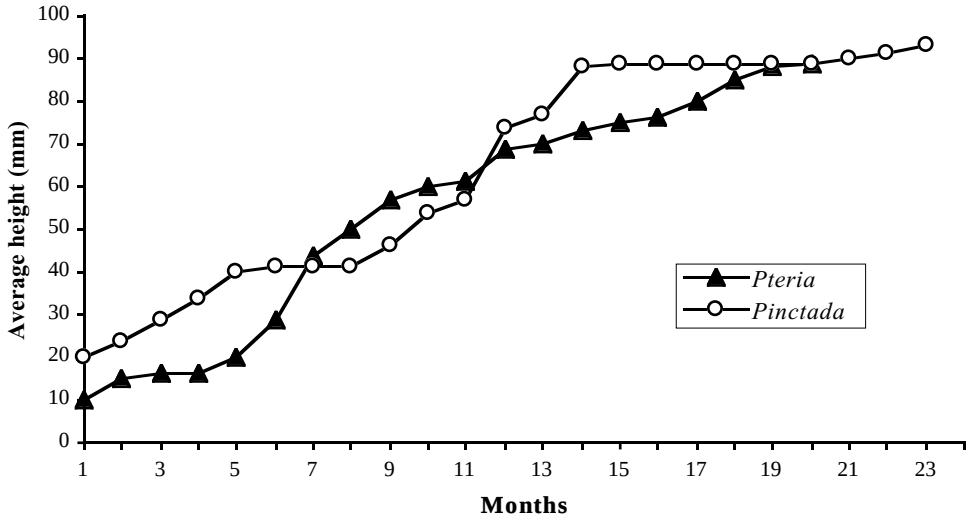
Pearl oysters were cultured at ITESM's suspended-culture/longline system installations, situated inside Bacochibampo Bay, Guaymas, Sonora, Mexico. The objective of the present study was to determine appropriate stocking density, mortality and growth rate on both species of pearl oyster.

*Pteria sterna* was subjected to four stocking densities (individuals per $m^2$)—150, 400, 650 and 1000—whereas *Pinctada mazatlanica* was stocked at 50, 70 and 125. A sample of each density was taken out and measured (height in mm) monthly, and mortality recorded (see figure on facing page). Wild pearl oyster spat was used in every experiment. Initial stocking was done inside pearl-nets. The oysters were later transferred to lantern-nets for grow-out. Mortality in *Pteria sterna* increased dramatically during the summer season (32°C) (with as much as 46%), whereas in *Pinctada mazatlanica* mortality is higher during winter months (16°C) (with as much as 14%), growth being affected similarly for each species. Experiments confirm the relation between mortality and temperature.

This study was funded by ITESM and CONACyT (Mexico).




**Comparative growth of pearl oysters *Pternia sterna* and *Pinctada mazatlicana*, in Bacochibampo Bay, Guaymas, Sonora, Mexico**

## Preliminary results in production of cultured half-pearls in *Pteria sterna* (Gould, 1851), in Bahia de La Paz, Baja California Sur, Mexico

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The crowded banks of pearl oysters, *Pinctada mazatlanica* and *Pteria sterna,* were over-exploited in Mexico up to 1940, when the fishery was formally prohibited. The population has not recuperated, as unlawful catches still occur. In 1993, the UABCS began a research programme to develop technology for culturing of pearl oysters, as well as implants to produce pearls. First results concerns the production of half-pearls, or 'mabe'.

In December 1993, a spawning of *P. sterna* was carried out following conventional hatchery methods, along with emplacement of mesh collectors to obtain spat from nature. The two groups of juveniles were separately placed in fine-mesh plastic bags and attached to longlines for growout, and, in March 1994, were transferred to plastic mesh cages (60 x 60 x 20 cm) tied on iron-rod racks. The racks were fixed to the bottom, at 10 m depth on a site near the Laboratorio Experimental de Maricultura in Bahia de La Paz, B.C.S. Organisms were dived up, byssal threads were cut off and they were brushed and placed in a clean cage every three months.

In April to June 1995, a total of 313 *P. sterna* (15 months old) were implanted. From these, 195 organisms were produced in the laboratory and the other 119 were obtained as natural spat. They were cleaned and anesthetised by adding Benzocaine. After five minutes, the pearl oysters open their shells and stay relaxed. At this time, the implant for plastic nucleus takes place. The nuclei consist of plastic half-spheres, 1.25 or 1.05 cm diameter. To attach one nucleus to every single shell, a carboxylate cement (used for dental practices) or a cyanoacrylate glue were used.

The implanted pearl oysters were cultured for another ten months, as mentioned above. In March 1996, a total of 166 pearl oysters were collected. 111 were laboratory-produced and 55 were wild spat. 73 laboratory-produced organisms showed an homogeneous 2 mm nacre layer over any of the two sizes of nucleus, a half-pearl completely moulded. As 30 were not well covered and another 8 rejected the nucleus, a 65.7 per cent success rate was attained. Of the 55 wild-origin pearl oysters, 36 were replaced in the sea, as the first 19 dissected organisms had only 58 per cent success rate (i.e. 11 organisms). In May 1996 the remaining 36 organisms were dissected, and half showed a good-quality nacre layer.

From this work, it is shown that hatchery seed is slightly better than the natural organisms, in terms

of survival, growth and nacre-quality deposition. Also, cyanoacrylate is better than carboxylate cement as nucleus adherent: nuclei were not rejected, and the glue is easier to use for application of the nucleus, and cheaper. Larger nuclei (1.25 cm diameter) are advisable in terms of profit. The present culture system is adequate, but it is recommended to clean pearl oysters and cages more often, as boring worms can damage shells, cause fouling and compete for food.

## Overcoming the scarcity of pearl oysters (*Pinctada margaritifera*) in Micronesia and Hawaii, new areas and opportunities for pearl farming

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Black-pearl culture is the biggest aquaculture industry in the Pacific Islands, earning over US$ 135 million in French Polynesia in 1994. This industry is presently confined to the Eastern Polynesian lagoons, where *Pinctada margaritifera* is naturally abundant, but the species is widely distributed throughout the tropical Indo-Pacific.

Expansion of black-pearl farming to Micronesia and Hawaii is limited by the natural scarcity of pearl oysters. We have been able to identify and overcome these constraints, making commercial pearl-farming a viable development option for virtually any atoll island with a suitable lagoon and regular air freight links.

Trials initially focused on identifying sources of oysters for pearl farming in the Marshall Islands. Oysters were reportedly most abundant on Namdrik Atoll, but a survey indicated a total stock of only 40,000, with a size frequency heavily skewed to the larger animals. The low rates of recruitment—only 5 per cent of the population was less than 10 cm shell diameter —are clearly insufficient to sustain a commercial pearl farm.

Spat collectors also showed poor yields, averaging around 0.04 spat/bag, compared to over one spat/bag for French Polynesian lagoons. The high tidal range in Micronesia (2 m spring tides, vs. 0.6 m in Eastern Polynesia) flushes most of the larvae out of the lagoon during the 2.5–6 week planktonic larval stage. Similar flushing of larvae may also suppress recovery of stocks of *P. margaritifera galtsoffi*, which were previously over-fished around the Hawaiian Islands.

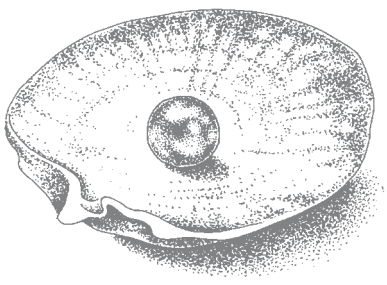
Longline culture trials in both Hawaii and the Marshall Islands showed that the oysters grew well, with little mortality among adults. Pearl farms could prove feasible if a reliable source of oysters could be found.

A remote hatchery system was therefore developed in Kona, Hawaii, to supply spat for grow-out trials in Namdrik and throughout the Hawaiian Islands, and to stock a commercial farm operation in Majuro Marshall Islands. The hatchery has since provided over 250,000 spat to Majuro, and 200,000 spat for culture trials in Hawaii. This avenue has proven to be the best and probably the only option for commercial farm development in these new areas.

Predation of small hatchery-produced oysters was heavy, with early nursery survivorship rates of between one and five per cent. The principal predators, *Cynatium* snails and *Stylochus* flatworms, are not problematic in pearl culture in French Polynesia or the Cook Islands, and their prevalence in the Western Pacific may contribute to the depressed bivalve stock levels found there.

Refinements of early nursery culture and innovative juvenile grow-out methods have overcome most predation problems. Some losses can be anticipated and accommodated by simply increasing the scale of hatchery production. The constraints of pearl-oyster scarcity now need not limit the expansion of this lucrative industry to other atolls of Micronesia and to Hawaii.

**Source:** World Aquaculture Society, Book of Abstracts, World Aquaculture '97, Washington State Convention Centre, Seattle, Washington, USA, 19–23 February 1997.



# Other abstracts

## Effects of different substrata and protective mesh bags on collection of spat of the pearl oysters, *Pinctada margaritifera* (Linnaeus, 1758) and *Pinctada maculata* (Gould, 1850)

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### *Abstract*

Refining techniques for the collection of spat is important to the culture of blacklip pearls oysters, *Pinctada margaritifera*, especially where the collection of spat is marginally effective. We deployed 40 spat collectors at 15 sites within the open reef complexes of Solomon Islands to test the effects of different collectors (constructed of shade-mesh and plastic sheeting) and protective mesh bags on the abundance of spat. After 6 months, we recorded abundances of *P. margaritifera*, and another pearl oyster, *P. maculata*, together with the numbers of predators associated with the collectors. Significantly more *P. margaritifera* were found on the shade-mesh, whereas live *P. maculata* were more abundant on the plastic sheeting. Collectors inside protective mesh bags did not yield more pearl oysters than those left unprotected. Mesh bags trapped predators such as *Cymatium* spp. gastropods and portunid crabs settling to the collectors from the plankton. The bags also fouled easily, impeding water flow to the collector. We conclude that experiments should be conducted to identify optimal materials for collecting the target species of pearl oyster and that collectors should not be placed in protective mesh bags in environments similar to those of Solomon Islands.

### *Introduction*

The culture of blacklip pearl oysters in French Polynesia and Cook Islands was based initially on the use of wild shell from the lagoons of selected atolls. Collection of spat provided only a minor proportion of the farmed shell (Coreoli et al., 1984). In the last 1980s and early 1990s, however, legislation was introduced to parts of French Polynesia and Cook Islands banning the use of wild shells. Consequently, the industry became more dependent on the collection of spat to provide the oysters needed for pearl culture.

The spat of the blacklip pearl oysters are collected on subsurface longlines, using a variety of settlement materials, ranging from branches of selected trees (Coreoli et al., 1984; Victor, 1987; Passfield, 1989) to a variety of plastic sheets, ropes, and meshes (Coreoli et al., 1984, Cabral et al., 1985). The use of plastic substrate is now widespread because of the ease of use and durability (N. Sims, pers. comm.). Spat collectors are hung at depths of 2–4 m, where settlement is greatest (Shirai, 1970; Cabral et al., 1985; Sims, 1993). Collectors are buoyed clear of the substrate to isolate them from benthic predators (Swift, 1985), and in some cases, mesh bags are used to protect spat on the collectors from predators (Coreoli et al., 1984; Gervis & Sims, 1992).

In the course of a large-scale sampling programme to identify spatial variation in abundance of spat *P. margaritifera* in Solomon Islands, we designed experiments to answer two questions. These questions were: 1) Do mesh coverings ('spat bags') increase the number of spat harvested from collectors? 2) Is there a difference in the number of spat harvested from collectors made of plastic sheeting and those made from shade-mesh?

We found that the use of spat bags did not increase the number of *P. margaritifera* spat on collectors and that more spat were collected from shade-mesh than from plastic sheeting. During the experiments, large numbers of another pearl oyster, *Pinctada maculata*, also settled on the collectors. This species, which produces baroque pearls of smaller size and value than those found in *P. margaritifera* (Sims, 1988), also provided a useful test for the effect of spat bags. At two of the three sites where this species settled in abundance, there were significantly fewer spat collectors within the bags.

### *Conclusions*

The choice of substrate used to construct collectors had a significant influence on the abundance of spat: *P. margaritifera* preferred shade-mesh, and *P. maculata* preferred plastic sheeting. This implies that further experiments are needed to select the best materials for collecting the spat of *P. margaritifera*, and that farmers may be able to design collectors that target particular species over potentially competitive species. Such experimentation is critical where the collection of spat is only marginally effective.

Predators such as *Cymatium* spp. gastropods and portunid crabs settle to spat collectors from the plankton. Bags placed around spat collectors to exclude predators such as fish can enclose *Cymatium* spp. and crabs as they grow, resulting in increased predation by these invertebrates. 'Protective' bags also become heavily fouled. In severe cases, this fouling may render the 'habitat' within the bag unsuitable for the growth and survival of pearl oyster spat. Because the number of spat on collectors held in protective mesh bags was significantly lower at some sites and because the installation of bags adds considerably to the cost of spat collectors, we do not recommend the use of spat bags for the collection of pearl oysters within environments similar to those in Solomon Islands.

### *Acknowledgements*

We are grateful to M. Gervis and G. Tiroba for their assistance during the study. J. Munro and J. Lucas provided useful comments on the manuscript. This study was conducted with funding from the Australian Centre for International Agricultural Research (ACIAR).

**Source:** *Journal of Shellfish Research*, Vol. 15, No. 3, 535–541, 1996

## Las otras perliferas (Bivalvia: Pteriidae) en el Caribe Colombiano

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On the north coast of the Colombian Caribbean, particularly along the littoral of the Goajira Peninsula, there was once a pearl-oyster fishery aimed at obtaining natural pearls. Today, only partial and fragmentary information is available on the species exploited, their ecology and distribution. The objectives of this study were to determine the distribution and general environmental characteristics of the oyster beds in this region, to evaluate the current extent of oyster populations and their potential as exploitable resources, and to gather and synthesise historic information about the pearl fishery. For these purposes, a variety of field and laboratory activities were undertaken between April and December 1994, including land and sea exploratory trips, reconnaissance of bottom types on the shallow-water continental shelf, SCUBA diving observations, assessments of oyster density, and interviews with local indigenous populations. The presence of two pearl oyster species was confirmed: *Pinctada imbricata* and *Pteria colymbus.*

Historically, the extraction of the mother-of-pearl oyster (*P. imbricata*) on the Goajira was characterised by its intermittence. The location of sites of most intensive past extractive activity roughly matches the current distribution of the main oyster beds. Evidence suggests that the last periods of pearl oyster exploitation in the Goajira lasted from about 1900 to 1940. The pearl oyster beds do not correspond to discrete ecological units; rather, they are areas of sea bottom that include the necessary conditions for settlement and growth of one or both species. The beds generally occur at depths of 3 to 10 m, and between a few hundred metres and several kilometres from the coast. The area of largest concentration of oyster beds is between the latitude of Manaure and that of Arema, occupying a total area of approximately 68 $km^2$, divided into more or less discrete units of between 0.0057 and 17 $km^2$.

Ecologically the beds were classified into five types, according to bottom characteristics, settlement, substrata for the oysters, depth and dominant biotic community. The presence of a type of oyster bed in a given area does not exclude other bed types, and transition zones may occur between them. The winged pearl oyster, *Pteria colymbus*, attaches itself almost exclusively to a few octocoral genera, while the mother-of-pearl, *Pinctada imbricata*, has less specific substratum requirements, which determines that the distribution of this species is wider throughout the different types of oyster beds.

The mean density of *P. imbricata* on a per-bed basis varies between 0.05 and 2.77 oysters / $m^2$ and that of *P. colymbus* varies between 0.37 and 2.03 oysters / $m^2$. These densities are high when compared with those reported for the same and other species of *Pinctada* and *Pteria* in other parts of the world. Since the oyster beds have remained unexploited during the last 55 years, the current densities are probably natural densities for this region. The Caribbean mother-of-pearl is capable of producing both cultured round and half-pearls of good quality. The winged pearl oyster seems to have more potential for the production of half-pearls. Although the beds constitute a potential fishery resource for obtaining meat, shells and pearls, their exploitation by means of intensive extraction is not ecologically or economically sustainable in the short to mid-term. The combination of programmes of protection of oyster beds and of field-spat collection practices as a basis for pearl oyster culture appears to be the best alternative for sustainable utilisation of the oyster populations in the Colombian Goajira.

# Perspectives and opportunities for pearl oyster culture development on the coast of Sonora, Gulf of California, Mexico

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## Abstract

This paper presents preliminary results and advances on experimental spat collection and hanging culture of the Panamic mother-of-pearl oyster, *Pinctada mazatlanica*, and the mother-of-nacre oyster, *Pteria sterna.*

## Introduction

These two species of pearl oyster inhabit the Sonora coastline as part of their natural distribution, but both species are present throughout Mexico's Pacific Coast, except for *Pinctada mazatlanica* which is not present on the outer part of the South Baja California Coast.

*Pinctada mazatlanica* can reach a height of up to 200 mm, and has long been considered by many authors to be a variety or sub-species of the black-lip pearl oyster, *P. margaritifera,* valued for its beautiful black pearls.

*Pteria sterna* can reach a height of up to 100 mm, and its nacre has an iridescent, multicoloured hue. Both species constitute the nacre resource of the Gulf of California, and their exploitation reaches back as far as 800 to 1400 AD, by the Seri Indians, native to the Mexican State of Sonora.

Since 1984, the Monterrey Institute of Technology's (ITESM-Guaymas) Bivalve Culture Program has focused on the culture of species native to the Gulf of California, emphasising the adaptation of proven commercial techniques.

This programme includes the polyculture of seven species of bivalves, including three scallops-pectinids (the catarina scallop, *Aropecten circularis,* the flying scallop, *Pecten vogdesi*, and the lion's paw, *Lyropecten subnudosus);* two species of pen shell-pinnids (*Pinna rugosa* and *Atrina maura)*; and the two target species of pearl oyster.

Since the number of adult pearl oysters is limited, due to overfishing and the established 1940s fishing ban on pearl oysters, the future of Mexico's Pearl Culture Programmes will be linked to and dependent on aquaculture operations that involve spat collection or production, nursery and grow-out operations. The natural pearl oyster stocks are not to be exploited in any way.

## Results

Pearl oyster spat is collected in a longline system devoted exclusively for the hanging of experimental mesh bags, similar to those used for scallop spat collection.

Once the seed is big enough to be handled, it is removed from the bags and placed in a nursery system consisting of plastic Nestier trays, when the seed is 3 mm or smaller, and pearl nets, when seed is bigger than 4 mm. When the juveniles reach a size of 10 mm they are transferred to lantern nets hanging on a longline system at a depth of 2 to 2.5 m.

For *Pinctada mazatlanica,* a survival of 20 per cent is expected, while *Pteria sterna* has a high survival of 96 per cent. Mortality is mostly due to crab predation and *Polydora* worm infestation.

Preliminary spat-collection results show that an average of 220 *Pteria sterna* spat per collector can be achieved in the fall season with the use of modified scallop collecting bags made of Rayon, but this method has proven less successful for *Pinctada mazatlanica,* and further spat-collector designs are being tested.

The presumed spat-collecting peak for *Pteria sterna* is in late autumn, and for *Pinctada maztlanica* no peak is yet determined, but a study of the reproductive cycle for both species in this area is under way.

The growth rate, in height, for *Pteria sterna* was of 9.48 mm per month, from 6.63 mm seed to 45.57 mm in a 4-month period. This same group has achieved a size of 57.59 mm 6 months after their collection date (see Figure 1 on next page).

In the case of *Pinctada mazatlanica,* a 3.83 mm per month growth rate was observed from 6.88 mm seed to 22.20 mm in a 4-month period for spat collected in early autumn, and of 4.44 mm per month from 7.0 mm seed to 42.38 mm in an 8 month period for seed collected in summer (see Figure 2 on next page).

Experiments on the production of half-pearls and other pearls on *Pteria sterna* have just begun, using five-to-ten-month-old organisms, and further experiments are soon to start with *Pinctada mazatlanica.*

## *Conclusion*

The culture of the pearl oysters, *Pinctada mazatlanica* and *Pteria sterna*, on the coast of Sonora, Gulf of California, Mexico, shows a good potential, as preliminary data demonstrate.

Wild spat collection, growth in hanging culture and fast pearl formation for both species are promising.

Furthermore, the geographical position of the Mexican State of Sonora makes it ideal for this kind of investment, taking advantage of NAFTA. It is south of the border of the United States, and has good communications by land, air and sea.

The State of Sonora has a total coastline of 1,207 km, most of which is suitable for pearl oyster culture, and virtually unexploited except for a few shrimp farms and rural edible oyster farms, found inside coastal lagoons and estuaries.

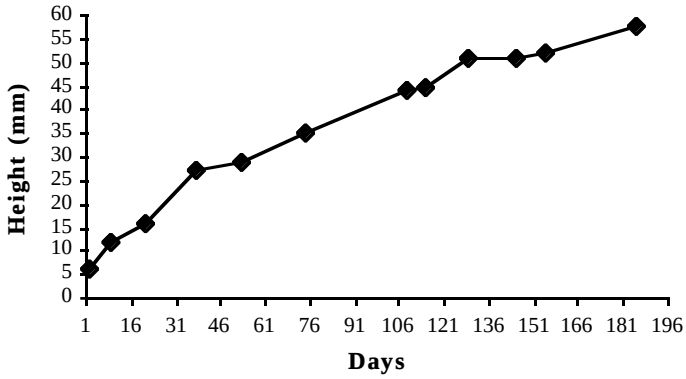



**Figure 1: Growth of mother-of-nacre, *Pteria sterna*, in Bacochibampo Bay, Sonora**

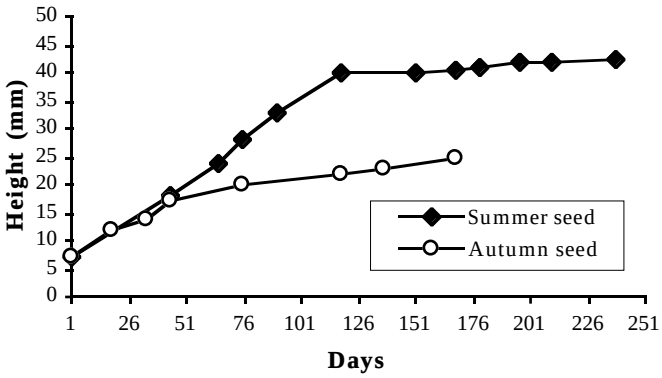



**Figure 2: Growth of the Panamic mother-of-pearl, *Pinctada mazatlanica*, in Bacochibampo Bay, Sonora**

## Suspended culture of the pearl oysters, *Pinctada mazatlanica* (Hanley, 1856) and *Pteria sterna* (Gould, 1851), at different stocking densities, in Bacochibampo Bay, Guaymas, Sonora, Mexico

Douglas Diego McLaurin Moreno,

MSc Thesis-ITESM Campus Guaymas, December 1996

The objective of this study was to describe the growth and associated mortality of a suspended culture, nursery and grow-out of the two native species of pearl oysters, *Pinctada mazatlanica* and *Pteria sterna*, inside Bacochibampo Bay, at different stocking densities.

Studies on the Panamic mother-of-pearl oyster (*Pinctada mazatlanica*) begun in August 1993 (N = 10) and August 1994 (N = 680). Spat was raised inside pearl nets for 6 months, being transferred to pocket or lantern nets for final grow-out. Stocking densities were the following: 30, 70, 125 and 200 org./m$^2$ in nursery culture, and 50, 100 and 150 org./m$^2$ in grow-out.

With the Western Winged pearl oyster, *Pteria sterna*, experiments begun with November 1993, spat collection (N = 3000), using the following stocking densities, for both nursery and grow-out: 150, 400, 650 and 1000 org./m$^2$. Later, an additional group was raised, being collected in May 1994, at 150 org./m$^2$.

Mortality and growth measurements (N = 40 organisms) for each experimental batch were done monthly. Monthly average water temperature was obtained by measuring temperatures daily by means of a Taylor Thermometer (°C). The hanging culture of every experimental batch was finalised by July 1995, although mortality records extended for one more month (August, 1995) for the remaining batches of *P. sterna*.

*P. sterna* had statistically significant differences in growth (ANOVA) at the end of the nursery stage in

the batch with the smallest stocking density (P = 0.000), which had a slower growth (SGR = 0.147 mm/day) compared with the other batches (SGR = 0.160–0.170 mm/day).

Afterwards, during grow-out, the two experimental batches with the highest stocking density had to be eliminated due to unexpected problems. The batch with the smaller density reported a higher growth rate (SGR = 0.131 mm/day). Von Bertalanffy's growth function (VBGF) was obtained, with the following values: $L\infty$ = 138 mm, K = 0.049864, $t^0$ = –1.052353 and ø' = 2.97795.

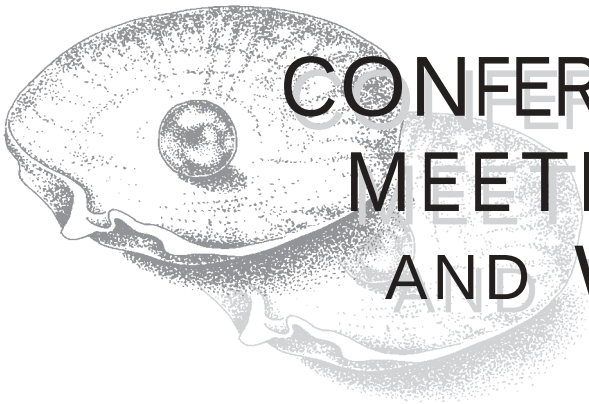
With *Pinctada mazatlanica*, no significant differences were found (ANOVA P = 0.603) during nursery (SGR = 0.10–0.16), although significant differences were found at the end of the grow-out period, both amongst lantern-net experiments (P = 0.033; SGR = 0.125–0.137). Experimental Batch 1, grown inside a pocket net (50 org./$m^2$) registered the best growth, and its VBGF values were the following: $L\infty$ = 180 mm, K = 0.0302; $t^0$ = –2.4228 and ø' = 2.991.

Highest mortality on both species of pearl oyster occurred on those experimental batches with the smallest stocking density, so mortality was attributed to inadequate handling of the oysters. With *Pteria sterna*, the highest mortalities coincided with the summer months (30°C), escalating to a mortality of 54.33 per cent when water temperatures reached 32°C for over 15 days.

In *Pinctada mazatlanica*, higher mortalities were associated with cold winter months (16°C). Batch 1 experienced the highest mortality of all (50%), while Batch 4 had the least mortality (3%), both during nursery. During grow-out, mortality is reduced notably, so it is deduced that the critical handling phase for this species is during its first months of culture.

## *Iranian Fisheries Scientific Journal* contents

The twelfth (Volume 4, No.3) issue of *Iranian Fisheries Scientific Journal* is published in Persian with English abstracts. The issue includes an article on a survey on population size structure and density of *Pinctada radiata* in Iranian coast of the Persian Gulf.



# CONFERENCES, MEETINGS AND WORKSHOPS

## Pearl session at Aquaculture '98, in Las Vegas

*Aquaculture '98*, to be held from 15 to19 February in Las Vegas, could be the largest aquaculture meeting ever held, with more than 3000 persons expected to attend. Pearl researchers are invited to submit papers for a special Pearl Session.

C. Richard Fassler, who headed *Pearls '94* in Honolulu, and chaired pearl sessions at international aquaculture meetings in San Diego and Bangkok, has been asked again to serve as chair.

Record attendance is predicted because of the large number of sponsoring organisations. Principal sponsors are the World Aquaculture Society, the National Shellfisheries Association, and the American Fisheries Society. Associate sponsors include aquaculture associations from Canada, Chile, Japan, Russia, the US, South-East Asia and Latin America.

Another reason for sizeable participation is the spectacular site: Las Vegas is a world-famous entertainment centre, the fastest-growing major city in the US, and one of the world's most exciting locales. In recent years, the city has added a great many attractions, in addition to its well-known casinos.

An added incentive for attendees is the low cost of food and lodging in Las Vegas. The conference hotel—Bally's—is offering rooms for US$ 103 (single/double). Other accommodation can be found in the US$ 50-a-night range.

To receive additional conference information, instructions and abstract forms, contact:

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Fassler is hoping for strong participation. 'Our sessions over the last few years have brought pearl farming to the attention of world aquaculture. This important meeting will provide us with a wonderful forum to show off our research progress and get better acquainted,' Fassler noted. 'And, you can have an incredibly good time in Las Vegas!'

# Paua (abalone) farming symposium held in New Zealand

A two-day symposium on abalone fisheries, biology and culture was held in Wellington during October 1996. The meeting brought together scientists, divers, managers, processors and many others with an interest in the abalone industry. Delegates were mostly from New Zealand and Australia, but other abalone-producing countries such as South Africa were represented.

Australia and New Zealand provide more than half the world's supply of wild-caught abalone. Concerns over dwindling wild stocks have prompted development of abalone culture, and progress in New Zealand's emerging paua-farming industry was a popular topic at the symposium.

Papers were presented on topics which included sea-farming of paua, performance of artificial foods, aquaculture and live transport, and farming prospects in the North Island. The research efforts on paua culture in New Zealand were put into sharp focus by an insightful and provocative review presented by David Schiel (Zoology Department, University of Canterbury).

Rod Ewing indicated that investment was needed to boost research and development in paua aquaculture in New Zealand. His paua-culture operation in New Plymouth had recently received substantial overseas investment geared to the production of abalone meat and pearls. David Schiel pointed to three primary sources of funding: Public Good Science Fund, Technology of Business Growth, and private investment. Research priorities in New Zealand for aquaculture are likely to be industry-driven, and several delegates pointed to the need for a more productive interaction between research agencies and industry.

Attracting investment funds to paua-farming operations in New Zealand will always be difficult until cost-effectiveness can be demonstrated. David Schiel and others had already indicated the prohibitively high costs of rearing paua to commercial size. Paua are lowly placed in the market hierarchy of acceptable product on export markets. However, Rod Ewing pointed out that New Zealand had a competitive advantage in producing the unique shell coloration characteristic of paua. Such an advantage was particularly useful in promoting paua pearls, which is a burgeoning industry in New Zealand and other abalone-producing countries.

**Source:** *Aquaculture Update*, Issue No. 16, Spring 1996. Published by the N.Z. National Institute of Water and Atmospheric Research, Ltd.

Interested readers should contact Bob Hickman, Editor, at P.O. Box 14-901, Kilburnie, Wellington, N.Z., or e-mail: r.hickman@niwa.cri.nz.

# Biology seminar in Tabriz, Iran

In September 1996, a biology seminar was held in Tabriz (northwest of Iran). Researchers of IFRTO participated actively in this seminar and presented the following papers, among others:

- Preliminary study on chlorophyll-a in coastal waters of Bandar Lengeh in connection with *Pinctada radiata*, by K. Rohani, Molluscs Fisheries Research Centre;
- Introducing causes of mortality in *P. radiata* in Bandar Lengeh, by A. Jahangard, Molluscs Fisheries Research Centre;
- Identification of habitats of *Saccostrea cucullata* along the coastline of the Persian Gulf, by B. Vosooghi, Molluscs Fisheries Research Centre.

# Bottle full of pearls

Dr Mario Monteforte, of Jefe del Grupo Ostras Perleras in La Paz, Mexico, posted the following note on the Internet (posted in aqua-l@listserv.ifmt.nf.ca):

Colleagues,

Anyone interested in a short Internet discussion on pearl oysters? I have a couple of responses (in this regard). I am not very advanced on (the) Internet, so I would like advice on how we could manage.

We all have something to share, we all need something to know.

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# Late news . . .

## Nuku'alofa

Pearl cultivations in Tonga will soon be extended to Tongatapu and Ha'apai islands, as the trial project in Vava'u has shown positive results.

This was revealed Tuesday by King Taufa'ahau Tupou when opening the Ha'apai Agricultural and Industrial Show, Radio Tonga reports.

He said pearl farming is a great success in French Polynesia, with an annual earning of about $US 100 million. And Tonga intends to produce cultured pearls for export as in Malaysia, Japan, Australia and Tahiti.

The King says negotiations are underway with a Japanese company to build rafts as the base for cultured pearls, which take three years to mature.

**Source:** PacNews

PIMRIS is a joint project of 5 international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the South Pacific Commission (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission (SOPAC), and the South Pacific Regional Environment Programme (SPREP). Funding is provided by the Canadian International Development Agency (CIDA) and the Government of France. This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ('grey literature'); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

PIMRIS

Pacific Islands Marine Resources Information System