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# PEARL OYSTER

*INFORMATION BULLETIN* Number 5 — September 1992

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## NOTE FROM THE EDITOR

The *Pearl Oyster Information Bulletin* and Special Interest Group were originally conceived as a medium for improved information exchange among Pacific pearl oyster people. The principal target audience was the South Pacific fisheries fraternity, and specifically the pearl oyster biologists, pearl farmers and industry management folk on the far-flung atolls within the area of the South Pacific Commission. As I said in the last issue, however, the broader perspectives and the wider network are also important to the South Pacific. We always wanted to be inclusive, rather than exclusive. We wanted to be flexible. This has inevitably meant that our growth has ended up being a little amorphous.

We are left feeling a little unsure as to what exactly it has all grown into. It might be appropriate now to take a look at ourselves, to see who we are and what we can do for each other. You will therefore find a reader survey and questionnaire appended to this issue. Please fill in as much you can, and return it to me, at the above address.

We recognise the difficulties that some members or their employers have with protection of information. We therefore are not going to publish any of this, if you ask us to keep it confidential. Just tick the appropriate box. If we can use your data or answers, but not in association with your name, then just tick the 'Anonymous' box.

We do have a couple of areas where we think some changes or additions might improve the *Bulletin* and give the Special Interest Group more of a sense of unity and purpose (cont. page 2).

## Inside this issue



PIMRIS is a joint project of 4 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's Pacific Information Centre (USP-PIC), and the South Pacific Applied Geoscience Commission (SOPAC). Funding is provided by the International Centre for Ocean Development (ICOD) 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

We would like to give it a little more shape, to encourage it to grow in the areas we think are beneficial. Before we establish any directions for change, however, we would like your opinion on how we could serve you better. We want to know what you want to know.

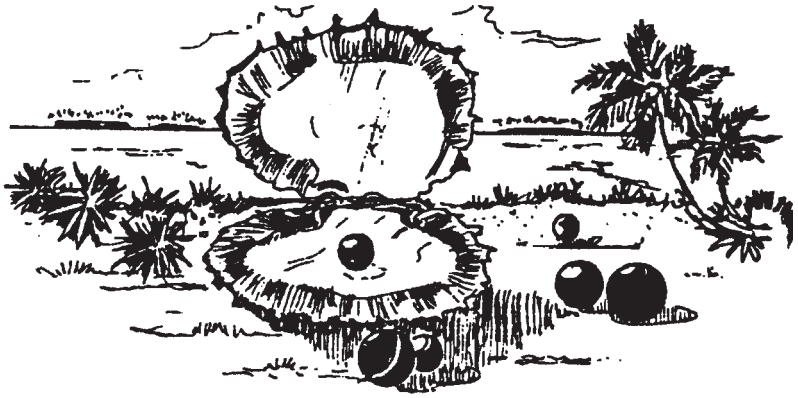
Equally important is finding out how much you are already know, and how much of this you might be willing to share. Would a pearl trade directory be helpful? Fine, but you will have to tell us who you trade with. You want to see more marketing information? You are going to have to send us clippings of reports from your auctions. You want to know more about the other readers and what they are up to? Well, then, you are going to have to tell us a little bit about yourself and what you are doing. You want more pictures? You are going to have to send us the photos. As in most areas of life, you get out of the *Bulletin* only what you put in.

These questions are all part of the bigger, broader question we probably need to be asking ourselves: 'Are we, as pearl people, going to remain isolated in our own protective shells? What can be gained by sharing information among ourselves? What do we lose? Is the wider perspective ultimately a good thing?'.

The *Bulletin*, like a democracy, relies on the participation of its constituents. This is more than your chance to vote — it is your chance to comment on the constitution.

Neil A. Sims

# NEWS FROM MEMBERS



## ERRATUM

***Source: Reuben Tylor, Auction Administrator, Rarotonga, Cook Islands***

*Mr Reuben Tylor, Auction Administrator in Rarotonga writes:*

"... I am concerned at the number of inaccurate reports concerning the Cook Islands industry at least in your February issue... e.g. the report on the auction says that those pearls not sold in the auction were later sold in a closed session at renegotiated prices. You can imagine how those buyers who bought at the auction and then departed will feel when they discover that the next day the rest of the pearls were sold at a lower price. They will not bid at the next auction and will wait for the closed session instead. The truth is that no pearls were sold after the auction in a closed session, and a copy of the newspaper's retraction is enclosed."

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*Note from the editor: The Pearl Oyster Information Bulletin regrets the error. We strive to maintain a high level of accuracy in our Bulletin, but our excerpts can only be as reliable as our sources. We will publish retractions and corrections whenever they are drawn to our attention. The offending paragraph (p. 11, POIB #4) was taken from the Cook Islands News, June – August 1991. The retraction by the newspaper reads:*

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The remaining third of pearls withdrawn from this week's auction were not sold during a private session from which the media and others were excluded, say the auction organisers.

The *Cook Islands News* had been incorrectly informed by an unnamed source at the auction that those pearls withdrawn from the auction (because their reserve prices were not reached) were sold after the auction proper had been completed.

The newspaper regrets any misunderstanding that might have arisen from that incorrect report.

Apparently, according to organisers, the media and others were excluded from the auction room for maximum security reasons after the auction was completed, so that the pearls could be brought out and recounted again for those who had successfully bought them. The 'private session' was also to work out how credit arrangements would be made for the pearl lots sold.

The *Cook Islands News* understands that alternative arrangements will be sought for the third of pearl lots not sold during the auction.

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Mr Tylor also provided the following items of interest from the Cook Islands:

## Pearl Consult Inc. formed in the Cook Islands

A specialist consultancy company has been formed specifically to provide services for the cultured pearl industry. The company, Pearl Consult Inc, has been formed by Reuben Tylor and Anthony Manarangi who have been involved in many aspects of the industry in the Cook Islands over the last five years. Mr Tylor emphasised that PCI gives access to the individual expertise that has been build up at various levels of the industry in the Cook Islands, at both private sector and government levels.

This expertise does not just include practical aspects of farming, seeding and marketing, but also economic appraisal for new projects and Government policy assistance on matters such as infrastructure requirements and attitude to foreign investment.

PCI is registered with various regional and other aid bodies and can be contacted at the following address:

P.O. Box 869
Rarotonga
Cook Islands
Fax (682) 23843

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## Cash flow shortages in Manihiki

Severe cash flow shortages have hit pearl farmers in Manihiki. Farmers had been earning income largely from the sale of oysters and employment by the island's biggest employer, Cook Islands Pearls Ltd. However, following decisions by the Manihiki Island Council to stop diving for oysters, Cook Islands Pearls Ltd stopped buying oysters and cut back its labour forces dramatically, leaving a serious shortfall in income for pearl farmers. Lack of support from commercial banks led to several farmers having to sell their farmed oysters off to new incoming farmers. Meanwhile an ADB pilot project is awaiting finalisation; if approved, it will make new sources of finance available to farmers. The project is targeted for September 1992.

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## Rarotonga auction cancelled for 1992

The Cook Islands Black Pearl auction that raised over $3 million in 1991 and attracted over 50 overseas buyers, will not be held in 1992. The 1991 Auction Administrator, R.W. Tylor, advised that the smaller private farmers for whom the Auction was to be organised did not have sufficient quantities of pearl to justify the expense of the Auction. The main harvest was expected in late 1992, after the normal auction date. It was likely, he said, that the auction would take place in 1993.

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## Lagoon warming

Regular temperature readings in Manihiki lagoon have not shown any evidence of a re-occurrence of the lagoon warming that occurred in 1991. The warming was commonly identified as being one of the major factors responsible for the comparatively lower quality of the 1991 harvest, as compared with the 1990 harvest.

## Activities of the Sudan—IDRC oyster culture research project

*by Dr Osman M. Farah,*
*Red Sea Fisheries Research Centre,*
*Port Sudan, Sudan*

### Introduction

The mother-of-pearl oyster *Pinctada margaritifera* var. *erythraensis* (Jamenson) has been cultivated in Dongonab Bay since 1904. Dongonab Bay, which lies about 160 km north of Port Sudan (Figure 1), is the major natural breeding ground for mother-of-pearl oysters. This is mainly because the bay is large (area of about 305 $km^{2)}$, shallow (average depth=16 m), protected and with many areas of rocky and sandy bottom offering good chances of survival after settlement. The circulation regime during breeding seasons favors retention of larvae inside the bay.

The oysters are valued only for their shells, which are mainly used in the manufacturing of large buttons for women's fashion, knife handles, jewellery, inlay work and poultry feed. The shells used to be exported, mainly to Italy and Germany. Recently there has been a good market for shells in Egypt.

The shell industry is getting very profitable because there is a good market for the shells. Shell price has increased dramatically during recent years. The selling price of a kilogram was 6 SDP in 1986, 30 SDP in 1989, 40 SDP in May 1990 and 60 SDP in October 1990 (12.1 SDP = US$1.00). The high price has attracted many fishermen and encouraged them to switch from catching fish to diving and collecting wild oysters. The private sector is also getting involved in the oyster business.

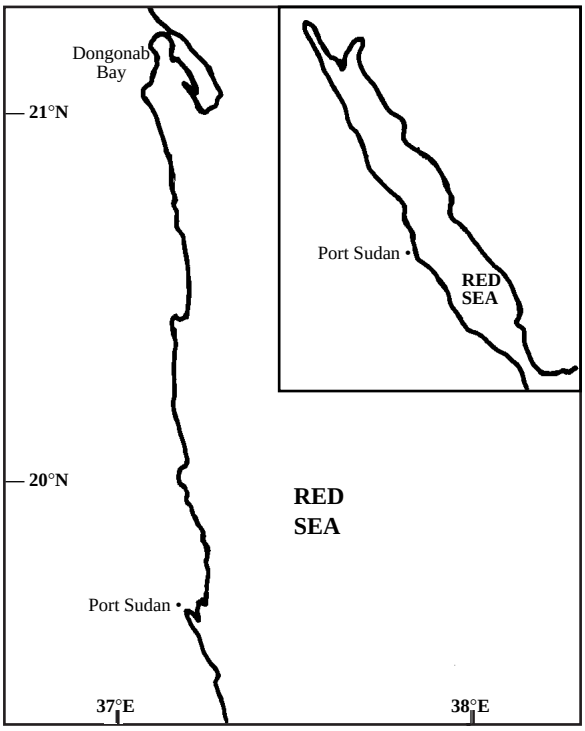


**Figure 1. Location of Dongonab Bay**

### Activities of Phase I (1978–1985)

The general objective of Phase I was to develop a culture technology that can be handled by artisanal oyster farmers.

The following activities were conducted during Phase I:

#### *1. Seasonal changes in the condition factor of Pinctada*

The objective of this study was to make general observations on the seasonal changes of condition factor (fatness) of the oyster and determine the breeding season. Results showed that there was a drop in condition factor in May to July due to the spawning season.

#### *2. Identification of Pinctada larvae*

Using the method of comparing and matching advanced umbonal stages of larvae with the prodisconch of recently settled spat, three types of larvae were suspected to be *Pinctada margaritifera*.

#### *3. Efficiency of different substrates in spat collection*

Several materials were tested to determined their efficiency in spat collection. Bamboo, half shells, plastic mesh and asbestos sheets were used. Half shells were the most efficient, followed, by bamboo, plastic mesh and asbestos in descending order.

#### *4. Distribution of Pinctada spat*

The objective was to discover the horizontal and vertical distribution of spat. Collectors were erected at several sites in Dongonab Bay, in addition to the traditional site at Um Elshiek, near the surface and down to the sea bottom at intervals of one metre.

Results showed that several sites inside Dongonab Bay were good for spat collection (e.g. Abu-faham, Abu Salama, Saatalla, Sarara). It was also shown that spat can be collected from sea surface down to 4 m with maximum density at 3 m.

### *5. Seasonal variation in spat setting at the Dongonab village site*

The main objective was to have an insight into the seasonal variability of spat setting, with the aim of defining the breeding season of *Pinctada margaritifera*. Fourteen shells were suspended from a long line just below the sea surface at Dongonab village site. Cultch were removed every two weeks and replaced by new shells of approximately similar dimensions. The shells removed were examined for number, height and length of attached spat. Results showed a high density of spat between July and August, indicating that the breeding season was from June to September.

### *6. Culture of Pinctada in various materials*

This was to test the efficiency of several materials of different designs in the cultivation of oysters. Folded plastic mesh sheets, nylon tubes and Japanese baskets were used. Results showed that nylon tubes are the best, followed by Japanese baskets, large mesh size plastic mesh and finally by small mesh size plastic mesh. But the nylon tubes were not practical and with Japanese baskets, the oysters are subject to predation. Therefore large mesh size plastic mesh was determined to be the best.

### *7. Influence of depth on the growth of oysters*

To check the suitability of the whole water column for oyster cultivation, oysters were cultivated at various depths from near the surface down to the bottom. Results showed that the whole water column could be used for oyster cultivation.

### *8. Growth rates in different localities*

The objective of this experiment was to explore the possibility of expanding oyster cultivation outside Dongonab Bay. Mohamed Qol and Shanab Bay were the sites selected in addition to Dongonab Bay. Results showed that the growth rates were satisfactory at all sites, with maximum rates in Shanab Bay.

### *9. Oyster growth in relation to fouling*

The purpose was to see the effect of fouling organisms on oyster growth rate. Results showed that fouling has little effect on growth especially at low densities (density used was 50 oysters / 0.2m$^2$).

### *10. Training*

Three graduates supported by IDRC obtained M.Sc. degrees. Two graduates supported by the Sudan Government obtained Ph.D. degrees.

It can be seen from above that the research done in Phase I was mostly biological and established the capacity of the Red Sea Fisheries Research Section to do research on the culture of the oyster. This led to Phase II where specific objectives were more concentrated on culture methods.

## Activities of Phase II (1985–1990)

The general objective of Phase II was to re-establish commercial mother-of-pearl oyster culture along the Red Sea coast. The specific objectives were:

1. To assess suitability of embayments, besides the traditional site at Dongonab Bay, for *Pinctada* spat collection and cultivation;

2. To evaluate, on a commercial and pilot scale, alternative culture techniques to maximise economic returns;

3. To develop the capacity for oyster pathology research and investigate the causes of the mass mortalities;

4. To help establish commercial farms by demonstrating culture techniques to farmers and extension workers;

5. To further strengthen oyster research capability within the Red Sea Fisheries Research Section.

To achieve the above objectives the following research was conducted.

Objective 1: To assess suitability of embayments, besides the traditional site at Dongonab Bay, for *Pinctada* spat collection and cultivation

This strategy is based on spreading cultivation over most of the Sudanese coast instead of at one site so that commercial production will not be jeopardised by occasional mass mortalities occurring at one or a few sites. In April 1986, only four sites were selected: Halaib, Arakyai, Halou and Swakin (Figure 2). In February 1987, another site (Dalaout) was added. The criteria for site selection are that the site should be protected and have wide areas of relatively shallow (<10 m) waters. The site should be near inhabited areas and easy to reach by truck.

At each site, 6 Japanese baskets covered with 1 / 2in rabbit wire were attached to a long line. Each basket contained 50 oysters randomly taken from spat. Initial oyster height was recorded and growth rates and oyster survival were monitored.

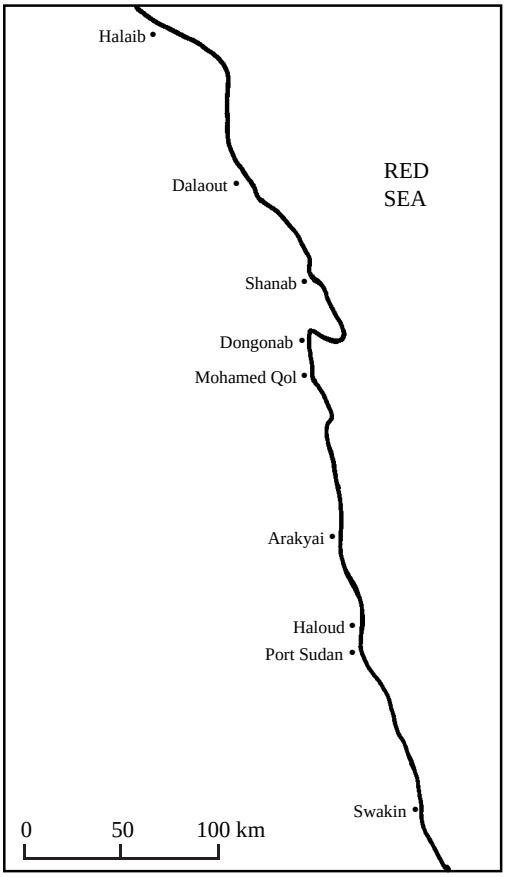


**Figure 2. Index map showing site locations**

The results show that growth and survival rates were good at all sites tested and were comparable to those at the Dongonab site. This finding indicates that most of the coastal area is suitable for oyster cultivation. Transport and other problems made expansion of the site evaluation difficult. It was decided that effort should be concentrated on three sites: Dongonab, Mohamed Qol and Arakyai. The first two have been used for many years and Arakyai seemed to have the most potential of the five sites, but was not successful.

Objective 2: To evaluate on a commercial and pilot scale, alternative culture techniques to maximise economic returns

## A. Spat collection

The traditional spat collectors (wood frame + bamboo sheets) developed by Crossland and Reed were too large and massive (1m x 1m x 4m) to be constructed, transported and handled by farmers who only have canoes or small boats. Therefore, collectors that are not expensive, small, efficient, and easy to install by a single farmer have been considered. In 1986, bamboo collectors (both frame and sheets) of varying sizes (frame dimensions 100cm x 100 cm x 100 cm, 100 cm x 75 cm x 75 cm, 100 cm x 50 cm x 50 cm) were constructed and used for spat collection. Sheets of Doum palm rope with bamboo frames (60 cm x 30 cm) were also used for collecting spat. To determine spat loss during the spat collection period (July–Nov.), some bamboo and some doum palm rope sheets were covered with 1/2in rabbit wire.

It was observed that small bamboo collectors are more efficient and less expensive than the medium and large bamboo collectors. Although the doum palm rope sheets are the most efficient and the least expensive, they are not recommended because they deteriorate so rapidly that if they are left in the water until November, the spat will be totally lost. If they are removed from the water before November, the spat attached to them will be too small and will pass through the 1/2in rabbit wire used in the trays and fall on the bottom. It was also seen that covering collectors increased spat production (26 per cent for bamboo collectors and 11 per cent for doum palm rope sheets) but the production cost/spat was increased by 69 per cent and 75 per cent for bamboo collectors and doum palm rope sheets respectively. Therefore it is not recommended to cover collectors.

In 1987, the above experiments were repeated. Bamboo collectors were made of 10, 9, 8, 7, 6, 5, 4 and 3 bamboo sheets to see the effect of sheet number/collector on the efficiency of the collector. Bamboo and doum palm rope collectors were erected at previously tested sites (Halaib, Dalaout, Arakyai, Haloud and Swakin) to investigate the possibility of collecting spat from these sites. The following results were obtained:

— Density of spat is independent of sheet number/collector. For bamboo collectors spat density/$m^2$ ranged between 60 and 956 oysters while oyster height ranged between 3.20 to 3.83 cm with an average of 3.5 cm;

—Doum palm rope collectors were about 3 times as efficient as bamboo collectors (spat/$m^2$ ranged between 480 and 2,000 with an average of 1,045 and oyster height ranged between 2.98 and 3.76cm with an average of 3.3 cm). However, most of these collectors were lost before November 1987;

—Size of spat increased with decreasing densities;

—No spat was recorded from collectors in the areas outside Dongonab Bay.

In 1988, 33 collectors with 4 sheets each were erected for spat collection. Results showed that the average

spat height was 2.4 cm and average spat density was 1,305 / $m^2$ which is greater than 3 times that of 1987 and double that of 1986.

In 1989, several experiments dealing with spat collection were conducted. Usually spat collectors are put out at the end of June or early July. In 1989, some bamboo collectors were put out in early June. Others were put out in early July to see if the spat collection period would be missed by putting collectors only at this time. To see the effect of protecting collectors, some of them were covered with rabbit wire while others were left uncovered. Collectors made of nylon ropes as netting material were also used, to test their efficiency.

It was seen that 1989 collection was poor with an average of 218 spat / $m^2$ for both covered and uncovered June and July bamboo collectors (≈1 / 6 of that of 1988). It is also strange that collectors put out in June (whether covered or uncovered) collected less spat than those put out in early July. In all cases, covered collectors produced substantially more spat than uncovered ones but despite this increase in production, the production cost was not reduced. Therefore it is not recommended to cover collectors.

Nylon rope collectors produced three times more than July uncovered bamboo collectors. Cost / spat for the nylon rope collectors was about quarter that of the uncovered collector. Therefore, nylon ropes are recommended but should be tested again.

It is concluded from spat collection studies that:

— Spat density and height vary greatly from year to year. Therefore, using a large number of collectors does not guarantee a large crop. Therefore, a spat-fall forecasting system should be developed;

—Cost of spat collection is increasing so rapidly that within 3 years (1986 to 1989), the cost increased almost 14 times. Despite this increase, the shell industry is getting more profitable because there is also a rapid increase in the selling price of oyster shells.

**B. Larval identification**

In Dongonab Bay, the annual breeding season could vary but in general oyster spawning occurs in summer. To establish a system of spat-fall forecasting, different larval stages must be known. It is necessary to follow larval growth as a method of spat-fall prediction. The accurate method of determining larval species is by culturing. It has not been possible to do the larval culture work necessary to establish larval identity. However some work was done on identifying the very early juvenile oysters.

In 1986, a study was undertaken for the identification of the advanced larval stages by matching the shape of the advanced larval stages (late umbo) with the disoconch of the smallest spat that was obtained. Results showed that the advanced umbonal stages observed were of 10 different shapes. Only two of these match with the *margaritifera* spat. More work is needed to culture larvae in the lab.

**C. Culture methods**

To improve production of mother-of-pearl shell in the Red Sea, grow-out culture methods such as ground, bottom and off-bottom were tested and evaluated in terms of shell growth, survival rate and cost of culture material. The experiment started in January 1986 and terminated in September 1987 with initial stocking density of 170 oysters / $m^2$.

The results show that the off-bottom culture method is the best of all three methods tested because the fast growth rate and high survival rate give high shell yield. The above experiment also showed that both growth rate and cost decrease going from off-bottom to ground culture. With proper management of the stocking density it seems that early off-bottom culture can be economical, with the second and third year in bottom trays.

A pilot scale experiment started in Dongonab Bay in February 1989 to evaluate the timing of holding the oysters in off-bottom trays, on the bottom in trays and directly on the sea bottom. In this experiment 1.8m x 1.8m trays were used. Each tray was stocked with 648 oysters (stocking density = 200 oyster / $m^2$).

The oysters were covered with 1 / 2in rabbit wire. Nine trays were hung from a long line and nine were placed on cement blocks 40 cm above sea bottom. For ground cultivation, oysters were placed directly on three sandy areas each 1.8m x 1.8m and covered with 1 / 2in rabbit wire. These trays have been checked regularly. Shell height and survival have been recorded as well as material cost, labour cost, etc for each system.

In December 1989, three off-bottom trays were moved to the bottom on cement blocks and three bottom trays were moved to ground areas (Figure 3). Also in December 1989, a new set of 21 replicates similar to those of February 89 were set up. In September 1990, 21 more replicates similar to those of December 1989 will be started, three off-bottom

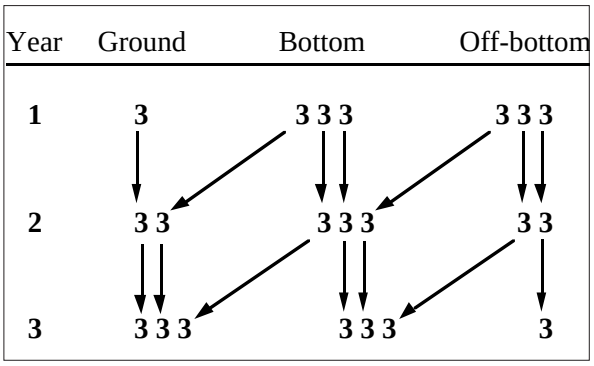


**Figure 3. Experimental design of the pilot scale project at Dongonab Bay. Numbers indicate groups of replicates as they are transferred from one culture method to another over the 3 years of the experiment.**

trays will be moved to bottom trays and three bottom trays will be moved to ground areas for the February 1989 and December 1989 replicates. Final results for February 1989 replicates will be obtained after February 1992.

### D. Testing new culture materials

Traditionally rabbit wire has been used to cover oysters on nursing and growing trays for protection. In recent years, the quality of the rabbit wire has decreased and the price has increased so rapidly that it might seriously affect the oyster industry in Sudan. Therefore, other materials that can be used instead of rabbit wire should be tested. In December 1987 an experiment was set up to test plastic mesh of various mesh sizes in addition to the rabbit wire. The experiment was terminated in May 1988. Oysters aged two years with shell height of 10.0 cm were cultivated at a stocking density of 200 oysters per tray in bottom culture system. It is concluded from the results that 3/4in plastic should be used to replace rabbit wire.

Because both plastic mesh and rabbit wire are imported, locally available materials (bamboo, wood, nylon ropes) have been examined as netting materials. Other materials (wood, metal pipe) have also been tested as tray frames in addition to the traditional heavy wire mesh. The experiment began in February 1989 and will continue for a complete culture cycle (2.5 years).

Shells of initial height of 3 cm were cultured at an initial stocking density of 350 oysters/tray. The oysters were cultured in 8 trays of different frames with different netting material. All wood frames (3) having bamboo, wood and nylon rope netting materials were damaged and excluded from the experiment, leaving only five frames (4 heavy wire mesh and 1 metal pipe).

It is really too early to draw conclusions from this experiment because we have to wait for a complete cycle (2.5 years). The general remark that can be made is that the tray that has the highest growth rate has the lowest percentage survival and vice versa.

### E. Size grading

In an M.Sc. thesis (ElNaiem, 1984) it was shown that shell production can be increased up to 27 per cent when animals are graded in their second year of cultivation. The effect of grading throughout the whole culture cycle was not tested. In January 1986, grading was started to determine its effect on shell growth, survival and shell quality for a period of three years. Three experimental groups of oysters were cultivated:

1. Graded small oysters with initial height of < 3 cm with an average of 2.2 cm;

2. Graded large oysters with initial height of <5 cm with an average of 5.5 cm;

3. Ungraded oysters of heights ranging from 1.7 to 7.5 cm with an average of 4.1 cm.

It is reported that the height-specific growth rate (HSR) used to measure the effect of grading on oyster growth indicates that the graded oysters (average of small and large graded shells) have a growth rate that is 30, 47 and 29per cent higher than the ungraded oysters for the first, second and third years respectively. The final shell weight of graded oysters is 35 per cent greater than that of ungraded shells. Oyster survival is slightly higher for graded oysters than ungraded oysters. Although it is recommended that oysters should be graded to have a better yield, grading needs to be tested satisfactorily on a large scale.

### F. Predation

Spat taken from collectors are covered with rabbit wire for protection until they are more than one year old. The size at which oysters become resistant to predation has not been determined. From January 1986 to May 1988, studies were undertaken to see the effect of predation on oyster growth and survival and to determine the size at which oysters become predation-resistant. Oysters of different ages and different heights were grown in exposed and protected trays. The results indicate that predation has no effect on shell growth. It also indicates that oysters over 11 cm, or about 2 years old, could be cultured without protection and still have reasonable survival. The culture of uncovered older oysters needs to be tested satisfactorily on a large

scale.

Objective 3: To develop the capacity for oyster pathology research and investigate the causes of the mass mortalities

The short-term training of a Sudanese pathologist in bivalve pathology was completed. Following this, a baseline study of *Pinctada margaritifera* was started by sampling normal oysters and examining them histologically. During this study and from other samples taken from groups held in stressful culture situations, there has been no sign of any pathogen. However, the technicians stationed at Dongonab have been shown how to take and preserve oyster samples if there is any sign of abnormal mortality starting in any group of oysters. So far there has been no mortality of this sort in Dongonab. There was one occurrence of very high mortality at Arakyai which is still completely unexplained. The lack of significant mortality in Dongonab Bay over the five years of Phase II is a big change from earlier times. One reason may be the improved maintenance now provided to the trays.

Experimental induction of stress was planned during Phase II. The biological response of the oysters and the role of stress in favoring pathogens was to be observed. An overcrowding experiment was conducted on 20-month and 10-month-old oysters. Densities used for the 20-month-old oysters were 20, 97, 179, 194 oysters / $m^2$. No trend relating survival to densities was observed. Densities used for the 10-month-old oysters were 247, 494, 741, 988, 1,235, 1,481 oysters / $m^2$. Results showed that survival decreased with increasing densities reaching 54 per cent at 1,235 oysters / $m^2$ and 30 per cent at 1,481 oysters / $m^2$. Apparently, these densities did not reach a stress level. Therefore more work is still needed. An exposure-to-air experiment was also conducted on oysters 5 months (spat), 15 months and 25 months old. Results showed that young oysters (spat) were less resistant to exposure and all spat died in the first day of exposure. Rinsing of oysters with sea water increased their resistance to air exposure.

Objective 4:To help establish commercial farms by demonstrating culture techniques to farmers and extension workers

Demonstration farms were initially set up at Shanab Bay, just north of Dongonab, and Mohamed Qol, just south of Dongonab. These farms consisted of several large trays to be maintained by a local fisherman. They were to receive 50 per cent of the production. The farm in Shanab failed when the fisherman left. Although it looks like a good site for oyster culture, Shanab has no resident human population, which causes difficulties. The farm at Mohamed Qol has had reasonably good maintenance and yield has been satisfactory. A third farm was set up in Dongonab a year later which has also been going well. Production at the farms was good in 1988, with about 300 to 500 kg per farm, but decreased in 1989, to about 50 to 90 kg per farm. It is thought that the decrease may be due to the 'unreported harvesting' of the stock.

A large farm at Arakyai was set up in collaboration with the Marine Fisheries Department in 1988. Unfortunately, there was complete mortality of the stock early in 1989. The cause has not been explained.

**Other related research**

Meteorological and oceanographic studies have been conducted at the Dongonab Bay, Arakyai and Halaib sites. Results showed that conditions were normal at these sites. In May 1989, a sudden rise in air and water temperatures (water temperature reached 27°C) was observed in Dongonab Bay. Oysters in shallow areas were reported dead. The sudden rise in temperature was thought to be the cause of that mortality.

Objective 5:To further strengthen oyster research capability within the Red Sea Fisheries Research Section

Short-term training has been completed for three of the full-time scientists in Port Sudan and for the pathologist who is stationed in Khartoum. One scientist presented a paper at the World Aquaculture Society Meeting in Guayaquil, Ecuador and subsequently had short term attachments at the IDRC-supported oyster culture project in Jamaica and at Dalhousie University. Another scientist attended the IDRC-supported Economics in Aquaculture short course at University Pertanian Malaysia. The third Port Sudan scientist had a two-month attachment at the University of Delaware to learn coastal oceanography methods. The pathologist spent two months with an oyster pathologist at Rutgers University in New Jersey, USA.

**Reference**

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*This article is a reprint of an article from* Out of the Shell: *Mollusc Culture Network Newsletter, Vol. 1 (4), February 1991, pp. 5–12.*

*Editor's note: refer also to the abstracts on p 44 and 45 of this issue of POIB.*

## Collaborative *Pinctada margaritifera* research programme proposed

*by Garry Preston,*
*South Pacific Commission,*
*Noumea, New Caledonia*

SPC Senior Inshore Fisheries Scientist Garry Preston has been working with Australian and Pacific Island marine scientists in the development of a major three-year research programme aimed at investigating specific research questions on the biology and culture of the black-lipped pearl oyster *Pinctada margaritifera*. The Pacific Island Pearl Oyster Resource Development Project is expected to form Phase 1 of a two-part activity, the second phase of which will focus on extension of research results to Pacific Island countries. The Phase 1 project is to be submitted for funding consideration to the Australian Centre for International Agricultural Research (ACIAR).

The project is still under development, but at present Phase 1 consists of four components, to be carried out by three different Australian institutions working in collaboration with interested Pacific Island governments and agencies. Collaborating institutions are: James Cook University, Townsville (coordinating organisation); the Australian Institute of Marine Science, Townsville; the Queensland Department of Primary Industries; the South Pacific Commission; the Ministry of Marine Resources, Cook Islands; and the Ministry of Natural Resource Development, Kiribati. Other countries are likely to join in as the project develops.

The overall aims of the project are:

— to support Pacific Island countries' attempts to develop and increase fisheries and aquaculture activities based on pearl oysters;

— to investigate methods of restocking, hatchery production and husbandry of these organisms suited to application in the Pacific Islands;

— to improve understanding of the population biology, genetics, pathology and histology of these animals in support of this work.

Specific research targets are:

— *Develop a simple, low-technology method for increasing settlement and survival of pearl oyster larvae in locations where resources are impoverished*

This component will be carried out by James Cook University, under the direction of Dr John Lucas, and will involve developing and testing a simple, low-cost larval and juvenile rearing system for improving pearl oyster spat-falls. If this can be done successfully, it is likely that a substantial part of the extension phase (Phase 2) of the project will involve applying the system in selected Pacific Island locations to assist pearl oyster replenishment in those islands.

Other activities will include the evaluation of simple hatchery culture techniques, the study of aspects of reproductive biology and early life history of pearl oysters, and investigation of the biological and technical characteristics of low-key culture technologies that may be applicable to pearl oysters.

— *Identify and describe common pathogens, diseases and parasites present in pearl oysters and recommend practices to minimise disease outbreaks*

Using samples collected by a variety of means, including pearl oyster surveys carried out by SPC and national fisheries agencies, Drs John Norton and Ian Anderson of the Oonoonba Veterinary Laboratory of QDPI will conduct pathological and veterinary examination of pearl oyster populations. Specific aims are to document the occurrence and distribution of parasites and pathogens within and between atolls, to estimate the likely potential for introduction of pathogens and diseases when translocating pearl oysters from one location to another, and to recommend action that might be taken to minimise deleterious consequences of such translocations.

— *Develop more productive methods of seeding cultured pearls using improved surgical techniques, and assess the feasibility of tissue culture as a means of improving pearl-sac and pearl quality*

This component, to be carried out by the Queensland Department of Primary Industries, will involve surgical and histological studies of pearl seeding techniques and of the pearl formation process, in order to identify means of increasing the proportion of gem-quality pearls produced by seeding operations. Specific areas of investigation will be: possible improvements in surgical techniques used during innucleation (stress reduction, anaesthetics, sterile technique, etc.) that will lead to fewer rejected nuclei and deformed pearls; to examine the histological process of pearl formation and identify characters of the pearl-sac responsible for variations in quality; and to develop mantle tissue culture lines that could ultimately be used as a superior alternative to donor oyster mantle tissue as a basis for pearl-sac formation.

—*Describe the population structure of pearl oyster resources in the Pacific, and monitor the effects of translocation and stock enhancement programmes on genetic resources*

Samples collected at the same time as those used in the pathological / histological studies (above) will be analysed by the Australian Institute for Marine Sciences using allozyme electrophoresis techniques, to determine variations in the genetic makeup of pearl oyster populations from different Pacific locations.

This work, to be supervised by Dr John Benzie, will enable documentation of the degree of genetic differentiation occurring within and between locations; estimation of the degree of genetic interchange occurring; and elucidation of the likely consequences, in terms of loss of genetic material, of translocating pearl oysters among atolls of the region. Monitoring of the genetic effects of translocation and resource enhancement programmes through repeat analyses in selected locations will also be undertaken. By the end of the three-year research phase, it should be possible to acquire a broad picture of the pearl oyster population genetic structure across the region, and to recommend action that might be taken to minimise deleterious consequences of translocations.

The activities to be undertaken during the extension phase will be developed in response to the results observed as Phase one proceeds. Likely activities during the extension phase, which should commence in 1995 (or perhaps earlier) are: extension to Pacific Island countries of low-technology methods for enhancing pearl oyster reproductive success and spatfalls; field trials of improvements to surgical methods used in pearl seeding to improve pearl quality; and dissemination of Phase one research results through a technical workshop on pearl oyster resource development.

In March 1992, the draft project outline will be discussed by representatives of the Australian agencies and Pacific Island countries that have so far been collaborating in its development. This will permit finalisation of the project document in time for the ACIAR board of management meeting at the end of March. In the meantime, SPC will be financing the genetic analysis by AIMS of pearl oyster samples collected from the Cook Islands (Penrhyn, Manihiki and Suwarrow) and Kiribati (Abaiang and Butaritari) during the first few months of 1992.

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*This article was originally published in the SPC* Fisheries Newsletter *No. 60 (January–March 1992), pp. 3–5.*

## Black Pearls, Inc. begins *P. margaritifera* hatchery research and development in Kona, Hawaii

***by Neil Sims, Black Pearls, Inc., Kona, Hawaii***

Mr Neil Sims, Research Director for Black Pearls, Inc. in Kona, Hawaii (and also your editor) provides a personal note:

The development of hatchery culture methods for *Pinctada margaritifera*, the Hawaiian variety of the black-lip pearl oyster, is the focus of initial research by a newly-formed company based in Kona, on the big island of Hawaii. Dr Dale Sarver, President of Black Pearls, Inc. said that the company will look at using the hatchery technology to supply spat to farms both in Hawaii and throughout the South Pacific. Initial hatchery trials will be on a small experimental scale using laboratory facilities at the Natural Energy Laboratory (OTEC) site in Kona.

The company can be contacted through:

Black Pearls, Inc.
P.O. Box 525, Holualoa,
Kona, Hawaii, HI 96725, USA.
Phone / Fax: (1) (808) 325 6516

## Pearl culture development: a proposal for a South Pacific Pearl Conference

*by Richard C. Fassler,*
*Hawaii Dept. of Land & Natural Resources,*
*Honolulu, Hawaii*

The purpose of this article is to provide information on some of the latest developments in pearl farming, and to introduce the idea of a South Pacific Pearl Conference.

### China and Japan

The Japanese have long held a monopoly on pearl farming, but recent information indicates that the Chinese are coming up fast. In the years ahead, China is likely to be the nation where expansion will be the greatest. What the Chinese have done to become the world's number one shrimp producer could enable them to become number one in pearls, too. They have an abundance of land, cheap labour, and strong technology which they have mostly developed themselves. There are more than a thousand freshwater pearl farms in central and eastern China, and several dozen saltwater farms on the island of Hainan.

The Chinese may start mass-producing large (13mm – plus) South Seas pearls from the saltwater oysters, *Pinctada margaritifera* and *Pinctada maxima*, and set up a hatchery with foreign investors. Recent improvements in quality have led some Japanese companies (in the spirit of 'If you can't beat them, join them!') to market Chinese pearls in Japan. Joint-venture operations in China are now being proposed, producing low-cost pearls with Japanese technology, and marketing them in Japan with strict quality and price controls.

### Indonesia

Indonesia promises to be another major centre of pearl farming. According to *Jewelers' Circular Keystone* magazine (April 1992), 'Indonesia has emerged as a strong producer and threatens to overwhelm the Australians in the sub-15 mm categories' .

As every shrimp aquaculturist knows, the nation has resources that are similar to China's: vast amounts of land (and water) and very inexpensive labour. Up to March 1991, the Indonesian government had granted 30 licences to companies to operate pearl farms. The Japanese are setting up joint ventures with local firms, uniting their technology with remote island sites to produce *Pinctada maxima*.

### Implanting

The lack of non-Japanese implanters has been a major factor restraining the growth of pearl farming. Our research over the past few months has turned up less than a dozen names. An American pearl farmer recently told us that he has six implanters who took three to four years to get to the point where they could perform sucessfully.

### Expanding the industry

In the last six months, the Aquaculture Development Program (ADP) has received inquiries from persons wishing to raise pearls in Australia, the Bahamas, Ecuador, Fiji, French Polynesia, Guatemala, South Africa, Tanzania, Tonga and part of the United States: Georgia, California and New York. In some areas, there is a considerable oyster resource already in place—Ecuador, for example (large edible oysters are common). In others, such as the Bahamas, there may not be a large supply of oysters, but grow-out possibilities exist, if the oysters can be hatched elsewhere.

One key question is: Can pearl oysters be grown in shrimp effluent, or even in shrimp ponds? Research recently completed at the University of Hawaii indicated that *C. gigas* and *C. virginica* not only survived, but thrived, in shrimp effluent (Jaw-kai Wang, pers. commun., 1992). These are not pearl oysters, however, but some research results for *Pinctada margaritifera* are available. *(Editor's note: see Abstracts section, p 47 of this issue)*

Abalone pearl production was pioneered by the Japanese in the 1950s (*INFOFISH International*, 1991), and today there are abalone farms raising pearls in Japan, Korea, New Zealand, Canada, South Africa and the United States (California and Hawaii). An abalone pearl takes on the blue-green colors of the abalone shell. One specimen, taken by an abalone diver off the coast of California in 1990, baroque in shape, weighed in at 118.57 carats, for an appraised value of US$ 142,248! (*Jewelers' Circular-Keystone*, April 1991). The cultured variety is likely to be a mabe, or half-pearl, or a 3/4-round pearl, with a value of US$25 to US$100. *(Editor's note: see also the article on pp. 41–42 of this issue)*

In January, Paul Cross, a freshwater pearl farmer with an operation in northern California, launched an abalone pearl project at Ocean Farms of Hawaii (OFH) on the Big Island of Hawaii. His implanter

has been able to produce mabes in 4-inch farm-grown abalone, implanting roughly 500 per day. Cross and farm management tell us that the mabe possesses the red, green and blue abalone colors, and the mortality rate is less than 20 per cent. Unfortunately, the firm declared bankruptcy in early July and Cross was forced to halt operations. There is speculation that he may wish to take over the farm, if the price is right. In addition to Hawaii, he has several implant pilot projects under way with abalone raisers in California, and is negotiating with an abalone ('paua') farm in New Zealand.

ADP has also received enquiries from persons associated with abalone operations in South Africa and Australia who would like to look into the possibility of culturing pearls in large, wild-caught abalones.

**American pearls and nuclei**

American pearl farmer John Latendresse, told us (14 July 1992) that the demand for mussel shell for making bead is down, reflecting the downturn in the demand for pearls. He said that the Japanese have enough shell for two years' bead production and predicts that only 5,000 tons of shell will be sold to the Japanese this year. He attributes low demand to the abundance of South Seas pearls, and the poor quality of Japanese akoyas.

In the last several months, American pearls (almost all mabes) have found a home in Nashville. Freshwater pearl farmers and business rivals Latendresse and Jim Peach are making the Tennessee city the centre of their marketing operations. In a most timely move, Latendresse sold his mussel business and is building a plant that will produce jewellery incorporating his mabes. Peach has a 5000 sq ft retail outlet called 'Factory Jewelers' that features his pearl creations.

Paul Cross continues to manufacture nuclei, but has been joined in this industry by several other American companies. Cross has increased nucleus sales to farms in the South Pacific and Australia.

**Freshwater Mussel Conference**

A major question concerning nuclei is whether the supply of American freshwater mussels will be destroyed by overharvesting and/or the rapidly invading European import, the zebra mussel. The zebra has proliferated to the point where it can outcompete or 'smother' our native mussels. These topics and others will be addressed at a symposium in St Louis in October *(Ed: see the notice in 'Upcoming Congresses').* Fortunately for the mussel resource, lack of demand has lowered the price to the point where divers are refusing to harvest. *(Editor's note: see the notice in the 'Upcoming Congresses' section, p48 of this issue)*

**The South Pacific Pearl Conference**

We believe that what is needed is a conference to pull the various segments of the pearl industry together in one location so that there can be discussion, examination and proper direction into the next century. The Aquaculture Development Program is proposing the first-ever international meeting of persons in the pearl industry. The focus will be on pearl farming as an important economic development opportunity for the South Pacific, but the meeting is expected to attract people from throughout the world.

The goals of the conference are to:

1.exchange technical information;

2.promote and market product;

3.monitor the quality of product; and

4.attract investment dollars to the region. We plan to have a heavy media presence, which should greatly boost the public's awareness of the beauty of South Seas and American pearls.

The target audience is farmers, government officials, equipment manufacturers, and retail and wholesale jewellers. According to Dr John Munro, South Pacific Director for ICLARM, 'Virtually all Indo-Pacific fisheries departments would be interested in the meeting and would try to send representatives'. (Munro, pers. commun., 1992).

The programme will include hatchery and grow-out technology; site location factors (e.g. resource surveys); disease considerations; government support (e.g. extension); quality control and marketing; research priorities; international funding support; technical assistance; environmental issues; social, economic and legal aspects of marine tenure; and training and education.

In addition, there will be a trade show that will feature the latest in equipment for pearl farming. We were most pleased to receive word from Dr Shohei Shirai, from Japan, that he would like to present an educational display of both cultured and natural pearls (Shirai, pers. commun., 1992). Dr Shirai is the author of a well-known volume on pearls. Also, we expect a great deal of trading to take place in black (*margaritifera*) and white (*maxima*) pearls.

The location of the conference will be Honolulu. The proposed date would be late 1993 or early 1994. We have not been successful in seeking funding

from international economic development organisations operating in the South Pacific but will now turn to private businesses active in the area. For more information, please write to me, Richard Fassler, at ADP.

**Looking ahead**

1993 promises to be a most important year for the culture of pearls. The Chinese will push ahead; the Japanese will continue to seek opportunities in the South Pacific; the feasibility of raising abalone pearls will most likely be determined; and, of course, there is the conference.

The non-Japanese pearl culture world will increasingly improve its implant techniques. The acquisition of the implant knowledge may be a good thing, or a bad thing, for pearl farmers. Latendresse points out that the implant monopoly acts as a price and quality control mechanism for the pearl industry. If the world is let in on the implant techniques, he says, there will be pearl farms on every island and atoll and prices will tumble. Other people we have spoken to say that the price declines were bound to occur, but will eventually be offset by long-term price stability. Demand will pick up as pearls become more affordable and people in such areas as the European Economic Community become more affluent.

Quality control is on everyone's mind, and there is much talk among farmers about forming a cartel to control quality (and, of course, prices), similar to the situation in the diamond industry. Others say that this would be impossible, given the expected expansion of pearl farming in China.

Regardless, pearl culture expansion will continue to foster increased jobs and tax revenues in areas of the world where few economic development opportunities exist.

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## Inter-island transfers of pearl oysters to blame for contamination of many atolls in French Polynesia

***by Philippe Cabral, EVAAM, Rangiroa, French Polynesia***

The development of pearl farming in French Polynesia and the success of new spat collection procedures have led several atolls that do not possess natural oysters stocks go into pearl farming by means of inter-island transfers.

In 1984, high mortality occurred on pearl farms in a number of atolls, the causes of which have still not been elucidated.

This massive mortality was the first sign of a hitherto unknown disease, apparently confined to the Gambier island group and the atoll of Hikueru.

The main symptoms of this disease are:

—arrested growth with brittle shell without growth barbs, and wasting of the animal;

—dysfunction of the mantle frequently associated with malformation of the inner shell.

The majority of the affected oysters eventually die, but a small percentage succeed in over-coming the disease and survive.

Wherever the disease is present, farms now have far higher production costs than a few years ago. A farm affected by this problem goes through four critical phases:

—before seeding, high mortality occurs once the oysters are removed from the collecting stations and reared for seeding;

—during seeding, the seeder selects healthy oysters and systematically discards all suspect

specimens, sometimes up to 30 per cent of the total stock;

—the days immediately following seeding are often fatal to sick oysters that were not discarded by the seeder because contamination was too recent to be evident, or which were given the benefit of the doubt;

—lastly, many more oysters will be contaminated and die during the post-seeding phase.

Overall, up to 50 per cent of the farm's stock may be lost.

On atolls where no oyster transfers have ever taken place, the only causes of mortality are predation and post-seeding shock which takes a variable toll depending on the seeders' skill. On these 'healthy' atolls, none of the symptoms described above have ever been observed in pearl oysters and it is very likely that the incriminated disease is of the epidemic type.

Pearl oyster transfers are now subject to an authorisation from the Ministry for the Sea, while EVAAM is preparing an atlas of atolls where pearl farming is carried on, so as to be able to delimit transfer zones and prevent spread of the disease.

Unfortunately, atolls at present producing the most spat are all affected by the disease. In addition to zoning therefore, EVAAM is endeavouring to develop collection in healthy atolls in order to protect them from unauthorised contaminated transfers, the demand of the large pearl farms exceeding by far the amount of spat these atolls can currently supply.

If the short-term commercial interests of some producers override the need to protect the healthy atolls, in a few years time, and despite the considerable efforts being made by the authorities to prevent the disease from spreading, not a single atoll in French Polynesia will be free of this disease.

## First harvest of hatchery pearls in French Polynesia

*by Philippe Cabral,*
*EVAAM,*
*Rangiroa, French Polynesia*

As part of the comprehensive pearl oyster research being conducted in French Polynesia, the Rangiroa station has been working on reproduction under artificial conditions as well as on pearl quality improvement.

Recently, it harvested the first lot of pearls ever produced by hatchery oysters. No significant difference was observed between the pearls produced by hatchery oysters and by oysters taken from the natural environment, seeded simultaneously and maintained in identical conditions after seeding.

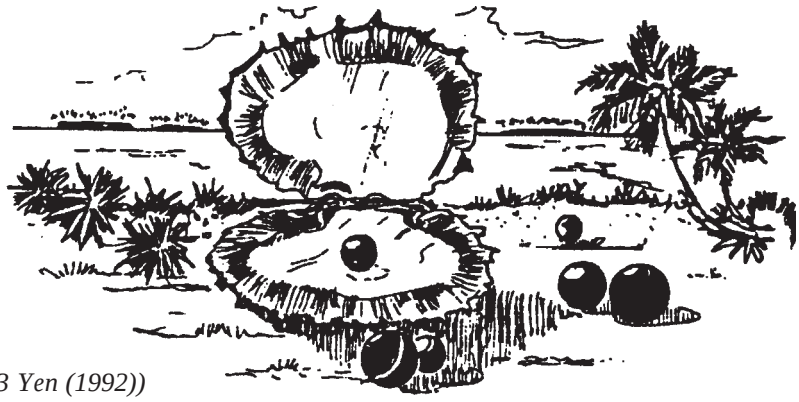
On the basis of this very promising result, more refined studies will now be undertaken on genetics and selection of oysters for seeding.

Other pearl quality research improvement in progress at Rangiroa deals with seeding procedures (insertion zone and place of nucleus) and the influence of the carrier-shell. Future investigations will aim to find ways of reducing post-seeding mortality, which has been very high ever since the outbreak in 1984 of an unidentified disease.

## Statistics of pearl imports to Japan

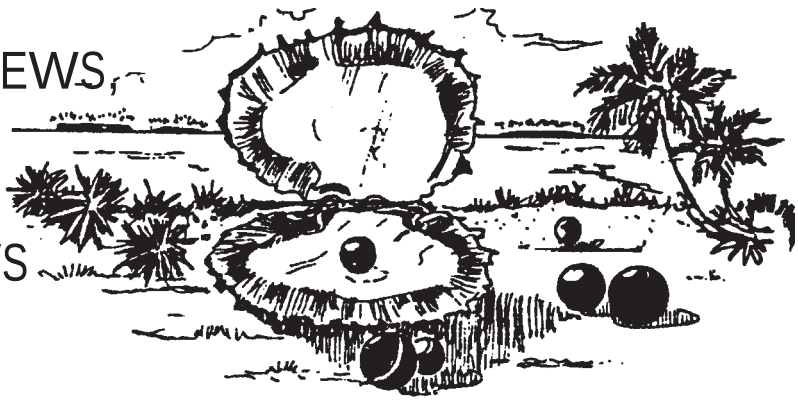
*by Hideyuki Tanaka,*
*FAO/SPRADP,*
*Suva, Fiji*

Two tables of monthly pearl import statistics reported in the *Weekly Shinjyu* (pearl in Japanese) *Newspaper* were translated. The tables show the various countries exporting pearls to Japan, pearl quantities and market prices in April and May 1991/1992 in Japan.



*(1 US$ ≈ 140 Yen (1991), 1 US$ ≈ 133 Yen (1992))*

# PEARL OYSTER NEWS, RECENT ARTICLES, AND REVIEWS



## Quality is the key to success for our black pearl industry

*Source:* **Les Nouvelles de Tahiti** ***(January 1992)***

**A thousand applications for marine concession leases are pending**

Black pearl production is one of the last adventures that French Polynesia's islands, high or low, can still offer. The sixth luncheon debate held in early 1992 by Hyacinthe Aline, Chairman of the South Pacific Regional Committee of French External Trade Advisers, proved an unprecedented success (bookings had to be 'frozen' at 120 participants). The Regional Committee comprises advisers for French Polynesia, New Caledonia, Wallis and Futuna, and Vanuatu; it works closely with the advisers for New Zealand and Australia.

In his welcoming address, the chairman said: 'There are 2,500 external trade advisers, all over the world, who are appointed by the French Minister of External Trade for a renewable period of three years. We are all in senior positions in the economy and in international trade in the private sector. We are committed to helping the State and Territorial authorities with advice and proposals stemming from our thought and research. This we do without any remuneration or financial assistance from either the State or the Territory'.

Flanking ministers Edouard Fritch, responsible for matters relating to the sea, and Patrick Peaucellier (Minister for Finance, who attended as a personal guest of Hyacinthe Aline), Mrs Grand, Mr Galenon, Mr Laborde and Mr Coeroli fielded a great many questions from the public.

**Taxation must evolve**

Minister of the Sea Edouard Fritch said that the black pearl's reputation, already well established in the Pacific, must now be extended to more distant frontiers and become internationally recognised.

In French Polynesia, the black pearl sector represented more than three thousand direct or indirect jobs in 1990, while the exports were worth over 3.7 billion francs (approx. US$ 36.3 million). Although there was a wide divergence between the largest investors, who control 80 per cent of the market and the small pearl farmers, returns were generally very high. The ratio of investment to turnover is one to ten on average for spat collecting and one to four for the actual farming.

Invited to explain how black pearl taxation was likely to evolve in the future, Patrick Peaucellier stressed the need for a review, since only a single 2.5 per cent tax on exports was currently being levied. Upscaling of black pearl tax was very likely, the Minister for Finance said, particularly as the Territory had financially contributed to getting the industry off the ground.

The subject had not yet been fully explored, but additional revenues could certainly be generated, for instance, by raising a tax per graft. The extra revenue raised could be funnelled into the copra price stabilisation fund, which would give the Tuamotu Islanders and those who work with them the satisfaction of knowing where their money was going, and alleviate the Government's budget-balancing headache. We can trust the Finance Department to make sure it doesn't lose out in the process!

Edouard Fritch also touched on the taxation issue when he told the audience that 'in view of the Territory's past and future efforts on behalf of the pearl industry, it was inevitable that a better balance must now be sought between the revenue derived from it and the amounts spent on research, training, technical assistance and promotion in this sector'.

**A precarious success**

Despite the inherent difficulties of rapid growth, pearl culture has emerged as an unquestionable economic success. 'But', the Minister warned, 'this success remains precarious, and it is now important to define the basic requirements clearly and formulate guidelines for co-ordinated development'. He then briefly outlined the state of the pearl industry in French Polynesia.

'The rapid growth of the pearl industry has generated considerable population growth in all the atolls involved. At the same time as we cash in on this treasure from the bottom of the lagoons, we must also face up to formidable psychological and relationship changes.

'These have given rise to protectionist attitudes towards the marine environment and an identity crisis in the islanders, with the 'native' seeking to assert his dominance over the 'alien'. 'Pearl fever' is affecting many people in every sphere of Polynesian society.

'At the economic level, there is a marked dominance by large investors, the only ones presently capable of initiating and sustaining large-scale development. The small investors still often need assistance from the Territory or from private sponsors to get started in the pearl business. The smaller enterprises must definitely expand, if we wish to ensure more even distribution of the economic spin-offs from the industry.

'We must also realise that the islanders' desire for quick profits is exceeded by their concern to build a long-term resource base producing a stable income for their children's future.

'In the technical and scientific fields, a number of problems have arisen: mortality (sometimes very high) in pearl oysters, difficulties in grafting, unreliability of spat supply, hazards of inter-island transfers, climatic perils and marine pollution. All these factors make pearl farming a somewhat precarious business.

'The major unanswered questions remaining concern feeding of the pearl oyster, causes of massive mortality, acceptable stocking density in the lagoon, status of stocks, etc...

'For long-term protection of the resource and the lagoons, it is therefore urgent to foster close co-operation between the investors, the islanders, the Territory and the State, and to implement lagoon management plans.'

**The concession lease headache**

Success inevitably generates demand. With regard to applications for marine concessions, a topic introduced by Jean-Marius Raapoto, technical experts must correctly gauge the advisability of developing a given site and assess the potential developer's technical and financial capabilities. It is important above all to safeguard the quality of the 'Tahiti black pearl' (its registered trade mark) in order to retain the advantage French Polynesia at present holds over other countries and territories that have more recently branched out into this profitable business.

Two thousand one hundred and twenty-six pearl farming permits have been issued since 1977. The atolls most in demand are Takaroa (304), Manihi (188), Arutua (187), Hao (177), Takapoto (165) and Mangareva (127). A further one thousand applications for concessions are under consideration or about to be approved, and the 'pearl rush' is gaining momentum, with over 945 applications received since the beginning of the current year.

'The Territory is taking the utmost care', Edouard Fritch affirmed, ' to ensure that its decisions will not entail irreversible consequences or be detrimental to the development of the pearl industry'.

'However', he added, 'the issuing of permits for marine concessions remains one of our trickiest problems'. The events of the last few days and the fact that the 'gendarmes' seem to target their investigation specifically on certain social categories, definitely bear out this statement.

The Minister for the Sea then laid out some more food for thought, in the following terms: 'We must ask ourselves whether an authority other than the Administration should be involved in the decision-making process (something the islanders have been asking for), and how the lagoon should be shared out: among individuals, families, groups or cooperatives of several families, etc...?

'Neither should the need to foster free enterprise be forgotten. This implies allowing extension of the most efficient farms and permitting people with no land entitlements in the zone to use the Territorial maritime zone.

'Everyone knows that lagoons are not expandable, and that every inhabitant is entitled to a share of the profits from Territorial property. Notwithstanding this principle, it must be realised that this type of problem, i.e. conservation of resources for the communities living in a marine zone, is not peculiar to Polynesia'.

**Sophisticated technology**

In the field of black pearl culture, training and technical assistance are also two keys to success. In this connection, the Rangiroa school must be upgraded, because we shall be facing ever thougher competition. The Cook Islands and Japan are already producing black pearls in small quantities. Micronesia, Fiji and Wallis also want to get into the market and are putting steady pressure on the authorities of our Territory. 'If French Polynesia does not start exporting its know-how, these countries or territories will turn to other partners (mainly the Japanese) and it will then be too late to be sorry', Mr Fritch observed. 'In the next five to seven years, strong development of the pearl sector is bound to occur in other Pacific States, and by contributing to this development we can expect to gain at least something from it.'

'The opening of a pearl oyster hatchery (a technique unique in the world) now allows us to control the beginning of the pearl culture process. The hatchery can produce up to 150,000 spats annually.'

'The French State is assisting the development of this promising activity. Over 200 million francs have been earmarked for research into the causes of pearl oyster mortality. All these efforts are geared to turning out a high-grade product that can hold its own against future foreign competition. But there is no point in producing if we cannot sell.'

The task of promoting the black pearl largely falls to the Territory (EVAAM), though foreign buyers sometimes help to finance exhibitions. As Mr Fritch put it: 'Promotion of any product obviously requires both time and money. If we wish to increase our sales substantially, it is essential to seek new markets actively'.

Black pearl culture will, for some years yet, remain a challenge that needs to be taken up anew each day. Some will be successful and become rich, others will weep salty pearls after a cyclone or disease has destroyed all their dreams. But the latter can always start again, for as long as there are women in the world there will be men who will want to adorn them with the beautiful jewels born of the magic alchemy of lagoon and shell.

**Government policy**

The black pearl, which has rapidly become the Territory's leading export, is a precious commodity to be handled with care. The government's five-pronged policy for this resource is as follows:

1.Strict conservation of the resource, involving:

— setting up lagoon management plans;
— research on the pearl oyster and its environment;
— monitoring of the environment and enforcement of regulations.

2.Maintaining opportunities for access to the resource by means of clear regulations that are acceptable to all, that give priority to the island inhabitants and provide for fairer sharing of funding for promotion, research and development.

3.Maintaining and improving the quality of the product, through:

— more active training in island locations;
— more efficient technical assistance;
— creation of a 'quality and origin' label.

4.Acceleration of scientific and technical progress, involving:

— closer scientific cooperation;
— setting up a data bank;
— sustained research, together with co-ordinated investment programmes.

5.Improved marketing, aimed at:

— expanding existing markets;
— prospecting for new outlets, particularly in Europe;
— dynamic marketing activities based on partnership with the private sector.

## Pearl oyster research for protection and development

***Source:*** **Les Nouvelles de Tahiti** ***(July 1992)***

During his recent visit to French Polynesia, the French Minister for Overseas Territories Mr Louis Le Pensec, with the High Commissioner and the President of French Polynesia, signed three Agreements ratified by the French Parliament in June as part of the 'progress pact' between France and French Polynesia.

One of these agreements is for research on pearl oyster mortality, which is regarded as high priority, since pearl farming is French Polynesia's top-ranking export activity. In 1985, massive mortality occurred in pearl farms on several atolls, and studies undertaken to date have failed to establish the causes of this mortality and find appropriate remedies.

Although the phenomenon has not recurred since, there is still enough concern about it for a comprehensive research programme, following on from the limited investigations carried out so far, to be included in the State-Territory development plan.

The programme's three main aims will be:

— to determine the direct causes of pearl oyster mortality by studying the functioning of the atoll / lagoon ecosystem;

—to learn more about pearl oysters in their natural environment and under farm conditions;

—to investigate the effects of pollution.

The programme will be conducted by EVAAM (Etablissement de valorisation des activités aquacoles et maritimes) and other local and metropolitan research institutions (ORSTOM, EPHE, VFP...). The management commitee appointed by France and French Polynesia met for the first time last January, when it decided that Stage 1 of the research would be largely completed in 1992 (even before the relevant Agreement was formally signed, field work had begun at Takapoto and Rangiroa).

Stage 2 will commence around 15 February 1993 and be based on the 1992 findings.

The 'Comprehensive pearl oyster research programme', as it is called, will have no less than 18 different field components involving the co-operation of a large number of laboratories, many of them located in French Polynesia.

It will cost 210 million CFP francs for stage 1 and 135.5 million CFP francs for stage 2, most of the funding being provided by MEDETOM and FIDES, as well as by the French Ministry for Research and Technology.

## French Polynesian cultured pearl export statistics

*Source: 'Te Avei'a'*
*Institut Territorial Statistique*
*Tahiti, French Polynesia*

**Cultured pearls exported from French Polynesia**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Volume (kg)** | | | | | | | | | | | | | |
| 1986 | 2.5 | 50.1 | 0.7 | 0.9 | 0.0 | 9.2 | 0.0 | 0.6 | 3.4 | 21.7 | 9.0 | 5.7 | **103.8** |
| 1987 | 99.6 | 1.3 | 19.0 | 4.2 | 0.2 | 0.1 | 12.9 | 83.4 | 24.8 | 32.5 | 68.4 | 61.7 | **408.1** |
| 1988 | 35.3 | 1.0 | 23.1 | 1.5 | 7.4 | 8.0 | 5.4 | 69.2 | 116.0 | 93.4 | 5.7 | 80.7 | **446.7** |
| 1989 | 28.8 | 4.8 | 2.8 | 0.8 | 10.8 | 11.9 | 15.9 | 242.8 | 56.2 | 118.1 | 16.5 | 113.0 | **622.4** |
| 1990 | 13.8 | 8.1 | 5.7 | 5.5 | 13.2 | 13.1 | 196.1 | 95.9 | 11.0 | 158.0 | 56.0 | 23.3 | **599.7** |
| 1991 | 134.0 | 0.7 | 6.4 | 21.9 | 14.0 | 22.9 | 32.9 | 51.9 | 92.0 | 366.1 | | | **742.8** |
| **Value (million CFP)** | | | | | | | | | | | | | |
| 1986 | 16.9 | 477.6 | 5.1 | 1.7 | 0.0 | 130.9 | 0.4 | 14.3 | 8.6 | 205.4 | 78.9 | 104.3 | **1044.1** |
| 1987 | 593.7 | 17.2 | 96.6 | 13.3 | 1.4 | 1.6 | 78.7 | 425.7 | 140.1 | 221.2 | 411.0 | 251.0 | **2251.5** |
| 1988 | 119.3 | 4.3 | 139.4 | 7.0 | 94.9 | 29.5 | 29.6 | 406.9 | 646.7 | 560.7 | 47.1 | 427.7 | **2513.1** |
| 1989 | 165.4 | 32.8 | 24.6 | 0.8 | 35.2 | 95.9 | 273.5 | 1196.4 | 468.3 | 767.5 | 92.1 | 638.2 | **3790.7** |
| 1990 | 82.8 | 60.6 | 37.4 | 61.7 | 83.5 | 94.1 | 1321.3 | 413.7 | 79.2 | 1092.5 | 278.5 | 153.1 | **3758.4** |
| 1991 | 849.9 | 12.5 | 43.5 | 67.4 | 70.1 | 54.3 | 109.7 | 252.0 | 499.6 | 2049.0 | | | **4008.0** |

These figures were extracted from 'Te Avei'a', Bulletin d'Information Statistique, Institut Territorial de la Statistique, Tahiti, Jan–Feb 1990, p. 10, and Nov–Dec 1991, p. 32.

| | | |
|---|---|---|
| **Value (million US$)** | **1988** | **23.3** |
| | **1989** | **32.1** |
| | **1990** | **36.8** |
| | **1991** | **37.5** |

## Cultivation and economics of pearl oysters in the Sudan: requirements for strengthening local technological and management capabilities

*Source: Dr. Sayed Mohamed Ali, Oyster Culture Research Project, Port Sudan, Sudan*

The improvement of management capabilities is essential in Sudan. The Fisheries Research scientists believe that most of the mass mortalities that have occurred since 1969 were due to mismanagement. Scientists (who conduct research) and fisheries administrators (who will supervise large-scale cultivation) must also be able to travel more easily between Port Sudan, Dongonab and other cultivation centres. Some of them must be permanently positioned in some of the cultivation sites. It must again be stressed that unless there is proper supervision of cultivated oysters and cultivation structures and proper maintenance and storage of cultivation materials after each season, an anticipated cost analysis will be invalid. Adequate supervision must be ensured by all means, even by paying a percentage out of cultivation profits to supervisors.

Without an awareness of the traditional way of living and socio-economic conditions of coastal natives, communication and mutual understanding may be difficult. It is important that studies on the socio-economic conditions and lifestyle of native fishermen be initiated as quickly as possible.

The transfer of technology from scientists to fisheries administrators and native fishermen must be initiated through joint projects and studies.

A transition stage, involving the establishment of pilot projects or farms jointly run by fisheries scientists, fisheries administrators and native fishermen, is essential as an introduction to large-scale cultivation. The profit from these farms must go to the owner-fishermen. During this period a system for providing capital to cultivators on the basis of long-term loans must be worked out.

In Dongonab Bay, the healthiest mother of pearl oysters are found at a depth of less than 5 fathoms, with very few found beyond a depth of 15 fathoms. Shells from deeper than 7 fathoms are usually infested with such parasites as mud worms (*Polydora*), boring sponges (*Cliona* spp.) and boring bivalve (*Lithophaga*).

### Uses

The tradition of fishing for mother-of-pearl oysters in Dongonab Bay is a very old one. Heaps of ancient shells are occasionally found buried in sand on the shores of the Bay and on some of the nearby islands. One such heap was estimated to contain 3,000 tons of shells. Radiocarbon dating has shown that these heaps are 1,500 years old.

### History of cultivation

In 1904 the late Dr Cyril Crossland made a study of pearl fisheries of the Sudanese Red Sea. He was subsequently employed as a marine biologist with the Government of the Sudan and directed a marine biological station and pearl shell farm at Donganab from 1905 to 1922. He was able to devise methods for the profitable large-scale cultivation of mother-of-pearl oysters from spat to commercial size. However in 1923, the Sudanese Government stopped all cultivation activities because prices had fallen to uneconomic levels. But the time the farm was closed in 1923, it was producing an annual crop of more than 300 tons.

In 1955 the Government requested FAO to help in developing its marine fisheries. In 1958 Mr. William Reed was assigned by FAO to investigate the shell fisheries of the Sudan. He carried out a survey of the natural stock and concluded that further development of shell fisheries would be better achieved through cultivation of mother-of-pearl oysters than by attempting to increase fishing of wild oysters that could result in over-exploitation of the resources. Reed improved and simplified the cultivation procedures used by Crossland. In 1961 he became an employee of the Sudanese Government. In 1961 he established four private family farms in Dongonab Bay. When his service was terminated in 1965 the number of family farms had risen to 65, with 130 native beneficiaries. Pearl culture (half and rounded) utilising the Sudanese oyster was first tried by Reed in 1964, but more professionally and successfully in 1968 by technicians sent by a Japanese firm under contract to the Sudanese Government.

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*Excerpts from an article in* Acquisition of Marine Surveying Technologies, *Report of the Expert Group Meeting on Acquisition of Marine Surveying Technologies in Addis Ababa, 19–23 October 1987. Department of International Economic and Social Affairs, United Nations, New-York. 1988. pp. 94–116.*

# The status of the pearl oyster fishery of Kuwait

*Source: Sulaiman Almatar,*
*Kuwait Institute of Scientific Research,*
*Salmya, Kuwait*

## Diving fleets and the pearl oyster grounds

The pearl oyster fishery of Kuwait is exclusively based on trade in natural pearls of *Pinctada radiata*. The diving fleets consist of 25 fibreglass speedboats of 3 to 8m in length, powered with a single 50 to 140 HP gasoline outboard engine.

The current pearl oyster fishing ground is located between the boundary of 20° 06'N, 48° 12'E, and 28°33'N, 48 ° 30'E, at depths ranging from 10 to 20m. Eleven major pearl oyster beds are scattered within this area.

Daily fishing trips begin at 8 am and last till noon. During this period about 6 dives can be completed of 30 minutes each, followed by 10 minutes rest. A hookah diving system is used for air supply. Wet suit, hood and gloves are worn in winter. Oysters are picked up and placed in a mesh bag as the diver walks or swims over the pearl oyster bed. The collected pearl oysters are placed unsorted in bags weighing about 6 kg (mean ± S.D., 6.27 ± 0.84; n=31), before being transported to the pearl oyster market.

## The market

The daily catch of pearl oysters in bags is transported from the landing sites to the only oyster market in Kuwait City. The auction starts as soon as the catch arrives, between 1 and 3 pm.There are about 30 permanent merchants of pearl oysters in the market who participate in the daily auction. A few other irregular buyers are present in the market each day. Their number increases substantially at weekends. The price of a bag of pearl oysters reflects the quality and the size of the pearl oyster shell. Large, clean shells with less bio-fouling are more expensive. The price also varies according to the ground on which the pearl oysters were caught. The pearl oysters in a purchased bag are individually opened in the market with a special curved knife and searched for pearls. The mother-of-pearl is disposed of.

When a big pearl (> 4mm in diameter) is found, it is usually auctioned among the permanent merchants on the same day. Tiny pearls are normally not sold individually, but may be auctioned as a group of small pearls. There are five pearl dealers in the market. These dealers resell to the jewellers in Kuwait or may travel to other countries in the region, especially Bahrain, to seek higher prices.

The pearl oyster market is exclusively for natural pearls. Because there may be attempts to sell a cultured pearl, pearl dealers are wary of people who are not regulars at the market. Pearls found by people other than the permanent merchants may be sold on condition that they are natural pearls. No money is exchanged until this is confirmed. Although the pearl dealers are experts in evaluating a natural pearl, they have occasionally been deceived by cultured pearls. Suspect pearls are usually taken to Bahrain and physically and mechanically examined for any impurity by the Bahrain Ministry of Commerce.

## Catch statistics

Pearl oyster landing data, including number of bags, number of pearls found and price, were collected daily from January 1982 to May 1990. Daily landings varied with the season and fluctuated with prevailing weather conditions (Fig.1).

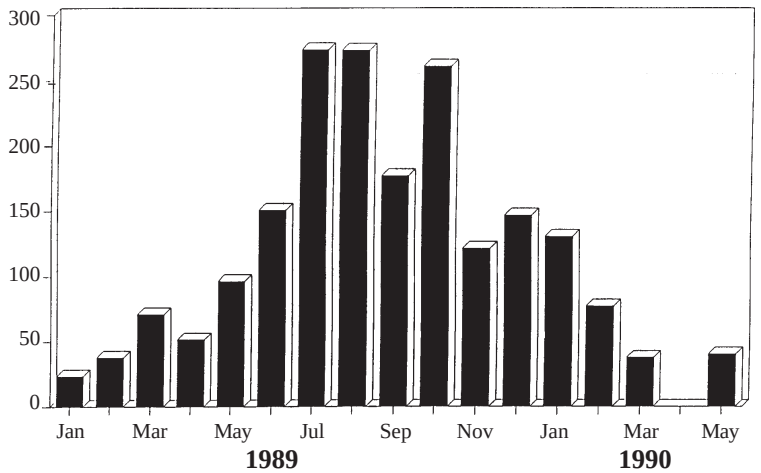


**Figure 1. Average number of pearl oyster bags daily landed in 1989–1990 (Mean number of pearl oysters per bag = 132.7± 24.0)**

Although the mean daily landing for 1989 was 138 bags, it ranged from 23.4 bags in January to 273.7 bags in July. The average number of pearl oysters per bag is about 132 (mean ± S.D., 132.7 ± 24.0; n=12). The relatively low number of bags landed in winter was due to the low effort exerted because of the low water temperature and inclement weather. Total landings for 1989 were 46,224 bags (287 tons) or about 6.1 x $10^6$ oysters.

The probability of finding either small or large pearls is approximately 1 in every 4,200 oysters. Tiny pearls (<2mm) are frequently found, at a rate of about 6 pearls per bag (132 oysters). The total value of the pearls sold in the market makes up only half of the value of the pearl oysters.

**Size composition of the landing**

Hinge length and dorso-ventral measurements were recorded monthly. The majority of pearl oysters landed were 40 to 56 mm in hinge length with a dorso-ventral measurement of 44 to 76 mm. Smaller oysters of less than 40 mm in hinge length were present throughout the year but were most abundant in January and October (winter and fall). Small oysters sold in the market were usually attached to a larger oyster.

The pearl oyster study in Kuwait plans to continue monitoring the catch and fishing effort in order to investigate the effect of variation in fishing effort on the stock size before any management measures can be implemented. The study also aims to evaluate the impact of the recent oil pollution on the pearl oyster beds.

## Northern Territory pearl fisheries in focus

***by Margaret Macreadie***

Pearling is another bright star on the Northern Territory's horizon.

The pearling industry includes the pearl oyster fishery, which is managed by the Northern Territory Fisheries Joint Authority (Commonwealth / NT) and the pearl oyster culture industry, managed solely by the Northern Territory.

Both sectors of the industry are limited entry, with six companies licensed to collect wildstock oysters, culture pearls and establish pearl oyster hatcheries.

Management of both sectors between 1988 and 1991 was guided by a Pearling Industry Development Plan. This will be replaced early this year by Management Plans prepared in consultation with industry members through the Northern Territory Pearl Industry Advisory Committee.

In the first two years of development, a large proportion of oysters collected was sold for mother-of-pearl while the remainder (those of suitable size / age) were used for half and whole-pearl production.

The projects of the six licensees are all in different stages of development. A number have had several half-pearl harvests and experienced their first whole-pearl harvest late in 1991. Others are still establishing pearl farm sites and conducting initial seeding operations.

Although the value of the industry is currently undisclosed, it has the potential to add many millions of dollars in revenue to the Northern Territory economy.

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*Excerpts from an article by Margaret Macreadie, 'Spotlight on the Top End: Northern Territory Fisheries in focus' in Australian Fisheries, February 1992, pp. 20–22.*

## Darwin's new pearl oyster hatchery

***by David Field***

The Northern Territory's Minister for Primary Industry and Fisheries, the Honourable Mike Reed MLA, opened the NT's first pearl oyster hatchery on 6 November 1991.

Speaking to a group of invited guests at the hatchery, Mr Reed pointed out that increased competition from South-East Asian countries was one of the reasons leading to the decision to develop the

hatchery. This development would help to sustain Australia's dominance in the pearl culture industry. Another major reason was the cost and danger of deep-sea diving for wild pearl oyster stock.

Interestingly, the venture is a combined operation, involving two licensed pearl operators, the Arrow Pearl Company Pty Ltd and Toombridge Pty Ltd. Pearl Oyster Propagators Pty Ltd provide the aquaculture service for the venture, which is sited adjacent to the NT Government's Darwin Aquaculture Centre at the old Stokes Hill Power Station.

Under the NT Government's Pearl Oyster Culture Industry Management Plan, each company may use 50,000 pearl oysters from hatchery production for pearl culture each year. Based on a single oyster having a value of about $20, the annual value of production from the hatchery is estimated at approximately two million dollars. However, it's important to remember that it doesn't stop there — any given oyster is capable of producing pearls worth thousands of dollars when implanted with a pearl nucleus and farmed.

Australia dominates the world in the culture of South Seas pearls. Opening of the hatchery is seen as another milestone in the NT's rapidly developing aquaculture industry. The hatchery location, adjacent to the NT government aquaculture research facility, allows the possibility of joint government / industry research projects.

Both the pearl hatchery and the Government's aquaculture facilities are part of a proposal for a national co-operative research centre in aquaculture.

Introduction of the hatchery is seen as a valuable support to the long-term viability of the pearl oyster culture industry in the NT.

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*Excerpts from an article by David Field, in Professional Fisherman, January 1992, p. 10.*

## ***BARRIER 2* and *BARRIER 3*: two unique aluminium pearl shell vessels**

***by Bill Beecham***

Twenty-three years of marine engineering expertise and experience are incorporated in the construction and fitout of *Barrier 2* and *Barrier 3*, two new pearl shell cleaning vessels delivered to a Broome pearl farm by M & J Engineering & Marine Sales.

Constructed, outfitted and equipped in M & J's modern engineering complex in the Perth suburb of O'Connor, they were designed by Phil Curran and are similar in many respects to two other shell cleaning craft recently delivered to a Darwin pearl farm.

'The reason we built the boats ourselves is that it is more convenient to build the boat and do the engineering at the same time', explained M & J managing director, Maurie Bozanich.

'We are engineers, not boatbuilders. So we're not interested in boat building, except for these particular units where the emphasis is on the manufacturing of machinery and engineering.'

M & J's engineering experience is reflected in a number of features designed to take much of the back-breaking work out of lifting pearl shells for necessary cleaning. The shells are carried in baskets on long lines which must be lifted from the water, fed into a cleaning machine and sprayed with high pressure water to remove marine growth. Any that remains is then chipped off before the baskets and their contents are returned to the sea.

'It normally takes two strong men to lift the long lines onto the side rollers, so we've placed a gantry near the bows of the boat, with a heavy duty hydraulic capstan to lift the line up on to the rollers. We've also lifted the rollers so the men can work at a comfortable height without bending their backs.

'We changed the style of the boats, made them a little wider, but kept things in proportion to get the deck space required. Both *Barrier 2* and *Barrier 3* carry all the equipment found on typical shell cleaning vessels.

'The machinery is the important part', Maurie continued. 'The boats are simply platforms to carry it. It includes a forward capstan capable of lifting up to one ton when the time comes to shift long line anchors. There's also the hydraulically driven high pressure water pump to feed the shell cleaning machine, which is also hydraulically driven.'

The transom of each boat has been left open so that anchors weighing up to 300 kg can be carried and easily slid over the stern as and when required. A drop-in transom gate then allows the transom to be closed.

Propulsive power is supplied by a single Hino four-cylinder turbocharged diesel that develops 150 hp at 3,000 rpm and drives a Hamilton 211 waterjet for a maximum speed of 20 knots. By reversing the steering and reverse controls in unison, a resultant thrust can be obtained in any direction, giving 360° thrusting ability.

Each shell cleaning vessel has an engine box and control console forming a single unit, hinged at the after end so that it can be tilted back out of the way when complete access to the Hino diesel and water pump is required. Delivery of the two Broome vessels followed closely in the wake of two for a Darwin pearl farm.

Though they shared the same overall length and beam *BH2* and *BH3* were not true sisters. One had a lower freeboard than the other, while its counterpart had a slightly deeper draught.

*BH3* was designed, built and outfitted to clean pearl shell as it is lifted in baskets from the ropes of the Bynoe Harbour pearl farm, while *BH2* operates further offshore with divers collecting shell from the seabed.

As it will operate mainly in sheltered waters, *BH3* has a much lower freeboard to provide easy access to the line carrying the pearl shell baskets. Both vessels have an overall length of 10 m and beam of 2.31 m. However, *BH3* has a draught of only 0.175m compared with the 0.32 m draught of its sister.

For further information on these unique pearl vessels or other marine engineering services available, contact Maurie Bozanich at M & J Engineering & Marfine Sales, 19A Zeta Crescent, O'Connor, Western Australia 6163. Phone: (09) 337 7817; Fax: (09) 331 3499.

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*Excerpts from an article by Bill Beecham, in Professional Fisherman, January 1992, pp. 26–27.*

## Pearl dealer's concern: are consumers sated or just short of cash?

***by Russel Shor***

*Jewellers must wait until times improve to see if customers remain in the mood for pearls. Better design and salesmanship can help improve the odds.*

Just a few years ago, the pearl market was white hot–women in the United States and Japan had come to regard a pearl necklace almost as a birthright. Pearls were seen as beautiful, relatively affordable and complimentary to virtually every fashion trend. Consumers couldn't get enough of them.

Now, however, pearl dealers wonder whether women did get enough. They wonder whether today's slow market is the short-term result of recession or the start of a long slowdown caused by market saturation.

Dealers of 'bread and butter' Japanese Akoya saltwater cultured pearls and high-end South Sea cultured pearls agree that demand from the United States and Japan has slowed considerably since the 1987—1989 boom, but they disagree on how long this may last.

Optimists such as Jesse August of August Gem Corp., New York City, acknowledge the U.S. market 'has been saturated by lower quality Akoya pearl necklaces, but there remains a great deal of room to trade up when times get better'.

Ray Mastoloni of Frank Mastoloni & Son, New York City, also believes in the future, as long as dealers and jewellery manufacturers are sufficiently creative and inventive in producing interesting pearl jewellery. 'We did sell a lot of simple pearl strands during the 1980s', he says. 'They are still a staple, but perhaps the market for them is a bit saturated. Now we have to work with jewellery designers to create new designs; from this, we'll create our own new markets.'

More sceptical dealers remember the difficult years of the early 1970s, when the market for Akoya pearls fell dormant following a necklace boom the previous decade. Sales were so sparse then that the Japanese Government stepped in to bail out some pearl farmers who found themselves in debt and out of customers.

Even the most pessimistic dealers today don't foresee a return of those problems, mainly because the pearl market is much more diverse and complex now. What they do forecast for the Akoya market, however, is long-term stagnation, with periodic gluts of supply of certain sizes and qualities and softening (not free-falling) prices.

Observes one dealer: 'It's true that pearls have grown in popularity, but it will take a big boom in pearl jewellery and add-on pendants and the like to

absorb the same number of pearls as an opera-length necklace'.

**Short-term outlook**

In the near term, supplies and prices for most Akoya pearls will remain generally stable, say dealers. Demand for the latest Japanese Akoya crop has followed the trend of recent years—heavier on larger sizes (8mm plus), lighter on smaller goods. This has created a small over-supply and softening of prices of larger goods (up to 10–15 per cent at dealer level) and a firming up of prices for smaller goods as they become scarcer.

In the high end, slowing demand in Japan means U.S. buyers will get their best shot in years. 'When prices began soaring in the late 1980s, the Japanese buyers were bidding them up. Americans weren't willing to pay the prices', says Avi Raz of A & Z Pearls, Los Angeles. 'Now that business has slowed in Japan, there are more quality goods at stable prices.'

Mastoloni says this is a good time to trade up for jewellers who previously dealt mainly in promotional qualities. 'First, it's apparent that jewellery consumers are becoming more discriminating and quality-oriented. This creates a good opportunity for trading up. Second, retailers will find that trading up is a lot more profitable. It takes a lot less effort to sell a US$1,000 necklace than two US$500 necklaces.'

He cautioned retailers not to sit back and wait for prices to fall in the mid-market (under US$3,000). The price of mid-size pearls (5mm–7mm) is expected to remain stable even though the supply is tightening as farmers concentrate on larger sizes. Says Raz, 'We'll see prices go up only if there's an unexpected surge in demand'.

Mastoloni says any price decrease primarily will affect the US$4,000 plus market, 'and the declines won't be that significant once the goods travel through the distribution chain', he says. Interim processors and distributors will absorb some of the discounts.

At the opposite end of the market, recent Far East press reports say the Chinese are working on an Akoya cultivation project in hopes of taking over — and possibly flooding — the low end as they have the freshwater market. The Chinese have succeeded in growing some Akoya pearls, say the reports, but they still lack the processing know-how to bleach them to an attractive, uniform color.

'There's a lot of talk about the Chinese', says Raz, 'but I haven't seen anything that would threaten the Japanese yet. I think the market is safe for the foreseeable future'.

**South Seas supplies**

Dealers say high-end South Seas pearls have always been too costly and scarce to worry about market saturation. Indeed, they believe that new, larger supplies will eventually open new sales markets once the recession ceases.

What does concern them is the U.S. luxury tax. 'I know the tax has deterred a lot of American buyers, recession or not', says Salvatore Assael of Assael International, New York City. Also, the Japanese aren't buying the quantities or outbidding competitors for South Seas pearls as they once did.

In the late 1980s, the price of South Seas pearls — white and black — soared to mind-numbing levels as Japanese demand boomed and harvests diminished because of pollution in Tahitian and Australian cultivation areas.

Now production is booming, not prices. 'The Australian harvests have improved tremendously because they've found better beds and decreased the mortality rate of the pearl oysters', says Albert Asher of Albert Asher South Seas Pearl Co., New York City. 'They've also learned to create much larger pearls by re-using oysters ... these 'veteran' oysters can produce pearls larger than 20mm.'

Not only has production increased in Tahiti and Australia, but Indonesia has emerged as a strong producer and threatens to overwhelm the Australians in the sub-15mm categories.

'The Indonesians are producing big quantities of white South Seas pearls', says Assael. These pearls are extremely attractive, he says, and priced 20—50per cent below comparable Australian pearls. 'This certainly means prices will be coming down throughout the market; they've come down 20—30per cent already and will continue to drop for at least two more years.'

Other dealers agree, but hasten to add that South Seas pearls still won't be cheap. 'Prices were too high several years ago', says Asher. 'This just means they will be more normal: Japanese buyers admit now they overpaid and overheated the market.'

The dealers also say there's little danger of over-supply because lower prices will open new markets. These markets include affluent consumers who

couldn't match the high prices the Japanese paid a few years ago.

The black South Seas pearl market also shows some price softening because of improved yields in Tahiti and lower Japanese demand, say dealers. As with white South Seas pearls, dealers see descending prices as an opportunity to introduce black pearls to consumers who had been priced out of the market. One dealer says, 'Black South Seas pearls will never be a price-point item, but they've been so scarce and unaffordable in recent years that new supplies and lower prices are bound to bring more customers.'

Demand for South Seas pearl is concentrated in the Pacific Rim, say dealers. Hong Kong, Japan and other 'traditional' pearl markets take 65—70 per cent of all South Seas production, the United States about 20 per cent.

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*Excerpts from an article by Russel Shor, in Jeweller's Circular-Keystone, April 1992, pp. 92–93.*

## Australia's magnificent pearls

***by David Doubilet***

*Pinctada maxima*, known in Australia as the silver lip and in Papua New Guinea as the gold lip, is cultivated in a wide belt of warm water stretching from Burma (now called Myanmar) eastward, including Indonesia and neighboring countries. This area is the source for so-called South Seas pearls, although the South Seas of legend — the islands of Polynesia — are actually home to another species of oyster, *Pinctada margaritifera*, that creates a smaller silver-gray or black pearl.

Australian South Seas pearls have recently emerged as the Rolls-Royces of the pearling industry: rare, robust, enormous (10 to 20 mm in diameter compared with the 2 to 10 mm range of Japanese cultured pearls), and expensive. Most cultured pearls still come from Japan, but north-west Australia has proved to be a perfect place to raise a pearl oyster. There is little industry, few people, no fertilizer run-off from agriculture — and tides as high as 33 ft.

'The big tides mix up the water, bringing a rich soup of organic particles to the oyster', Dr. Lindsay Joll of the Western Australian Marine Research Laboratories explained to me. 'But the tides don't just wash in and out of the shells. The oyster feeds itself, constantly beating the water through with tiny hairs on its gills.'

In 1956 Sam Male, with Australian and New York partners, formed Pearls Proprietary, Ltd., which joined with Japanese entrepreneur Tokuichi Kuribayashi to establish the nation's first pearl farm 250 miles up the coast from Broome, centre of Australia's pearling world. It was called Kuri Bay, after Kuribayashi.

Sam Male's son, Kim, reflected on those times when I visited him in his office in Broome's Chinatown. 'It took my father over 15 years to get enough good pearls to make a necklace', he said. 'When cultured pearls came in, they seemed as plentiful as marbles.'

With only a handful of farms, Australia was soon producing 60 to 70 per cent of the world's large South Seas pearls. But Australian oysters are not yet *conceived* on farms, as Akoyas are *(Editor's note: They are now. See the article on the Darwin hatchery on p. 23 of this issue)*. Young oysters must still be found in the wild and gathered by divers on the flat sea bottom off Australia's north-west coastline.

A pearl boat serves as a divers' platform and can transport 5,000 or more live oysters in its holding tanks. Two 30-ft-long booms holding towropes extend from each side. Six tethered divers can operate simultaneously on the bottom, at depths of 20 to 60 ft, and cover a swathe 60 ft across as the boat creeps along.

On Mick Bray's 72-ft catamaran, divers in Lycra-and-neoprene suits were already at work. They breathed through 'hookah' gear, standard scuba-diving regulators attached to long, yellow hoses that ran to an on-board air compressor. On their backs were small, emergency air tanks.

Mick, the lead diver, shouted to us over the compressor noise: 'Your bloke will come with me on the next drift!'. Each dive is called a drift, because the boat drifts with the tide. Today was the top of the neap tide, so there was little water movement, and the water was clear.

Mick pulled on his mask, checked his hood and gloves to see that no skin was uncovered to stingers, and took a waterproof yellow switch box off a hook: 'I control the boat by signalling with this box'.

On Mick's next drift, Gary and I tumbled in and clutched the towrope. Dreamily we passed finger sponges, fan corals, an occasional anemone. Mick hung one-handed, like a trapeze artist.

But where were the fabled giant oysters? Mick reached down, snagged something from the silt that looked like a petrified pancake, and shoved it into the catch bag around his neck. He clipped each full bag to a line, signaled with a tug, and the bag was hauled up. We parted a shoal of silvery baitfish, and for an anxious moment a large, poisonous sea snake got entangled in my flippers.

On the back deck, the oysters were counted, cleaned of marine growth, weighed, then placed between layers of nylon netting stretched inside a window-size, rubber-coated metal frame. The panels, holding six to nine shells, were put into a salt-water tank for a quick ride to the 'dump', a holding area. There the panels were attached to the sea bottom so the oysters could recover from the stress of their capture.

In two to five months the panels are hoisted back to the ship, and each oyster is opened and seeded by a technician, usually Japanese. Then the oysters are put back in panels and quickly returned to the dump for another period of convalescence. Several months later the panels are transported to a pearl farm, sometimes hundreds of miles away.

Pearl farms, spread along Australia's north coast, must be located in a sheltered area of active tides. Here the oysters are coddled like prize beef cows. The panels are hung on long lines, like underwater clothes lines, supported by buoys, and the shells are kept clean of algae, sponges, crabs, and other encrusting creatures. The tides work their nutritional magic. Intermittently the oysters are hauled up and examined by X-ray to gauge their progress.

From gathering to harvesting, pearl cultivation can take 30 months. If a pearl is good, its oyster is reseeded with a new nucleus as many as four times. As the shell grows, it can take progressively bigger nuclei and may produce its largest pearl in its twilight years. If an oyster is non-productive, the nacre-covered inside is marketed as mother-of-pearl. Its dried meat brings as much as US$350 a kilogram in Hong Kong and Shanghai, where it is prized as a delicacy. Everything is used. 'The poor oyster winds up like the proverbial horse at the glue factory', fisheries scientist Lindsay Joll joked.

The Japanese have been inextricably linked to Australian pearling through expertise and investments. Their seeding technique has been a closely guarded art, and Japanese technicians have been known to stop work when observers are present.

I asked Kim Male why there were so few Australian seeding technicians. 'Practice', he replied. 'The Japanese can practise on as many as 50,000 Akoya shells before they get to be good. Fifty thousand shells in Australia is more than a year's quota for most operators. We can't afford practice.'

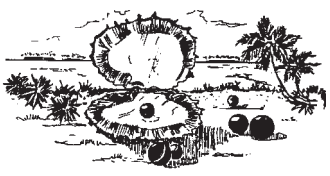
But now the Aussies are asserting themselves more strongly in the industry, and the dominant figure is Nicholas Paspaley, a rugged and intense man of 43, born to a pearling family, who has built an empire from his headquarters in Darwin. Paspaley and his sisters, Roslynne and Marilynee, purchased Bruce Farley's Roebuck Deep Pearls company in 1986, and by 1990 they had acquired Kim Male's firm of Pearls Proprietary, Ltd., including the historic farm at Kuri Bay. Paspaley Pearling Company now controls about 60 per cent of Australia's pearl business.

Pearling is a closed society, with only a dozen pearlers, licensed by the Western Australia Fisheries Department, operating on the north-west coast. Big or small, pearlers walk an economic tightrope. Any increase in production could lead to overfishing, wiping out the beds. Pearlers are not dealing with minerals but with living animals. The oyster is not a pearl factory; it will often produce a pearl full of lumps and stains or spit out an introduced nucleus and produce no pearl at all. It is as unpredictable as the sea itself. Pearling is still more alchemy than business. Not that Nick Paspaley hasn't tried to take the alchemy out of marketing South Sea pearls. In 1989, he organised the first Australian auction at Darwin.

From auction houses the pearls move from dealer to jeweller, arriving in the world's cities as objects of great desire. In midtown Manhattan I spoke with Koichi Takahashi, a vice president of the Mikimoto company, originator of cultured pearls.

'South Seas pearls are very rare, very valuable', he told me. 'Worldwide there are only 300 kan of these pearls harvested every year, and that includes all the black pearls from Polynesia.' (A kan, a Japanese unit of measure, is about eight pounds.)

To those who own them, South Seas pearls exercise a powerful mystique.



*Excerpts from an article by David Doubilet, in National Geographic, Vol. 180, No. 6, pp. 109–123.*

## Farming jewels: the aquaculture of pearls

*by Richard C. Fassler*

**New opportunities arise as pearl culture spreads beyond Japan**

### Introduction

Most people are aware that Japan has been the world's major pearl grower, but few persons know the basic facts of pearl production. Most do not know that the bead that forms the heart of almost every cultured pearl is a strictly American product.

This ignorance is curious in light of the fact that the farming of pearls, in terms of value, is one of the world's leading aquaculture industries. In 1990, more than US$ 900 million worth of pearls was produced. A catfish grower may smile when he can get 80 cents a pound, and a shrimp raiser will be happy with US$ 6.00. A South Seas pearl farmer, on the other hand, will receive an average price of US$27,578 for a pound of his product.

Moreover, recent breakthroughs in pearl culture technology have brought an important economic development opportunity to both the smallest and largest of nations. In the South Pacific region, where export products have been minimal or lacking altogether, Island states are discovering that they may now produce an extremely valuable commodity on their tiniest and most remote atolls. Consider this: Manihiki, an island of 1,344 acres and 400 people in the Cook Islands, recently harvested US$ 2.8 million worth of black pearls.

The excitement is occurring in the United States as well. Four pearl farms, encouraged by record high prices for both pearls and beads, are getting into the business.

### The nucleus

One of the major problems Mikimoto experienced in attempting to culture pearls was finding the right irritant to insert into the oyster. He tried a variety of substances that included glass beads and buckshot, but his oysters rejected objects that did not have the right material density. He settled on a round bead made from the shells of freshwater mussels. Moreover, the polished shell was white and similar in colour to the pearl, so that even a pearl expert might not be able to detect the bead under thin layers of nacre.

These molluscs could not be found in Japan. They were located in the Mississippi River basin of the United States, mainly in Tennessee. Here 'pig toe' or 'washboard' mussels (family Unionidae), some weighing as much as 7 lb, were found in various lakes and rivers and could provide beads from a few millimetres in size up to 14 mm.

So, because the middle United States was one of the few places on earth where large mussels grow, world cultured pearl production became largely dependant on the unique partnership of Japanese pearl farmers and U.S. shell exporters or, put another way, between Japanese oysters and American mussels. Divers sent mussels to processors who cleaned the shells and shipped them by the ton to Japan where they were sliced and rounded into beads.

This meant that a pearl farmer supplied the lake or lagoon and cheap labour, but it was necessary to purchase the services of a Japanese technician who brought with him the all-important beads.

This was highly beneficial to pearl culture in two important ways: because the Japanese controlled the supply, they controlled the world market price, and kept it high; and they established inspection offices which attempted to maintain a high quality product for export.

### The Japanese market

Japan is the largest importer of pearls. In 1989, the import value of the product reached US$ 156 million, up from US$ 121 million in 1988. Pearls were purchased from some 33 nations, led by Australia, French Polynesia and Indonesia (*Weekly Pearl Newspaper*, 1990). The bulk of this consisted of unworked cultured seawater pearls.

Japan is also the world's largest exporter of seawater pearls, sending US$ 352 million worth abroad in 1990. The largest buyer was the United States (US$101 million), followed by Switzerland (US$80million) and Hong Kong (US$ 64 million) (based on the Japanese Marine Products Importers Association's figures, 1991).

Up until 1988, the United States was the world's largest market for pearls. Today, the Japanese buy more pearls than anyone, taking 60 per cent of the annual world supply. This surge of interest in increasingly affluent Japan in its 'national gem' has caused rapid increases in prices locally and overseas. Even the smaller sizes of Japanese-produced pearls are selling for 30 to 40 per cent higher than two years ago (Edwards, 1991).

**Pearl farming in Japan**

Japan is also the world's largest pearl-producing nation. In 1988, production totalled 71.6 t, of which 70 t were saltwater pearls and only 1.6 t were freshwater pearls. This production was worth US$482 million, making pearl farming one of the country's most valuable aquaculture industries (Japanese Government statistics, 1989). Most activity takes place in Mie Prefecture.

Today, some 2,000 pearl farmers are raising the **akoya** oyster (*Pinctada fucata*), but their numbers have been cut in half over the past 25 years due to polluted water from industrial and agricultural sources, and competing uses for waters, including recreational uses and fish hatcheries. This has led to overcrowding and an increase in parasites and predators and this, in turn, has meant dramatic increase in oyster mortality (reaching 55 to 60 per cent in the Mie area) and fewer valuable pearls. From 1980, no more than 10 per cent (some say 5 per cent) of the pearl crop has been of fine quality (Federman, 1990). To boost production, farmers have resorted to greater crowding which, of course, has resulted in further decreases in quality.

The Japanese have reacted to this dire situation by 1) resorting to biotechnology to maintain or increase yields, and 2) increasing overseas activity.

**Grafting**

The success or failure of the farm hinges on the skill of the grafter, for his surgical abilities will determine the number and the quality of pearls harvested. The grafter repeats the same operation over and over, 200 to 400 times a day. For this, he is paid the highest wages in the world's aquaculture industry: US$3.50 per implant (over US$ 1,000 a day).

While the implant expense continues to be a major obstacle to profitability, there have been several important developments only within the last year which show promise of reducing costs. The Government of French Polynesia has started a school for grafters which could place a key phase of pearl culture in local hands. Moreover, a Californian firm, Cross Pacific Pearls, sent a team of grafters to the Tuamotus to explore the feasibility of utilising American expertise. This same firm, which manufacturers the bead, is going head-to-head with the Japanese in the nucleus market of French Polynesia and elsewhere. Cross plans to undercut Japanese prices (Cross, pers. commun., 1991). This is the first time that a U.S. company has sold the American bead and offered pearl farmers a choice of suppliers.

How many pearls can we expect from the five to six year process? Out of every 100 oysters, only 5 will produce gem quality pearls, 15 will yield saleable pearls, 20 will produce unsaleable rejects, and the remaining 60 will produce nothing at all (Coeroli, 1991). The small number of pearls harvested has much to do with the fact that 30 per cent of the oysters will die after implantation and 40 per cent are likely to spit out the bead. Despite their rugged appearance, oysters are extremely sensitive to handling (Porter, 1991).

The pearl farmer could have as much as US$ 35.00 to US$ 45.00 invested in each harvested oyster. There is the cost of the young oyster (US$ 1.00), the bead (US$ 5.00), the implant (US$ 3.50), other labour, equipment, buildings, etc... and costs are on the rise. Farms that rely on gathering shells from the wild are finding that these are getting hard to find, and nuclei are also scarce, especially for large sizes. Nuclei for South Seas pearls have sold for as much as US$ 30.00 a piece (*Jewelry News Asia*, 1990). One estimate, made in 1986, put the cost of starting a pearl farm at US$ 100,000 (Salomon and Roudnitska, 1986), but the figure is undoubtedly much greater now. Despite these high costs, rapidly escalating prices have assured profitability.

Demand for black, or 'South Seas', pearls has skyrocketed in recent years, increasing by 30 per cent in 1990. Last year, the average price of Tahitian pearls was US$ 60.80 per gram. A necklace with 27 black pearls was sold for US$ 1.5 million — or US$55,000 for each pearl! (Porter, 1991).

**Conclusion**

Sales of pearls and pearl jewellery in the United States this year are likely to top US$ 750 million (Macnow, 1991). Japanese and European sales will push this figure over US$ 2 billion. Dramatic increases in production will be required to meet this demand. According to *National Jeweler* magazine, production of South Seas pearls is expected to increase by 25 per cent in 1993. The reasons for this include:

1. better farming techniques and improved operation systems;

2. multiple implants in oysters, which can produce larger pearls;

3. new farms; and

4. increased use of hatcheries for stocking farms (Anon, 1991).

From Thailand to Tahiti, the successful spawning and grow-out to stocking size of *Pinctada margaritifera* and *P. maxima* is the most crucial problem facing pearl researchers today. With this obstacle removed, the industry will rapidly expand.

Increases in production will also depend on the spread of Japanese technology around the world and, importantly, the sharing of this technology.

At a recent meeting of the world's jewellers, a leading Japanese businessman, with many years' experience in the pearl industry, sounded a positive note. Mr Shunsaku Tasaki pointed to the 'internationalisation of pearl cultivation' and called for a 'first-ever world conference, so that persons involved in pearl culture can come together to share ideas'. For pearl aquaculturists in the audience from outside Japan, it was a giant step in the right direction — and long overdue.

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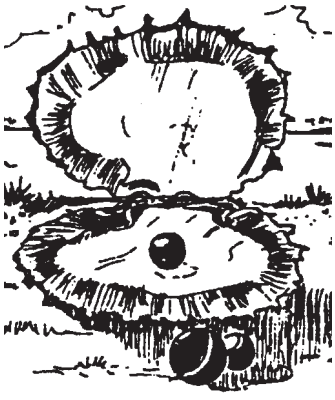

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## The unique, beautiful mabe pearl

*by Morimitsu Muramatsu*

### Its special features

The beautiful colour of **mabe** (large winged) pearls, which are born and raised in the warm ocean currents of Amamai in the southern part of Japan, is very special. Its shine varies from pale pink to a fascinating rose colour; some pearls are the gorgeous colour of the peacock's wings and others radiate the calm hazy moon-shine. On rare occasions a golden colour pearl is produced.

The **mabe** pearl represents the semi-spherical pearl.

### Origin of the name

There was a time when semi-spherical pearls from the white-lipped and the black-lipped oysters were also called **mabe** and there was a lot of misunderstanding and confusion. Until the success of artificial fertilization techniques by Tasaki Shinju, mentioned later, the production of the **mabe** pearl was sporadic and few pearls were produced because of the very poor natural supply.

Before 1976, every pearl store in Japan (maybe everywhere in the world) put the label **mabe pearl** beside white-lipped semi-spherical pearls. Recently, white-lipped semi-spherical pearls have almost disappeared from retail stores in Japan.

High quality semi-spherical pearls from mabegai, the real **mabe** pearls, are gradually spreading, with their rich shine, throughout Japan. I do not think the misuse of the word **mabe** for white-lipped pearls will happen again in the retail stores, at least not in Japan.

### The history of mabe pearl cultivation development

### Its dawn

During 30 years or so, from 1908 to 1943, many people were attracted by the **mabe** pearl and tried cultivating the mabegai. However, the results were not very successful. Some people managed to export beautiful **mabe** pearls to Spain but the project was cut short after five years because of the limited supply of mabegai oysters.

Jusaku Nakamura, in Anami Oshima, was said to be successful for a relatively long period of time; however, at the peak period, the number of seeded nuclei he produced reached only 1,000 to 1,500 pieces and this lasted for only five years.

Although many people tried round pearl cultivation in mabegai, when I was diving in the Palau ocean I saw many dead oysters on the sea bottom and realised there was trouble. Even with efforts to improve the technology, the ratio of **mabe** to round pearls was very low. The reason is that the body structure of the mabegai, which belongs to the *Pteria* species, is very masculine due to its environment and there is no room in the structure to cover the pearl softly as there is in the Akoya oyster (*Pinctada*).

From 1943 to 1950, **mabe** pearl cultivation, along with pearl cultivation in general, almost disappeared due to World War II. In 1952, after the post-war confusion settled, Kiichi Kozuka, who restarted **mabe** pearl cultivation at Yuikojima in Amami, faced difficulties in getting mother oysters after a few years. At the same time some people attempted cultivation in Miako, Anami and Tanegashima, not only mabegai, but also of black-lipped oysters. As their autobiographies tell us, 'It was a continuous nightmare'.

Thus the **mabe** pearl was unstable, and too often someone started cultivation, arousing attention, only to quickly disappear. So it has been that the mysterious beauty of the 'phantom **mabe** pearl' has been talked about among 'people who chase dreams.'

### Prelude to the new era

The Oita branch of the Fisheries Research Institute of Kagoshima Prefecture started researching mabegai artificial fertilization. After 10 years of steady endeavour, technology reached a point where a few thousand 3 mm spats were raised annually.

In January 1965, the *Nankai* newspaper reported '**mabe** mass production has bright prospects ... bright pearl cultivation in Amami'. This article sparked people's attention. Even though a few thousand spats were cultivated, farm management in the ocean was so difficult that the yield rate dropped after a half year. It requires four years for an oyster to reach a size suitable for nucleus seeding. The local staff said that although 'research level is possible, cultivation is further away on the industrial level'.

In the next spring, 10 pearl cultivation companies which had started Akoya pearl cultivation in Amami and 11 people from Setouchi-cho Fisheries Cooperative Association came together and started the '**Mabe** Pearl Promotion Association'. Their aim was to establish and use mabegai artificial fertilization technology. Shunsaku Tasaki, the president of Tasaki Shinju Co., Ltd., became the president of this association. I started technical training programmes at the local fisheries institute as the person in charge of the **mabe** Pearl Association, following a request from Mr Tasaki. With assistance from local areas, three technicians of the Fisheries Research Institute and I started new experiments.

Although it was an advanced facility for the time, it would be considered primitive by todays standards. A mabegai egg (0.5 um, or 1 / 20 of a mm) was taken from the mother oyster's ovary and fertilized in a Petri dish. The fertilized egg was then carefully washed. The spat was then bred after it was hatched and had started to swim.

I made many efforts to raise spat, following a manual which was based on research from the past 10 years, but things did not go well. Although we aimed at 5,000 to 10,000 spats, we raised so few spats, even working without holidays during the long six-month summer in Amami, that our results seemed totally out of proportion to our aims.

**Interesting problems**

During our concentrated efforts, I sometimes wondered if what we were doing was appropriate. One of the reasons for this was that we took the lives of many precious mother oysters, cutting them in order to collect eggs: as well we were responsible for the eventual deaths of their offspring. Furthermore, sometimes we lacked perspective, as our thinking was too concentrated in one direction.

I was devoted to collecting shells when I was a student. I never bought any but collected them from the beach or from the ocean while observing how oysters lived. Sometimes I dissected oysters and was very excited to find how oysters differed. However, there were no mabegai among my collections.

Many fishermen in Amami come from Itoman. They are noted for their world-class diving expertise. We bought the mother **mabe** oysters that fishermen collect for artificial fertilization, but they would never tell us where the **mabe** oysters were collected. mabegai were very expensive, so they would not tell us where the treasure lay. Furthermore, the place was too difficult for amateurs to dive.

My interest was aroused. Where did the **mabe** oyster live? When dealing with living creatures, I believe we cannot develop the best methods without understanding the way they live.

I started to visit a fisherman's home and he eventually took me on the ocean in his boat. At first, diving with no equipment, I harpooned a hanging squid and acted as a gill-net beater. I passed his test and was taken to the **mabe** area.

The combination of myself equipped with scuba gear and the strong-diving 'dark shining fisherman', who was naked except for his goggles, was an interesting contrast.

Since the current flow was very fast, as soon as the fisherman kicked off the boat I followed him to the bottom and clung to the coral reef. Even with my fins and the fisherman's strong kick, we could not make headway against the current and were forced to grope our way along the coral reef and rock bottom.

Finally I found the natural mabegai! A 20 cm mabegai was fixed by a strong dark byssus to the trunk of an ocean pine (a group of coral) whose branches were bent and moving because of the strong current. Another small mabegai (5cm) was attached near the branch and it trembled sporadically due to the current.

The black shining mabegai living in the strong current flow was very strong and beautiful; I felt it was a different living being from the mabegai hanging in breeding cages from cultivation rafts. The manual about spats and maintenance of breeding cages seemed to be like a mischieveous boy put in a baby's pen.

Furthermore, what should breeding management in the water tank of the hatchery room be? As soon as I saw the natural environment of a living mabegai for the first time, it taught me many things instantly. I realised that to treat the mabegai as a 'pearl oyster', like the Akoya oyster, and cultivate it in breeding cages, was a great mistake.

**Troubled era of the pearl industry**

Many people were critical because artificial fertilisation of Akoya oysters was still not at a level suitable for industrial production, and 'mabegai artificial fertilization was too difficult'.

At the same time the pearl industry fell into a deep recession. From 1967 to 1968 many members quit and the **Mabe** Pearl Association was forced to disband. The people who left Amami did not listen

to anything that I said. There had been 15 years of research and researchers who were always talking of 'hope', but there were no results to support this talk and nobody listened to me.

**Foresight, tenacity and luck**

During the recession many dealers went bankrupt and others just tried to survive forgetting their farms. Tasaki Shinju continued research alone, relying on the faith of the president Shunsaku Tasaki, who said: 'What will happen to the future of the pearl industry if everyone forgets pearl cultivation? Without cultivation, processing and sales cannot succeed'.

Since few resources were available during this period, we worked day and night without rest. During this period, I talked about our dream with Mr Mamoru Shouji (now Tasaki Shinju Amamai Pearl Cultivation Headquarters Director), who continued to show great determination, conducted our research and imagined a successful future.

We thought about and discussed every measure that we should undertake, looking for a site, designing a building, and constructing an underwater ocean water pump facility. By 1970, an artificial fertilization room had been built and we were lucky to fertilize 90,000 spats that year.

We attained 100,000 spats in the next year and 110,000 the year after by a non-conventional method of artificial fertilization and spat management in the ocean. We achieved better-than-expected results.

Prior to this we had only achieved 100 or 1,000 spats in this area. Even if we succeeded that far, we only dealt with spats and mother oysters. We required more time for nucleus seeding, processing and marketing. A lot of money had been spent on rafts, boats and labour for farm management, which meant we did not have any income.

**Beginning of a new era**

In 1975, a healthy number of pearls was harvested; the next year, many **mabe** pearls radiating a rainbow shine were produced. Those pearls had thick nacre and everyone in the pearl industry was surprised. **mabe** pearls started with high quality and their reliability in the industry was established.

Before going into a mass production system, I researched a nucleus seeding method different from the conventional method. The change proved fruitful, putting an end to the 'phantom' **mabe** pearl era, which lasted 60 years, and started a new era in pearl cultivation history.

As soon as people discovered the success of Tasaki Shinju, many started artificial fertilization and cultivation. However, Tasaki Shinju's technology is far advanced in quality improvement and Tasaki Shinju deals with the highest quality **mabe** pearl throughout Japan as well as abroad.

**Raising the** mabe **pearl**

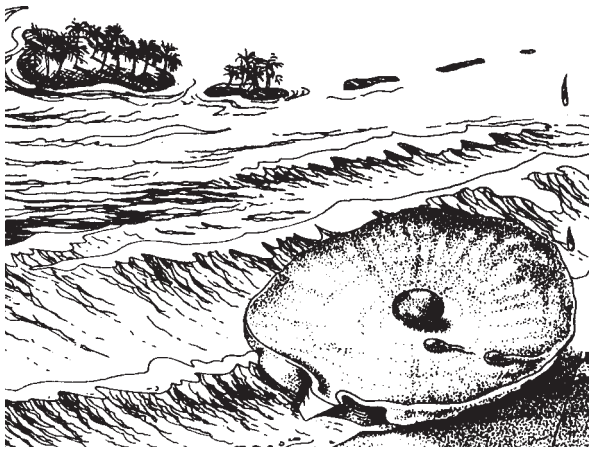
The **mabe** pearl starts its life as a small egg of 50 µ. Every year in the spring, the most beautiful and healthy mother oysters are selected among many mabegai. The eggs, which are laid in the water tank of the fertilization room, are raised with care.

When spats grow to the size of sesame seeds, they are moved to breeding cages in the ocean.

Spats grow well in the warm ocean. After 3 to 4 years, spats grow to mother oyster size of approximately 20 cm. During this period, the people who are involved in cultivation work strenuously and pay close attention to seasonal management. They have to protect oysters from enemies which eat them and from typhoons.

To avoid the hot summers and cold winters, nucleus seeding procedures are conducted in spring and autumn. Carefully selected moderate-sized nuclei are inserted without damaging the oysters' health.

After five and a half to six years, a rainbow shining **mabe** pearl is taken from the harvested mabegai. When the temperature is relatively low, the pearl is smoother and even more beautiful.



*Excerpts from an article by Morimitsu Muramatsu, in "Pearls of the world (II)", Les Joyaux Special Edition, September 1991, pp. 99–106.*

## Chemical processing of pearls

*by C. Denis George*

This technique is today the most secretive part of the Japanese pearl industry. Approximately 150 processing establishments are fully occupied in the artificial improvement of pearl quality. The processes consist basically of the application of chemicals and heat and final polishing by mechanical means.

In the first stage of the processing treatment the pearls undergo a lengthy bleaching process inside an incubator at a temperature of 40° C. This may last some 30 to 60 days, depending on the condition of the pearl. During this stage, organic substances, seen as black spots just under the nacre layers, are bleached, becoming white. The bleaching does not work on the crystals of the nacre, but affects the organic material which binds the crystals.

The structure of the nacreous lamellae varies widely due to differences in the physiological condition of the animals and the seasonal changes in their environment. Generally the aragnite lamellae are connected to each other by a thin organic membrane of conchiolin which varies in thickness from 0.3 micron to 1.0 micron; the aragonite crystals may range in size from 1.0 micron to 8 micron. During the bleaching this thin organic membrane of conchiolin is affected and almost dissolves, thus the binding between the aragonite crystals is weakened. An additional effect is that the crystals become softer and are more easily damaged.

By further application of heat in an incubator with pressurised immersion in chemicals and dyes, tinting to the desired colour is achieved. After some further polishing the pearls are ready for the market.

It is interesting to note that some of the processes do not result in fast or permanent colour in the pearl, and that after a period the tint fades, either partially or totally. One often hears stories of pearls losing their colour because of the characteristics of the skin of a particular lady, or for some other obscure cause. This is far less likely a reason than the deterioration arising from the inability to improve permanently the quality of inferior pearls by bleaching and coloring processes. A cultivated pearl, like a natural one, never fades, discolors or loses its lustre if it has not been subjected to the effects of acids or other detrimental processes.

Chemically processed pearls can be very easily detected under ultra-violet light. Any string of pearls which have the same colour tint, lustre and appearance can be classified, with little risk of error, as having been artificially improved. In some cases extreme poor-quality, thin, whitish-looking pearls are offered for sale.

In conclusion it is regrettable to note that the Japanese pearl industry has apparently reached the limits of home development and is facing grave problems from the drop in productivity of the culture grounds. The present average quality is not desirable. Already some American and European buyers are objecting to handling appreciable numbers of inferior quality Japanese pearls.

The pearl industry appears now to be developing outside Japan, and already cultivation has commenced in Korea, Hong Kong, the Philippines, Burma, Indonesia, Borneo, Okinawa, Australia, and possibly in other waters as yet unknown to the writer. The most important development is that taking place today along the coasts of the mainland of China in the production of their first pearls. Because China has abundant resources of the Japanese type of pearl shell, ample suitable locations, cheap labour, a mental attitude similar to that of the Japanese, and the desire of the government to reconstruct their country, it will not be very long before Chinese pearls of better quality will offer important competition on world markets. This is a development that the Japanese greatly fear. But after all we must not forget that the Chinese originated the cultivated pearl.

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*The above excerpts are from a reprint of an article from Lapidary Journal of America, July–September 1967: The cultured pearl: its history and development to the present day, 16 pp.*

*Note from the editor: Although much dated, these excerpts describe some of the little-known techniques used to 'treat' **Akoya** pearls of poorer-quality. Tinting of pearls has become increasingly widespread and may already be affecting the marketability of black pearls. Any further comments or information from readers would be welcome.*

## Transfer of technology and strategy for pearl culture in India

*by K. Alagarswami*

The first cultured pearl of India was produced on 25 July 1973 in a pearl oyster which had been operated on 12 June 1973. Results were confirmed in succeeding batches of oysters. Against the background of India's interest in pearl culture as evidenced by the past experimental programmes of the Department of Fisheries and the Governments of Tamil Nadu (Devanesen and Chacko, 1958) and Gujarat (Pandya, 1974), and failures of natural pearl fisheries in both the regions, an important recommendation was made at the 'Group Discussion on Pearl Culture' on 24 January 1974 to exploit the new technology commercially (Swaminathan, 1974).

It was also decided that the Central Marine Fisheries Research Institute (CMFRI), Cochin, should organise training courses in pearl culture for the benefit of the intended development programmes in the country.

**Transfer of technology – training courses**

As a result of the above decision, the CMFRI developed curricula for a long-term training course of six months and a short-term technicians training course of 4–6 weeks (*fide* Anon., 1977). The programme was made demand-oriented for the target group of fisheries development officials of the Governments of the Maritime States and Union Territories. A *Manual on Pearl Culture Techniques* was later published as a practical guide to the training courses (Alagarswami and Dharmaraj, 1984).

The long-term course is a comprehensive one aimed at managerial and supervisory personnel, comprising the subjects of pearl oyster resources, biology, ecology, farming, surgery, pearl production and management (Alagarswami, 1987d).

The short-term course has a restricted scope, offering training at the technician level in mother-oyster culture, surgery, and pearl production. The training courses are heavily oriented towards field work and practical training, keeping the class-room lectures to the essential minimum.

With the development of hatchery technology for pearl oyster production, a short-term training course of four weeks in pearl oyster hatchery technology was introduced in 1986. The course curriculum includes shellfish hatchery, breeding of pearl oyster, induced maturation and spawning, larval rearing, water quality management, microalgal production, spat settlement and juvenile rearing (Alagarswami, 1987d).

The only component in the total technology of pearl culture which has been lacking is the production of nuclei. The experimental and commercial programmes are dependent on shell beads imported from Japan. This is an engineering problem which will have to be solved with some urgency (James, 1987).

**Beneficiaries**

The first long-term training course in pearl culture was organised from September 1976 to March 1977. The subsequent courses were of a short-term nature; four were organised in 1977,1979,1984 and 1986. The first training course in pearl oyster hatchery technology was conducted in 1986.

The beneficiaries of these programmes were predominantly fisheries development personnel from the states of Gujarat, Karnataka, Kerala, Tamil Nadu and the Union Territory of Lakshadweep. The Fisheries Departments of the Union Territory of Andaman and Nicobar Islands, and Tamil Nadu and West Bengal also sponsored qualified private candidates. A few scientists and technicians of research institutions such as the Konkan Krishi Vidyapeeth, the Central Agricultural Research Institute for Andaman and Nicobar Islands, and the Central Marine Fisheries Research Institute have also undergone training. A fisheries technician from the South-East Asian Fisheries Development Centre of the Philippines participated in one of the short-term courses in 1979. Officials of the joint venture pearl culture industry were also given training.

Besides regular training courses, the Institute has included pearl culture and hatchery technologies in the curriculum of post-graduate education programmes leading to Master's and Doctoral degrees. A component on pearl culture has been included in the Summer Institutes on subjects relating to molluscan shellfish culture organised by the Institute. In the transfer of technology programmes, the Central Marine Fisheries Research Institute has adopted an open policy to extend the technology to Indian nationals as well as foreigners, subject to the arrangements falling within the policy framework of the Charter of the Indian Council of Agricultural Research.

**Strategy for pearl culture**

India has gained some practical experience in commercial production of cultured pearls and this has given an insight into the travails of the new industry. Any biology-based industry will have some problems in control of production and the maritime base of pearl culture adds another dimension to it. A new venture in the above context is bound to show some unpredictability due to variability of parameters which were not known previously or not taken seriously, but the experience gained is invaluable in filling the loopholes, bridging the gaps and considering more appropriate strategies suitable to the Indian context. Some of these aspects are examined here in general terms.

**Environment**

The basic tenet of any aquaculture programme is the soundness of the environment most appropriate to the candidate species and the technology. This should not be compromised under any circumstances. Detailed topographical and site surveys should precede project preparation. Although data of a general nature are available for the Indian coastline and island territories, these are not adequate for making decisions on sites for establishing pearl culture farms. Specific surveys should be made to look at all these aspects.

While dealing with the mariculture potential of Andaman and Nicobar Islands, Silas and Alagarswami (1983) indicated the potential areas for pearl culture but emphasised the need for further detailed survey. In Lakshadweep, although the islands are situated in the same generic ecosystem, the lagoon of Bangaram has been found to be different from that of Agathi (Alagarswami et al.,1989) in supporting pearl oyster farming. The gulfs of Mannar and Kutch, the natural abode of pearl oyster, similarly show differences within and between the ecosystems. The mainland coastline is bereft of bays as found in Japan or the Philippines and is subject to the effects of the south-west and north-east monsoons, as well as cyclones in certain areas. Considering these limitations, ideal sites for pearl culture may be few and these have to be chosen after a careful study of all relevant parameters.

**Species**

The second aspect to be taken note of is the species of pearl oyster. Undoubtedly *Pinctada fucata i*s the major species on which work has been carried out in India and is the species on which Japanese pearl culture industry is based. This should be complemented with *P. margaritifera* for its special quality of producing black pearls. The resource position in the Andaman and Nicobar Islands and initial success achieved in hatchery production of black-lip pearl oyster have already been referred to (Alagarswami, 1983; Alagarswami et al.,1989). Technology for production of pearls in this species remains yet to be developed in India. This work may be taken up in the Andaman and Nicobar Islands. The possibility of occurrence of a third species, *P. maxima*, in the Adaman and Nicobar Islands, is based on parallels with the Mergui Archipelago of Myanmar and Phuket region of Thailand (Alagarswami, 1983). An appropriate survey of the deeper waters of the shelf is required to explore its occurrence and distribution.

**Shell beads**

The third and important gap in the total technology of pearl culture is the shell bead. The early attempt of Velu et al. (1973) has not been followed up vigorously. It has been felt by the industry that the cost of imported shell beads is even higher than that of imported raw pearls. Hence, this technology gap should be filled, with extreme care in the choice of indigenous shell material from among *Xancus pyrum, Tridacna* spp., *Trochus niloticus, Turbo marmoratus,* etc. which are some of the larger species. The operculum of some of the gastropod shells may also have to be examined. Occurrence of large shells of freshwater mussel *Parreysia corrugata* requires investigation. Cultured pearls are largely sold by weight and hence the density of shell bead should be close to acceptable international standards.

**Farming**

Certain engineering problems remain to be solved with reference to farm structures as suitable for the sites. Floatation and mooring devices for rafts, longlines or under-water platforms are to be made operationally easy, logistically sound, economically viable and durable. To make pearl oyster farming cost-effective and less fatiguing for people working in the farms, it is necessary to modify and improve the system, design and materials of farming. A separate R&D programme on open-sea mariculture structures will go a long way in helping the development not only of pearl culture but also of other shellfish and finfish culture.

**Options for organisational set-up**

Pearl culture is a composite industry, like textiles, with different components. These include raising of mother-oysters, pearl production, processing and marketing. Each is a field specialisation requiring separate technology, skill and equipment. Put together, they become a composite industry, raising the capital, manpower and technology require-

ments to a higher level. The advantage will be that a composite enterprise can mobilise resources, manage problems with competence and have greater control over situations. The disadvantage will be that any miscalculation in a single area can upset the entire system.

Japan's pearl culture industry has been of a decentralised nature. Mother-oyster culture and pearl culture are practised mutually exclusively. The pearl trade looks after processing and marketing. The 1966 production of 127 tonnes of *P.fucata* pearls came from 4,710 independent management units (Mizumoto, 1979). Of them, 48.7 per cent were very small, operating only 1–14 rafts and very few units operated over 1,000 rafts (Furukawa,1972). There were 8,633 units engaged exclusively in mother-oyster culture in the same year (Furukawa,1972). The data show that more small units contribute to pearl culture in Japan.

In French Polynesia a number of small units and a few big companies, besides co-operatives, are engaged in pearl culture. In Australia, the companies are big in view of the heavy investments required for collection of oysters from distant grounds. In Papua New Guinea the Pearl Farmers Association operates village-level units. In Myanmar too, the co-operative society is engaged in oyster collection. Thus, a wide range of options is excercised in other pearl culturing countries in the world.

**Pearl farmers' co-operative**

With the background of India's experience in pearl culture, a second option is perhaps worth contemplating. A co-operative structure of smaller units with State support in critical areas in the early stage of development may be considered. Young fishermen with aptitude for pearl culture may form themselves into a Pearl Farmers' Co-operative Society with financial support from the Co-operative Sector. The society may have, besides its executive, a technical advisory body represented by fisheries, co-operative and trade interests to plan and guide the functioning of the society. The society will look after both input supply and output management.

***Input supply***

Activities under this may include:

(a)facilitation of leasing of sea area and shore facility;

(b)supply of oysters;

(c)supply of farm materials;

(d)supply of nuclei, chemicals and equipments;

(e)security arrangements ; and

(f)arrangements for training of the members.

While the society should have its own hatchery in the course of time, spat supplies may be arranged with Government organisations in the early stages. Collection of oysters fom the natural beds may be kept as a secondary option in seasons of abundance. While import of shell beads may be unavoidable in the beginning, the society may set up its own unit for their production without much loss of time.

***Output management***

The society will:

(a)purchase the pearls produced by the individual units;

(b)attend to sorting, grading and processing;

(c)sell the pearls to the domestic market and/or export them; and

(d)dispose of byproducts in value-added form.

The above is a very generalised picture of the suggested set-up, but details will have to be worked out.

**Policy support**

Pearl culture has some potential for generating employment for skilled and semi-skilled persons in the coastal rural areas, particularly among the fishermen families. It also gives employment opportunities to managerial and technical personnel. It will add to the GNP and can also earn foreign exchange. It can cut down imports of raw pearls. It is a new industry and would need policy support, financial assistance, subsidy and economic incentives from the Government in the early stages until pearl culture becomes a sound economy on its own merit. 'The only economically sound way of making the Indian....pearl fisheries permanently and regularly remunerative is to concentrate upon the inducement of pearls by artificial means in comparatively limited number of cultivated pearl oysters.' (Hornell, 1916); 'Pearls give the highest profit return of all marine products cultivated in coastal waters' (of Japan) (Wada, 1973); and, according to Hollyer (1984), pearl culture is a long-term investment and big profits can be made in a successful culture operation as there is still a great demand for pearls.

*Excerpts from a chapter of the same title, pp. 98–103, in Alagarswami, K. (1991). "Production of Cultured Pearls". Indian Council of Agricultural Research, New Delhi. 112 p.*

## The Badjaos pearl divers of the Sulu Archipelago

*by F. Doumenge, J. Branellec and A. Toulemont*

Natural populations of the large silver-lip *Pinctada* are scattered between the islands of the Philippine archipelago. The largest area of distribution stretches over 35 000 km$^2$ around the Sulu archipelago. No limits have been imposed on *Pinctada maxima* harvesting, neither quotas nor time restrictions. It would be impossible to police this activity in these far-flung areas. The Philippine Bureau for Fisheries and Aquatic Resources records eight active pearl-farms, which are situated close to natural oyster grounds.

### Deep-diving fishing sites

Sea currrents are intensified between the islands, bringing well-oxygenated water loaded with organic matter. They cut channels where the coarse coral sand, with an average grain size of between 0.5 and 3mm, is scattered with blocks of dead coral. There, between 5 and 60m, lies the domain of gold- and silver-lip Pinctadas. But divers now have to go deeper. Owing to over-exploitation, oysters have readapted to the fine foraminiferal sands, 0.05 to 0.20 mm average size. They are observed down to 120m. However, the oysters that live on gravel are thicker and rounder than those living on muddy sand.

The white-lip *Pinctada* lives half-buried in the sand. Its shell can be oriented freely, owing to foot-muscle contractions that enable it to adjust its position. Camouflage is provided by a coating of numerous organisms that fix themselves to its shell. These include sponges, cnidarians, bryozoans, serpulid worms and barnacles. Divers must, therefore, be very experienced to spot an oyster on the sea bed.

At the end of the fifteenth century, the local people used Pinctadas as a source of fine pearls and buttons,

1. Government farm, Guiuan
2. Surigao farm
3. Zamboanga farm, Sacol
4. Palawan farm, Busuanga
5. Guiuan farm, Sawar
7. Bohol farm
8. Bugsuk farm
9. Cebu farm

made from the nacre. Today, substitution of skin divers by those equipped with air tanks and other diving apparatus has resulted in the exhaustion of a great number of oyster beds

In 1930 the ports of Jolo and Zamboanga were exporting 250 tons of mother-of-pearl (mostly gold-lipped shells) to London and Paris via Singapore, or to the Oriental markets. It was at this time that Kashiwagi successfully experimented on pearl culture with the gold-lip *Pinctada.* He grafted a spherical 5mm nucleus onto which 2mm of bluish nacre was deposited in one year. Political events were to hold back the expansion of oyster farms in the Philippines.

*Pinctada maxima* is now much sought after, mainly for pearl farms. Skin divers can bring oysters to the surface without too much stress, but depths where the sparse populations are now scattered encourage highly dangerous ventures.

**The Badjaos — Deep-diving fishing for gold-lip Pinctadas**

For many centuries, the Badjaos, semi-nomadic fishing people from the Sulu archipelago, have practised skin diving to obtain the nacre and fine pearl from large Pinctadas, which were so coveted by Arab and Chinese merchants. A pearl-fishing fleet was organised at the end of the nineteenth century. Starting in 1880, Arabs, Chinese, Americans, and the Japanese equipped heavily a 30–60-strong fleet of boats, first under sail, then motorised. Each crew included one or two armoured divers, usually Japanese, who gathered the oysters.

The daily catch, from depths of 25–30 m, was seldom as much as a dozen *Pinctada maxima* per diver, throughout the annual 100-day season. Around 200 Badjao divers were still active around Tawi-Tawi Island. Each brought half a dozen pearl oysters to the surface in a day's diving. Aboard 20 sailing vessels (vintas), other Badjaos worked by trawling. Consequently each year up to 1940, about 100,000 pearl oysters provided 150–250 tons of shells, and some fine batches of pearls.

Fishing by heavily-equipped divers came to an end when many oyster grounds became exhausted. The skin diving practised by the Badjaos, however, continued and supplied pearl farms with living, healthy great Pinctadas.

The Badjaos belong to an Indo-Malay fishing culture which extends along the coasts of a vast group of islands. They are close to the dominant linguistic population in the Sulu archipelago — Samals. They are easily distinguished from the rest, however, because of their dark skin and reddish brown hair caused by constant exposure to the wind and the sun. The Badjaos may seem awkward on land, due to days spent hunched at the stern of their boats. On board their vessels, they are astonishingly agile. A mutual mistrust reigns between them and their land-dwelling neighbours.

About 20,000 Badjaos have settled in the Sulu archipelago. The society is centred on a close family unit, living on a vessel, involved in fishing operations, using various implements: harpoons, baskets, lines and nets. A community usually comprises between 100 and 350 people, but the largest group has nearly 3,000 town-dwellers on Sitankai Island.

Badjao men are permanently busy with fishing and boat maintenance. The women, on the other hand, take on fishing from the lagoon and household tasks, complemented by some handicrafts and weaving. As they have no agricultural land, fishing activities on the coral reefs enable them to set aside a surplus of resources to acquire essential vegetable food produce. Goods and material that improve living standards can then also be obtained.

The most profitable of these activities is the sale of *Pinctada maxima.* These Pinctadas are harvested by the Badjaos, who dive more than 80m deep and are able to stay near the seabed for three minutes. The Badjao diver accomplishes extraordinary feats to collect the 'mutya tipay', the nacreous shell. Without the use of air tanks, he works at depths where a scuba diver rarely ventures; the Badjao goes down two or three times a day as far as 80m. Before each dive, he uses relaxation and hyperventilation techniques similar to those in yoga.

His equipment is simple: a rope as a lifeline, a stone as ballast and a pair of wooden-framed goggles. When he is near enough to the sea-bed to choose a good spot, he directs his path with the aid of a stabiliser with rudimentary wings. Each diving campaign is subject to ritual meetings and preparations to ensure the operation's success. In order to see better at the bottom of the sea, the diver's eyebrows must be shaved.

A good diver succeeds in gathering three to five *Pinctada maxima* per day, which assures him an enviable fee, for each oyster judged suitable for grafting can bring him 10 dollars. This, however, can encourage imprudence among some divers who persist despite unsafe diving conditions and end up in some sort of accident. Some divers use brake pumps from heavy lorries to supply compressed air, which they breathe under water, through hoses without pressure regulators. The

Badjao's daily catch provides the same number of oysters as his ancestors', but he dives twice as deep and takes more risks.

The annual demand from pearl farms approaches a million individuals suitable for grafting, which, without protectionary regulations, results in a rapid depletion of natural populations. From the scattered colonies, which are gradually becoming more limited, the diver gathers even unhealthy old specimens for which the farmer must pay a high price. Tension on the market causes prices to soar disproportionately, to reach 20 dollars per oyster.

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*Excerpts from Doumenge, F., J. Branellec and A. Toulemont (1991). "The South Sea Pearls: The Philippine golden pearl". Musée Océanographique, Monaco. 54 p.*

## Pearl culture in abalone

***Source:*** **INFOFISH International** ***(4/91)***

*Unlike culture in the more conventional oyster, pearl culture in abalone poses some interesting problems. The unique purity and lustre of the abalone pearl, however, make it all worthwhile.*

Cultured abalone pearls appeared for the first time during the late nineteenth century. In 1897, the French scientist Louis Boutan successfully inserted 6–7mm natural pearls between the mantle and shell of the European abalone *Haliotis tuberculata* to act as nuclei for culturing blister pearls. Production methodology for blister pearl culture was not defined until the pioneering work by Dr Kan Uno at the Tateyame Fisheries Station in Japan in the mid-1950s.

Dr Uno was very successful in his culture experiments on growing semispherical pearls in several species of abalone including *Haliotis discus*, *Haliotis gigantea* and *Haliotis seiboldii*. Unfortunately, he met with only fair results in his attempts to produce round pearls from conventional nuclei. Failures in round pearl culture were attributed by Dr Uno to several factors, including nucleus dislodgement and infections precipitated by the sometimes violent activities of the abalone's large muscular foot. Today, abalone pearl culture is carried out in about six farms in Japan, Korea, Canada and the United States.

### Unique beauty

The nacre of abalone shell is often multi-hued in tones of silver, orange, pink, green, blue and lavender. It is not unusual to find individual abalone pearls (especially natural pearls) which reveal several of these colours simultaneously. Due to their rarity, abalone pearls do not enjoy the popularity of other molluscan pearls. However, the beauty of abalone shell inlay and natural abalone pearls has been prized historically and examples of the gemstone material can be found in cultural artefacts dating back centuries before man began to think about the culture of abalone pearls.

The quality of abalone pearls, as reflected in their surface texture, is superior to that of pearls produced in fresh water mussels and comparable to the best pearls cultured in marine pearl oysters (*Pinctada*). Abalone pearls typically posess the additional caveat of lacking the 'doctoring' treatments given to cultured pearls grown in bivalved molluscs, including the common industry practices of bleaching, dying, removal of the conchiolin base layer and underpainting with pearlescent lacquers. Perhaps as a result of this, only a few *quality* cultured abalone pearls appear on the market, and these command high prices (about US$300 for an AAA grade 13mm semispherical or mabe pearl).

### Pearl culture in cold water

In contrast to pearl oysters which require sea water temperatures of at least 15°C to secrete the nacre required for growing pearls, many temperate species of abalone thrive in colder waters. Thus, while it is not feasible to cultivate pearl oysters in countries surrounded by temperate waters, it is possible in many of these same locales to culture pearls in wild or hatchery-raised abalones. For instance, on the West Coast of Canada and the United States, there occur naturally at least six species of abalone large enough to nucleate for pearls (100mm in length as adults). Moreover, several of these species, including the world's largest species, the red abalone *Haliotis rufescens*, are also cultured and grown within licensed California hatchery facilities.

### Nucleation methodology

Abalone pearl growers have their own proprietary techniques and materials for producing semispherical or mabe-type pearls, but the essence of nucleation is slipping a nucleus of plastic, soapstone or mother-of-pearl beneath the mantle epithelium and securing it to the shell so that is not rejected by the strong muscular movements of the snail's large foot.

Within several days following nucleation, a thin chalky layer is secreted against the nucleus surface. This is followed by the mantle's secretion of a thick, tan-brown layer of horny conchiolin. The latter forms the foundation for the deposition of a porcelain-like, prismatic layer of upright aragonite crystals followed by a thinner (0.35–0.5mm) layer of nacreous aragonite sheets. In a properly cultured abalone pearl, the total thickness of the conchiolin and new pearl is about 1.0–1.2mm.

Depending upon the interaction of the host abalone's genetics, age and external factors such as water temperature regimen and food supply, a gem quality 14mm semispherical pearl can take between 3 and 18 months to grow. At the pearl laboratory at the Bamfield Marine Station on Vancouver Island, the author has successfully cultivated gem-quality semispherical pearls in *Haliotis kamtschatcana* to a size of 17mm diameter. In Japan, Dr Kan Uno reports growing semispherical pearls to 22 mm in *Haliotis discus*.

**Finishing of abalone pearls**

To prepare mabe-style abalone pearls for market, they must first be cut out of the abalone's shell with a diamond saw. If a non-permanent nucleus has been used (i.e. soapstone or a slippery plastic), the new layers of abalone pearl are carefully lifted or 'popped' off the nucleus, and the resultant 1.0–1.3mm thick 'button' is refilled with cold-cure epoxy resin. If a more natural weight to the pearl is desired, mother-of-pearl pieces or pearl dust can be mixed with the epoxy resin prior to filling the button.

**Culture practice**

Unlike bivalve molluscs used for pearl culture, abalones are highly valued for food. The strong fishing pressure on wild stock reserves has resulted in short supply. This means that pearl culturists must purchase their abalones from fishermen and / or abalone hatcheries. Whatever the source, the culturist must pay the current market price (in Canada the cashboat price for abalone in the shell is about $16 / lb).

While the pearl grower will recover his investment when he sells the abalone meat after harvesting, he is placing his investment at risk during the pearl culture period. And should the grower's abalones die from nucleation or other causes during pearl cultivation, his loss for each abalone is the original purchase price, the post-nucleation husbandry, if any, and the cost of nucleation. Successful nucleation of abalone for pearl culture is a problematic exercise and is not for the amateur aquaculturist. Even with highly skilled operators, mortality rates following nucleation can rise well above the normal 1–10 per cent. Abalones surviving nucleation procedures must be handled with exceptional care. The rough handling practices common to many grow-out facilities, including the use of wheelbarrows to move abalones from one location to another, can cause the death of a nucleated animal.

Abalones also differ from their bivalve relatives in that they are quite mobile and must be contained within a secure enclosure to prevent their escape. In British Columbia and California, both screened plastic drums suspended in the water and inland concrete raceways are used for the grow-out of young nucleated abalones. Each of these culture systems has its pros and cons. In the case of drum culture, the initial investment is less and the system is not susceptible to the power failures which can cause massive mortalities in the raceways. Raceways, on the other hand, can be installed on open coasts where they are immune from the seasonal storms which can easily destroy an exposed drum culture system.

Nucleated abalone are also labour-intensive to husband. The grower must collect or purchase fresh algae (*Gracilaria* sp, *Laminaria* sp., *Macrocystis* sp., *Nereocystis* sp.) or some suitable substitute to feed the abalone every 3–7 days. The containment system must also be maintained in a healthy, disease-free condition through constant removal of marine fouling organisms, abalone morts, predators (sea stars, octopuses), etc.

**Pearl culture — a bonus to the abalone farmer**

Depending upon the species, many commercial abalone growers elect to sell their product after it reaches about 65–80 mm in length. This size may represent about three years of cultivation and often marks the point in the grower's operation at which it is more economical to sell his product and use the space to start again with seed than to grow the older stock for another year.

If, on the other hand, the grower has the opportunity to enter into a contract with an abalone pearl company for the latter to nucleate his older abalone for pearls, at the end of a year he would have older, larger abalone which would be more competitive in the market place. Morevover, the abalone grower's accrued costs from the additional year of husbandry would be more than offset by his share of the net profits on the pearls after they were harvested, finished and marketed by the abalone pearl company.

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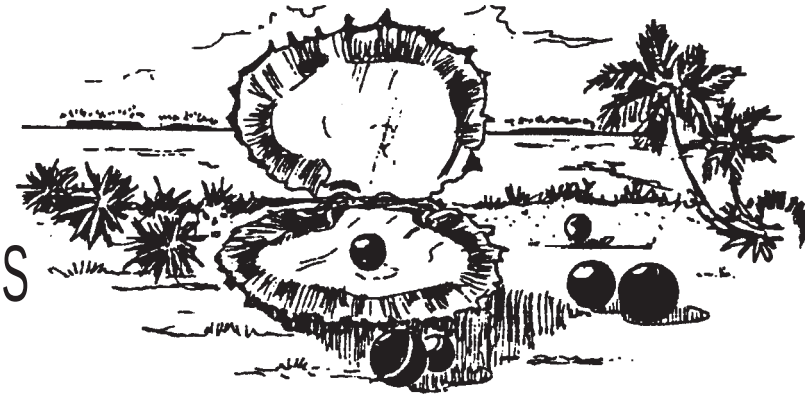
*Excerpts from an article of the same title by Peter Fankboner, in Infofish International (1991), 4/91, pp. 52–55.*

# ABSTRACTS and PUBLICATIONS



## Two new Indian pearl manuals: hatchery production and cultured pearl production

***Book Review by Neil Sims***
***Kona, Hawaii***

Indian pearl farming developments have provided an interesting model for other developing countries. The approach has involved close cooperation between a government-funded research programme and prospective farmers, with regular publication of articles and information, and concerted extension efforts. Over the years there have been many pearl publications produced by the research team at the Central Marine Fisheries Research Institute, in Tuticorin. Now there are two more.

The first volume, *Production of Cultured Pearls* by K.Alagarswami, is a useful overview of all aspects of pearl culture: the history, taxonomy, pearl fisheries, hatchery culture (a shorter account than in the manual reviewed below), farming methods and pearl seeding. Most of it may be familiar to the reader, but there are some interesting extras.

There are some SCUBA survey data from the paars in the Gulf of Manaar and there is a section describing attempts to set up a cottage industry to manufacture beads. The use of menthol as a narcotising agent prior to the seeding operation is described. Shirai's (1970) outline of pearl grading methods is reproduced, tables of pearl sizes, weights and average values are given and there is an overview of recent advances in biotechnology for pearl culture. The etymology of the word pearl, for example, was new to me: *margarita* was the Roman word for pearl (which I will remember next time I order a drink in a Mexican restaurant), and has been traced back to the Babylonian *mar–galiter***.** An appendix provides a cost-benefit breakdown of pearl culture in India using *P. fucata*, but only provides values in Rupees. U.S. dollar equivalents would have been helpful.

The final chapter provides an excellent synopsis of the policies and approaches to development of pearl culture in India. This highlights the active role played by the Indian and regional government research bodies and extension training strategies *(Editor's note: Excerpts from this chapter have been reproduced above, pp. 36–38).*

One point of dubious taxonomy: Alagarswami refers to *P. margaritifera* from the Gulf of Mexico (p.15), and places its distribution on a map (Fig. 10) at two locations in the Caribbean Sea, off Panama and in the Gulf of Mexico. Elsewhere the author describes accurately the *P. margaritifera* fishery in the Gulf of California (p. 35) and in the Gulf of Panama, which is on the Pacific side (p. 36). Another section indicates that the Venezuelan fishery was for *P. imbricata* (p.36).

The American sub-species, *P. margaritifera mazatlanica* is only known from the Pacific Coast. Jameson (1901) lists the geographical distribution as 'Panama, Gulf of California, Mazatlan, Vancouver', but he doesn't say which side of Panama, and I have been forever puzzled by the reference to Vancouver. The earlier identifications of *margaritifera* on the Caribbean side of Central America have all since been shown to be *P.imbricata* , I believe.

The second publication is a small hand-book style manual, entitled *Hatchery Production of Pearl Oyster Spat,* P. fucata, by Dharmaraj, Velayudhan, Chellam, Victor, and Gopinathan. This provides a clear and concise outline of hatchery design and larval culture techniques used at Tuticorin. While referring specifically to the relatively simple methods for *P.fucata* culture, the descriptions are a useful starting point for anyone interested in bivalve spat production.

Two final chapters provide an economic analysis of

the construction and operation of the hatchery and spat grow-out. An annex lists the capital equipment requirements for the hatchery. Again, the financial breakdown might have been more useful to other workers outside India if U.S. dollar equivalents had been included in the cost-benefit analysis, rather than just Rupees.

One correction needs to be noted : the reference to the feeding of microalgae at a ration of 10 cells per ml should probably be 10 cells per µl, or 1 x $10^4$ cells per ml.

**References :**

Alagarswami, K. (1991). *Production of Cultured Pearls.* Indian Council of Agricultural Research, New Delhi. 112 p.

Dharmaraj, S., T.S. Velayudhan, A. Chellam, A.C.C. Victor and C.P. Gopinathan (1991). Hatchery Production of Pearl Oyster Spat, *P. fucata. CMFRI Special Publication*, No. 49. Central Marine Fisheries Institute, Cochin, India. 36 pp.

## Pearl culture in the Philippines

***Book Review by Neil Sims***
***Kona, Hawaii***

A recent publication by the Oceanographic Museum of Monaco describes the current status of pearl culture in the Philippines using *P. maxima*. Entitled *The South Sea Pearls: The Philippine golden pearl*, it is written by Doumenge, Branellec and Toulemont.

The book contains the predictable basics of biology and taxonomy of the two larger species of *Pinctada*, and then focuses on a couple of particularly interesting aspects: the Badjao divers of the Sulu Archipelago *(Ed: Excerpts from this chapter have been reproduced above, pp. 39–41)*, a *P. maxima* hatchery in the Philippines and the daily operations of a Filipino pearl farm. There are some superb electron micrographs of pearl shell showing calcite prisms and aragonite layers forming the nacre. There are also lots of glossy coloured photographs of huge pearls and stunning pearl jewellery.

**References:**

Doumenge, F., J. Branellec and A. Toulemont (1991). *The South Sea Pearls: The Philippine golden pearl*. Musée Océanographique, Monaco. 54p.

## Bibliography on pearling and beche-de-mer in Australia

***by H. Berni Aquilina***
***Broome, WA***
***Australia***

*Ms. H. Berni Aquilina writes:*

'...Murdoch University in Western Australia has published a select historical bibliography of the Australian fishing industry. One chapter is devoted to pearling and beche-de-mer fishing. It lists books, monographs, journal articles, conference proceedings, reports, newspaper articles, dissertations, manuscripts, audiovisual material and motion pictures that relate to historical aspects of the industry in Australia...'

**Reference:**

Smith H.J. and M.T. Tull (1990). *The Australian Fishing Industry: A Select Historical Bibliography*. Department of Economics Research Monograph Series No.1, Murdoch University, Murdoch, Australia.

## Variability in growth of mother of pearl oyster (*Pinctada margaritifera*) in the Red Sea (Sudan)

***by Abdalla Gadain ElNaiem***

The growth of the mother-of-pearl oyster (*Pinctada margaritifera*) under different culture conditions such as grading the shells and stocking them at different densities was studied in Dongonab Bay (Red Sea). The growth variability and interrelationship of parameters were also investigated in this project. The animals used in this study were individually labelled and were grown for one year in a suspended system. The growth was measured regularly by weighing and recording linear dimensions.

The results show that the shell height was a good parameter to measure the linear growth but oyster weight was a more reliable estimate of the growth rate. *Pinctada* shell has a rapid growth rate (9g / month) during the third and the fourth year. The biomass parameters were more variable than linear dimensions and the variation in both declined with the oysters' age.

The results of grading oysters showed that the average weight of graded oysters was 27 per cent higher than that of ungraded shells and the variation in weight of the graded shells was reduced to less than 50 per cent of the weight variation in ungraded ones. This will have a significant impact when applied to commercial culture in the Red Sea. The optimum stocking density to raise this bivalve during the second year of cultivation is 10 to 20 animals / 0.1m $^2$.

The shell density (2.425 g / cm$^3$) did not vary with the shell age and was a poor parameter for determining the shell quality. The wild shells had a thicker nacre layer than suspended shells. The allometric growth analysis indicated three types of relations in this animal: isometric in shell diameters, positive allometric in shell weight / whole weight and negative allometric in dry meat weight / whole weight, suggesting that the relative growth of the hard tissue was faster than in the soft tissue of this bivalve in the Red Sea.

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*Abstract of a thesis (of the same title), submitted for an M.Sc. at Dalhousie University, Halifax, Nova Scotia, Canada. 1984.*

## Economics of tray culture of the mother-of pearl shell (*Pinctada margaritifera*) in the Red Sea, Sudan

***by Ismail Haj Rahma and Gary F. Newkirk***

An economic analysis of tray-cultured oysters in Dongonab Bay, Red Sea was conducted based on production costs collected by the Red Sea Fisheries Research Centre. The analysis showed that off-bottom oyster farming was economically attractive at a price around 1.5 Sudanese pounds (US$0.75) per kilogram of shell and discount rate of 40 per cent or less.

The black lip mother-of-pearl oyster, *Pinctada margaritifera*, has long been prized and collected for its high-quality nacre. Pearl shell is used for the manufacture of large buttons, jewellery, inlay work and various personal adornments.

Crossland (1957) was able to develop a culture system for this bivalve in the Red Sea, and the extension of this system resulted in an enormous increase in total shell production in the Sudan (Reed, 1962). Using the basic culture techniques of Crossland (1957) and Reed (1962), the Fisheries Research Centre of the Red Sea, Port Sudan, with the support of the International Development Research Centre (Canada), has been refining the culture techniques in order to revive the previously valuable industry which went into decline following mass mortalities in the 1960s (Nasr, 1982).

Disease has been suspected as the cause of the mortalities, but so far no direct evidence has been found. In this paper, the economic feasibility of the culture of the mother-of-pearl oyster in the Red Sea has been projected using data collected over the past few years (Red Sea Fisheries Research Section, unpublished data).

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*Abstract from a paper in: Journal of the World Aquaculture Society, Vol. 18, No 3, September 1987, pp. 156–161.*

## Anatomy and histology of *Pinctada margaritifera* (Linnaeus, 1758)

***by Tint Tun***

The anatomy and histology of *Pinctada margaritifera* (Linnaeus, 1758), the systematic position, distribution, fishing, economic importance, utility of pearl oysters and associated animals is described. The organ systems include the shells, the mantle, the foot and the byssal organ, the alimentary canal and its associated gland, the muscles, the branchiae, the vascular system, the nervous system and the urogenital system. General discussion of various aspects is given. Suggestions for the future scope of study are outlined.

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*Abstract of a thesis (of the same title), submitted for an M.Sc. degree in Zoology at the University of Rangoon, Burma (now University of Yangon, Union of Myanmar), 1984.*

## The last pearl oyster bibliography you will ever need

*by Neil Sims*

Mark Gervis' comprehensive pearl oyster bibliography has recently been published by The International Center for Living Aquatic Resources Management (ICLARM) and the Overseas Development Administration of the United Kingdom (ODA).

This represents a real milestone in access to information on pearls and pearl oysters and will prove to be an invaluable research and management tool. It also makes for fascinating browsing.

There are over 1,221 references listed alphabetically, with both subject and geographical indexes. The references cover all aspects of the biology, distribution, fisheries and culture throughout the world of all the species of the Pteriidae. Paleontological works and references to freshwater pearl-producing organisms and marine pearl-producers other than the Pteriidae have been excluded. This is the sensible approach — to have spread the effort further would have probably left it feeling unwieldy.

There is an added masterful stroke: the entire bibliography has been made available on diskette, with supporting Paperbase software, to enable updates and searches and to make printing citations easier.

Mark suggests in the introduction that readers finding any errors or omissions, or with new additions should provide corrections and updates through the *Pearl Oyster Information Bulletin*. A 'Bibliographical Update' section will be included in each forthcoming issue of the POIB and we look forward to hearing from you.

The bibliography is available free of charge from:

The Editor
ICLARM
MC P.O. Box 1501
Makati, Metro Manila
PHILIPPINES

The diskette is also available from the same source, for a charge of US$10.00 (cheques from US branches, please).

**Reference:**

Gervis, M.H. (1991). A bibliography of the pearl oysters (Bivalvia: Pteriidae). *ICLARM Bibliogr.* 11, 99p.

## Two pearl oyster papers presented at PACON '92

*Source: Abstracts, PACON '92*

### Preventing the unpredictable: reducing the risk of pearl oyster diseases by improved lagoon and farm management

(by Neil Anthony Sims, Kailua-Kona, Hawaii, USA)

Pearl oyster diseases have become endemic in most major pearl culture areas. Poor oyster health and farm mortalities have profound impacts on the profitability of individual farms, result in increased pressure on already depleted natural stocks, and cause instabilities in the pearl market.

This article discusses the problems of avoiding the establishment of diseases in developing pearl culture areas in the Pacific Islands.

The etiology of pearl oyster diseases is often poorly understood, and the available literature is meagre. Commensal organisms, parasites, pathogens and secondary infections are difficult to distinguish in bivalves, and the taxa associated with pearl oyster diseases in different culture areas are diverse. It is therefore inappropriate to base limits of farm numbers on estimates of the original stock abundance, phytoplankton production and oyster filtration rates, or lagoon water turnover, particularly where no disease has yet been identified. Histories of disease patterns, farming practices and farmed stock numbers in different lagoons could provide useful guidelines, but such information is carefully protected.

Management must be based on the understanding that there is a continuum of increasing disease risk with increasing farm numbers and densities. The industry itself must determine its own acceptable limits on the number of farms in any enclosed body of water, the number of oysters on farms, spacing and cleaning regimens, and restrictions on stock transfers. The short-term rewards of higher production must be balanced against the increased risk of disease. No ecologically determined limit can provide any assurances.

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## *Pinctada margaritifera* in an integrated shrimp culture system

(by Charmaine Marie Gallagher, Jaw-Kai Wang and David Robichaux, University of Hawaii, Honolulu, Hawaii)

The Department of Agricultural Engineering at the University of Hawaii has been leading a five-year research project growing edible oysters *Crassostrea virginica* and *C. gigas* in an integrated oyster and shrimp production system which has proved to use energy, food and water resources efficiently. This project has achieved excellent results, rearing oyster spat to market size in six months in fluidised bed tanks requiring little maintenance. Current research interest has included the black-lipped pearl oyster, *Pinctada margaritifera*, in this integrated and semi-closed system.

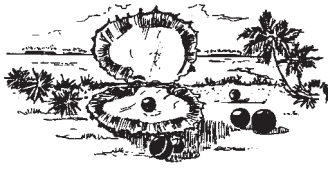
The *P. margaritifera* pearl oyster is a species valuable for its lustrous pearl as well as its shell and is native to Hawaiian waters. It is also of interest because it is not usually found in waters with high suspended-solid loading, unlike the edible oysters. It is found in high current areas along coral reefs in areas typically low in nutrients. Culture of *P. margaritifera* has traditionally been extensive in open lagoons; it has yet to be reared in closed and intensive systems.

Fifteen individuals of *P. margaritifera* are held in the same water as the *C. virginica* in order to compare general growth and survival characteristics for a ten-month period. Due to an initial 87 per cent loss of *P. margaritifera* in the 100 per cent shrimp effluent solution, a biofilter and step-down dilution system were designed and added to the existing system to meet the water quality requirements of the pearl oysters and determine the optimal growing solution for this species. Information on growth rates and water parameters are included in this study. This dilution system is dependent on the amount of suspended solids from an algal bloom in the shrimp effluent and monitored by a Hach turbidmeter and daily visual inspection.

The newly constructed facility at Coconut Island with two shrimp ponds, a nursery tank and a fluidised bed chamber has been used for the additional pearl and edible oysters for ten months. The dilution tank system is designed with three chambers to house *P. margaritifera.* These tanks are diluted with well water from the Coconut Island Facility which is filtered seawater from Kaneohe Bay. Additional controls are obtained by placing some *Pinctada* in the nursery tank with the *Crassostrea* and others in the lagoon at Coconut Island. Those in the lagoon are suspended vertically and surrounded with a metre square cage to exclude predators such as the puffers which frequent the lagoon.

Results to date indicate that there is an adjustment period in the *Pinctada* which is not perceived in the *Crassostrea.* This is seen by an initial drop in weight in the first month of holding. Additional pearl oysters have been placed in the shrimp ponds at the Amorient Aquafarm in Kahuku to obtain increased growth rates in a higher suspended solution.

The study includes the collection of preliminary data on growth and survival, using new methods on a species currently grown throughout Polynesia and South China in open lagoons. These existing aquaculture facilities have been able to culture a product which currently represents the largest export in French Polynesia. The results of this project are to be used to obtain additional funding for further aquaculture research on this species and the methods of effluent use.



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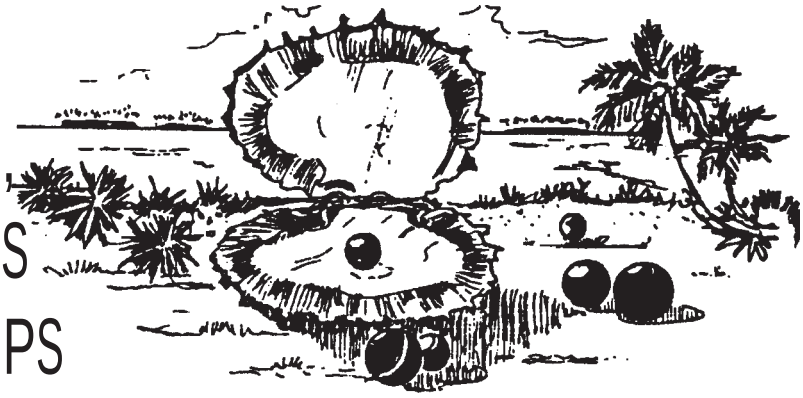
*Abstracts of two papers presented at the Pacific Congress for Marine Science and Technology, held in Kailua-Kona, from 1 to 5 June 1992.*

# UPCOMING CONGRESSES, CONFERENCES and WORKSHOPS



**THE CONSERVATION AND MANAGEMENT OF FRESHWATER MUSSELS**

This symposium, sponsored by the Upper Mississippi River Conservation Committee, will be held from 12 to 14 October 1992 at the Embassy Suites Hotel, in St. Louis, Missouri, USA.

**Contact:**

Mr Kurt Welke, State of Wisconsin Department of Natural Resources, 111 West Dunn St., Prairie du Chian, WI 53821, USA
Tel: (608) 326 0233

**THIRD INTERNATIONAL CONGRESS ON MEDICAL AND APPLIED MALACOLOGY**

This congress, sponsored by the International Society of Medical and Applied Malacology, NSW Agriculture and the Australian Museum, will be held from 19 to 23 October at the Elizabeth MacArthur Agricultural Institute in Camden (Sydney).

Three general symposia are proposed:

1. Economic, medical and veterinary aspects of parasites transmitted by molluscs;

2. Molluscs and agriculture;

3. Aquaculture of molluscs.

**Contact:**

Phil H. Colman, Division of Invertebrate Zoology, Australian Museum, P.O. Box A285, Sydney South, NSW 2000, Australia.
Tel: (61) (2) 339 8112 Fax: (61) (2) 360 4350

## Welcome to new members

*by J.P. Gaudechoux,*
*South Pacific Commission,*
*Noumea, New Caledonia*

The Pearl Oyster Special Interest Group is growing. We had received additional completed questionnaires from the individuals listed below. The previous lists of members are available in the first four issues of the SPC *Pearl Oyster Bulletin*.

If you are on the list and your name and address is wrong, please send us a correction. If you are not on the list and would like to be, fill in the form enclosed with the bulletin or write to us for a new one.

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# QUESTIONNAIRE and READERSHIP SURVEY

**PERSONAL**

Name: .....
First Middle Last

Age: ..... yrs Sex: M / F

Title: Dr / Mr / Mrs / Ms / Rev. / Other: .....

Position / Title: .....

Work address: .....

.....

.....

Phone: ..... Fax: .....

Home address: .....

.....

Phone: ..... Fax: .....

**TREATMENT OF INFORMATION (circle as appropriate)**

A. Open: **Yes**. You may publish my answers along with my name

B. Anonymous: **Yes**. You may publish my answers, but not with my name

C. Confidential: **No**. Please do not use my answers in any way

**ABOUT THE PEARL OYSTER INFORMATION BULLETIN (circle as appropriate)**

1. How long have you been receiving POIB? Recent / 1 year / 2 years

2. How did you find out about POIB? : .....

.....

(e.g. friend / co-worker / business associate told you / showed you a copy?)

3. a. Can you think of others who might be interested in receiving POIB?

**Yes** / **No** : Names / Addresses: .....

.....

b. Can you think of others who might be able to provide information or articles of interest?

.....

.....

4. a. Have you ever contributed an article to POIB which you wrote yourself ?

**Yes** / **No**: How many? .....

b. Have you ever contributed clippings/pieces of information to POIB which you found elsewhere? **Yes** / **No**: How many? .....

c. If you have never (or rarely) contributed to POIB, can you tell us why?

i. Company or Government specifically restricts information exchange with others;

ii. Company or Government disapproves information exchange with wide audience;

iii. Professional diplomacy (don't want to report other's work without their permission; want to keep a low profile in front of supervisor or other workers);

iv. My work, or other information/articles I come across are probably not of interest to POIB readers;

v. I am very busy and will only contribute if I am forced to or enticed into it;

vi. Other: .....

d. Would you be willing to occasionally review books, magazines or other articles for the POIB, if requested: **Yes** / **No**

5. Which of the following describes your need for/and use of POIB?
   a. It fills a big hole in my professional information needs — it is very useful
   b. It plugs a few gaps and adds a bit of extra detail to the pearl picture — moderately useful
   c. It provides a few interesting stories, but not really usable
   d. Good for lining the bird cage or making paper darts
6. a. How much of each POIB issue do you read?
      i. All of it — I read the interesting articles a couple of times;
      ii. Only those articles of interest to me;
      iii. I flick through it once or twice, but don't actually read much.
   b. What proportion do you read?: 5% / 25% / 50% / 75% / 100%
7. a. Have you ever used POIB articles or information in other work you have done? How often? How many? .....
   b. What sort of information did you use or cite (e.g: farm design or description, trade statistics, production data, other: .....
8. a. What other sources of information do you have on pearl oysters and pearl culture Newspapers / other newsletters / magazine articles / television / discussions with business associates / correspondence with colleagues / intellectual osmosis
   b. Do you receive other publications which specifically address pearl oysters and pearl culture issues? **Yes** / **No** Details : .....
      .....
   c. Do you receive other publications which regularly contain articles on these topics? **Yes** / **No** Details: .....
9. a. Would you find it useful if there was a directory of pearl oyster and pearl culture people, such as an expanded list of members and description of their work? **Yes** / **No** Details: .....
   b. Would it aso help if this included farm material suppliers, pearl wholesalers and/or dealers, technicians and bead suppliers, etc? **Yes** / **No** Comments: .....
      .....
   c. Can you provide names, addresses and other details for some of these suppliers/dealers, etc?: .....
      .....
      .....
   d. Do you have other suggestions for such a directory or similar publications?:
      .....
      .....
      .....
10. What other areas do you think POIB should be covering?
    .....
    .....
    .....
11. What other activities do you think the Pearl Oyster Special Interest Group could be undertaking?
    .....
    .....
    .....
12. What other comments or suggestions do you have?
    .....
    .....
    .....

Thank you for your co-operation. *Neil Anthony Sims*