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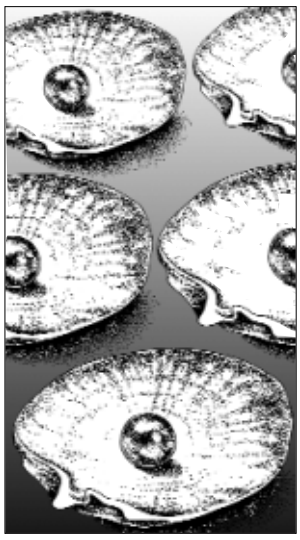
PEARL OYSTER

Number 9 – September 1996

INFORMATION BULLETIN



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Editorial

Reaping rewards

With each issue's editorial, I find myself consciously trying to tone down the sense of heady, breathless excitement at the speed with which developments are happening in Pacific pearling. Before sending an editorial off to the presses, I wade through and purge my writing of any excess of exclamation marks, overstated adverbs, and the worst examples of hyperbole. We want to strike a note of guarded optimism, without being gushy or over-the-top euphoric.

It has been hard, sometimes, not to wax light-headedly lyrical, as the industry in the Pacific has opened up, and as we have seen our aspirations begin to take form. Since the first Pearl Oyster Information Bulletin, there has been the dramatic growth in French Polynesia and Cook Islands farm production, coupled with an industry commitment to better co-ordination; there is evidence of a maturing consumer awareness, with greater promotional emphasis producing a broader, deeper market base; and hatchery- and spat-collecting trials have fuelled new possibilities, leading the extension of pearl-farming efforts across the Pacific, and the rest of the world.

The past year has seen these developments yield rewards that leave us unapologetically agog! Let the punctuation prance unfettered!! Rhetorical restraint-be damned! This is a string of marvellous milestones!! We are giddy with your successes!

The seeds that were planted a year or more ago have begun to flourish and bloom, with fruits now well set on many branches. In some cases, early harvests are already in, and the results are encouraging.

continued on page 2

Inside this issue

Consider the array of articles in this issue reporting on:

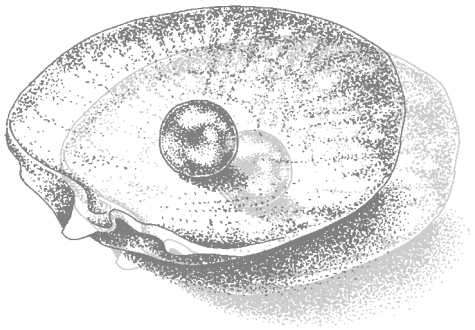
- expanded pearl promotion programmes,
- heightened co-ordination of the French Polynesian industry,
- hatchery successes in Tarawa and Penrhyn,
- encouraging spat-collection results from the Solomon Islands,
- the scaling-up of Hawaii's remote hatchery production,
- first seedings for round pearls in an outer atoll in FSM,
- first harvest of round pearls from Marshall Islands oysters,
- expanded work in Venezuela and Colombia,
- the first commercial mabe pearls produced in Sonora, Mexico (from *Pteria sterna*),
- pearl farming development trials in Vanuatu.

Besides all of this, we also have the definitive answer on the problematic etymology of *Pinctada*. "Aahh!" you say. "At last I can rest easy again!"

Read and enjoy, and do drop us the odd line when you have time.

Neil Anthony Sims, Editor

NEWS AND VIEWS



GIE Tahiti Pearl Producers

Yves Tchen-Pen writes:

We are pleased to write you for several reasons. Firstly, we would like to thank your information bulletin for providing accurate and efficient documentation of the industry's trends and developments. It has become both scientifically and professionally valuable for us.

Secondly, we would like to introduce our organisation to the staff and readers of *POIB*. Our trade association, the GIE Tahiti Pearl Producers, is composed of about 32 medium-to-small pearl producers from Tahiti and its neighbouring island. We are an independent, legitimate organisation, supported and recognised by the governing state pearl organisation of French Polynesia, the GIE Perles de Tahiti. Like the other trade associations, the Syndicat professionnel des perliculteurs privés (SPPP) and GIE Poe Rava Nui, our aim is also to promote and develop the pearl industry, stimulate trade and diversify our markets.

Contact: Yves Tchen-Pen, Vice-President and Auction Administrator, GIE Tahiti Pearl Producers, B.P. 9045, CMP Motu Uta, Route de Faré Ute, Voie 16, Immeuble ITC, Papeete, Tahiti, French Polynesia. Telephone: (689) 430233; Fax: (689) 430277.

Cook Islands pearl farm developments

The Great Northern Hope

Ask Cook Islands Development Bank Manager Unakea Kauvai whether he believes the pearl farming industry is making it in the Cooks, and he gives you a clear "yes".

Despite a record low in terms of yield from seedings in last year's harvest—some farmers as low as 20 per cent or 15 per cent—the first round of millions of dollars in loans given to farmers in the North for marine culture two years ago has only NZ$ 600,000 left to be paid back.

The export figures speak for themselves—last year, 1,173 kg of pearls were sent overseas, reaping a FOB value of almost NZ$ 3.8 million.

In outer island books, that's development—and so it should be, argue those who have seen the pearl farming money lead the Government's aid to the outer islands.

Loans, research stations, and tax breaks have made ownership of farms accessible to people who live in the outer islands, but they also face hard work and a lack of management skills in running their businesses.

Kauvai says that book officers based on each island will tackle this problem by training outer islanders in business management—much like the Small Business Advisory Unit (SBAU) here runs training for locals.

And contrary to local perception, not every Manihikian or Penrhyn Islander is a pearl farmer.

According to Paka Worthington of the Pearl Authority, there are those who have tried it and left it. "Part of the problem is we have had too many people who are in it as recreation—they're not serious about pearl farming."

And yes, there are still those who reject auctions and the idea of marketing, sling their pearls in their pockets and take off for New Zealand, out to cash in their shares of The Great Northern Hope.

Source: *Cook Islands News*, 28 March 1996

Tongareva Research Station

Reports out of Tongareva indicate that the research station is making steady progress with its hatchery.

The research station has been operational for several months, and is now conducting successful spawning. These spawnings have produced millions of larvae. The station has been able to take the project to the settlement stage, and the larvae are currently undergoing trials.

Marine officers have found that one of the most critical times is between the larval and spat stages; it is at this point when the larvae are so young and fragile that any conditional changes can cause mortalities. Research has shown that the highest number of mortalities occur at this stage.

The elements that seem to make this process succeed in Tongareva are the excellent physical conditions of the lagoon, the warm water and the limited temperature changes of the lagoon and water. It is encouraging to note that the entire station is staffed by local people.

In addition, the local staff have become very adept at producing excellent algae (feed) for the parau.

We look forward to the continued progress of the research station and its hatchery programme. The project is expected to be completed by late 1997.

Source: P*oe Parau Kuki Airani, Nuti Peapa*, volume 1, no. 6, February 1996

Asian Development Bank assistance to the Cook Islands

The Cook Islands pearl industry is being given US$ 1.37 million by the Asian Development Bank (ADB) to provide services to help improve its efficiency.

Most of the money (US$ 817,000) will help the Government and private sector establish the Cook Islands Pearl Authority, which is intended to provide the industry with such services as marketing, distribution information, and instruction in new production technologies. The Cook Islands Government is contributing another US$ 200,000.

The balance of the ADB grant is for technical assistance to help the Government monitor the lagoon ecology on Manihiki, the country's main pearl-producing island.

An environmental management plan will be prepared to determine the maximum sustainable number of oysters that can be farmed without damaging the lagoon's ecology. The bank said the loan and assistance will enable the Cook Islands to develop a profitable pearl industry.

Source: *Pacific Magazine*

Cook Islands hire outside marketing consultants

Allshouse & Winters, a marketing practice based in Albuquerque, New Mexico, has won a substantial consulting contract to develop an international marketing plan for the Cook Islands Pearl Authority. The principals of the firm have based their operations on the island of Rarotonga for an initial contract period of three months, beginning in mid-November. The contract may eventually be extended by the Pearl Authority to a total of eight and a half months.

If the South Seas sounds like an unlikely place for a landlocked New Mexico firm with little experience in marketing cultured pearls to begin a consulting contract, it surely is. But it's a classic story: a mixture of professional expertise and personal relationships.

"A little over a year ago, on our last day of vacation in the Cook Islands, we met the owner of a shop which specialises in black pearls grown around the island of Manihiki," reports Richard Allshouse. "We saw that the shop was wellstocked with both high-quality and high-priced pearl goods, yet the islands are very small and not a stopping point for big cruise ships or other large commercial travel ventures. So we started asking the owner about marketing and sales."

Many questions and answers later, the Allshouses parted with business owner Joan Rolls, believing that they were unlikely to meet again. But upon returning home, Edith Winters Allshouse began corresponding with Joan Rolls by fax and phone, and was eventually told of a contract for marketing consulting which would soon be advertised. The Albuquerque business couple documented their marketing experience and successes, presented two port-folios to the Pearl Authority, returned to the islands for a face-to-face meeting with the Pearl Authority, and signed a contract on 4 October.

As it turned out, the Chairman of the Board of the Pearl Authority was Joan Rolls-a well-respected business leader who was appointed to her post by the Prime Minister. While the work is to culminate in a creative, usable marketing plan, the path to the end point is not clear. "The pearl industry is truly global, and information gathering for the strategy process will undoubtably prove to be an important factor for success," the couple said.

"Part of our task is to help the private sector with creative marketing, and the other part is to help the Cook Islands Government develop a plan for public actions which will facilitate private sector success and help avoid actions that overload ecosystems or impinge on cultural systems... economic development which could require significant governmental action. It's a wonderful opportunity to exercise all of our skills and experience, and to acquire new ones," said the business partners who have employed a balance of strategic thinking and disciplined creativity in developing new products and establishing growth for successful service businesses and non-profit organisations. The firm was established in Albuquerque in 1986, and has worked with clients ranging from new enterprises to established manufacturers with annual sales of more than US$100 million.

Source: *The International Pear ling Journal*

Cook Islands Pearl Authority restructuring

Staff and board members of the Rarotonga-based Cook Islands Pearl Authority (CIPA) have been terminated from their positions as part of an industry-led restructuring of the office.

Current manager Paka Worthington and assistant Doreen Boggs will continue in an interim role until the industry decides what the fate of the Authority will be and who will do what.

Interim

Interim board chair Joan Rolls says the existing CIPA office on the back road in Atupa will remain open during the transition, "but in agreement with Government and ADB (Asian Development Bank), efficiency measures will mean staff changes—we don't know yet how the transition staff will be structured, but we will make all the changes public in a timely way".

"There is no question that Doreen and I will go," said Worthington yesterday, "but under what circumstances and when... none of it has been worked out yet."

Premature

He says it's too premature to comment on the restructuring, but agrees that it's time the industry ran itself.

With the board appointed by the Prime Minister and CIF A employees on Government tenure; Worthington notes the office has not endeared itself to its critics and has been viewed with suspicion by those living in the isolated northern islands where the pearl industry is based.

Rolls made yesterday's announcement on behalf of fellow CIPA directors Unakea Kauvai, Peter Willima, Paka Worthington and David Wright of the switch from CIF A being government-controlled to industry-led.

Rolls says "All our current work programmes of assisting the development of spat collection as a business enterprise, bringing in high-quality seeding technicians and developing a marketing action plan have made it obvious that the private sector of the Cook Islands black pearl industry—not a government-appointed agency—ought to be determining the future."

Mission

The ADB and the Government had started up the CIPA under ADB funding in 1994. With its mission to be self-funding by October 1997, everything that has or hasn't happened up until now has dictated the current changes—even as they come on the heels of a visit by the ADB consultant following up on what the authority has achieved since its inception.

Rolls greets the news of her own termination with enthusiasm, saying the changes being made are the wish of the industry, who have wanted more say. "ADB and the Government gave funding in the hope that the industry would take it on and be self-reliant and self-motivated, and prosper on their own," she says. "It's time to change the whole concept of where we are now into where we wanted to go right at the beginning."

Source: *Cook Islands News*, 4 April 1996

ACIAR research programme

International blacklip pearl oyster project under way

By: Dr Paul Southgate, Zoology Department, James Cook University, Townsville, QLD, 4811. Phone: (61-077) 815 737; Fax: (61-077) 251 570.

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

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

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

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

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

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

Culture systems

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

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

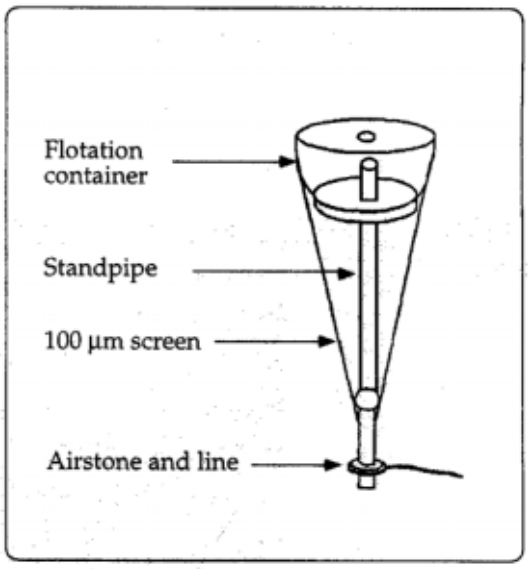


Figure 1: Flow-through cone used for giant-clam culture

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

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

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

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

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

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

Larval nutrition

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

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

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

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

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

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

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

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

Extension

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

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

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Source: *Austasia Aquaculture*, 9(5), September-October 1995.

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

By: Masahiro Ito, Research Officer, Department of Zoology, James Cook University of North Queensland, Townsville, QLD 4811, Australia.

Introduction

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

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

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

hatchery spat production was undertaken along with hatchery training of the Fisheries Officers.

Materials and methods

In June and July 1995, 59 broodstock *P. margaritifera* were collected by local divers of Abaaing Atoll, 50 km NE of Tarawa, transferred to Tarawa and kept suspended from submersible longlines at 20 m depth for about 2 months.

Spawning induction

All the broodstock were thoroughly brushed free of fouling organisms and washed with fresh water. The filtered seawater was used for a final rinse. Spawning induction was carried out on 11 September. Simple techniques, exposure to air for 2–3 hours and thermal stimulation transfer between 23°C and 31°C, were employed to induce spawning. Wooden wedges and a shell opener were used for assessing gonad conditions, and they were separated in single sex groups. Spawning animals were transferred individually to 20 litre containers with 1 μm filtered sea water. After checking viability, sperm were introduced into a container with a spawning female oyster for fertilisation. Methods for estimating number of fertilised eggs were basically the same as described by Braley (1992). One 500 litre fibreglass tank with gentle aeration was used for incubating eggs.

Micro-algae culture

A micro-algae culture room was air-conditioned and kept at 22°-25°C. Six micro-algae species of axenic and non-axenic master stock cultures were purchased from CSIRO Marine Laboratories in Tasmania, Australia and subcultured at the James Cook University of North Queensland, then transported to Tarawa by airfreight. Nutrient medium ingredients were modified from Hayashi and Secko (1986) by Ito (unpublished data). The mixture of diatoms (*Chaetoceros mulleri*—formerly *C. gracilis*), and golden-brown alga (*Pavlova lutheri* and *P. salina*), were used as main diets (see Figure 1 for densities).

Seawater was filtered to 0.46 μm and UV-sterilised for culturing micro-algae. Although some of the culture techniques were simplified for the Kiribati situation (Ito, 1995), most of the procedures were similar to standard micro-algae culture techniques (e.g. Lewis et al., 1986, Brown et al., 1989).

Larval and spat rearing

One 1000 litre polyethylene tank (1400 litre capacity) and two 500 litre fibreglass tanks (600 litre capacity) were used with sea water filtered to 1 μm for rearing larvae, and were situated outdoors under shade. Water temperature during the larval run ranged from 28–30.5°C. The tanks were com-

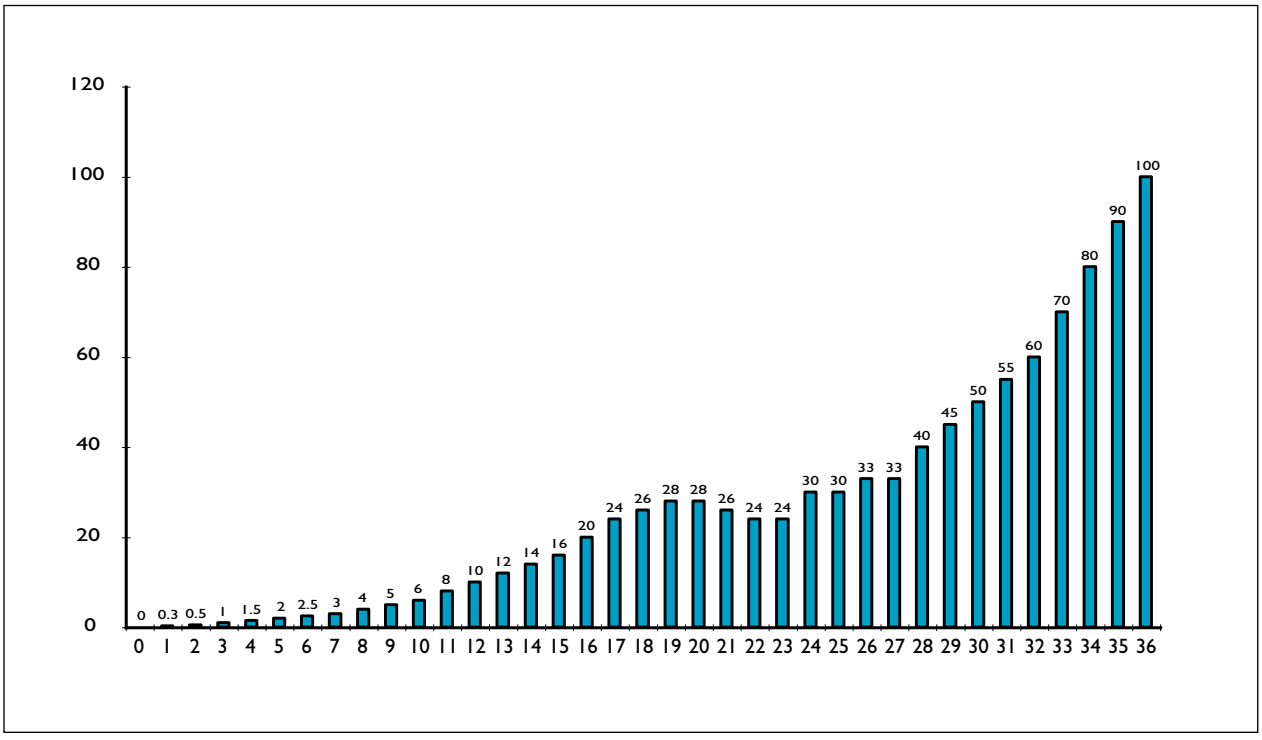

Figure 1: Densities of micro-algae supplies (1000 cells/ml/day)

pletely drained and cleaned every 4 days until Day 13. After Day 15, a partial flow-through was employed for water exchange, and flow rate was adjusted from 100% to 300% per day based on the progress of the larval and spat rearings.

During every tank draining, all animals, including dead ones, were collected with combinations of different sizes of mesh screens (between 37 μm and 150 μm) for the larval selection and counting. A sampling method for estimating number of larvae in each tank was basically the same as described by Braley (1992).

Spat collectors were made of 50 cm long mussel rope or a black plastic woven shade-cloth (50 cm x 30 cm) suspended in the settlement tanks. They were deployed in 1000 litre and 500 litre tanks on Day 18 and on Day 21, respectively.

All the spat collectors were installed in plastic cages (50 cm x 60 cm x 50 cm) protected with mesh screens (500 μm and 1000 μm) and transferred by a fisheries research vessel to the neighbouring Abaiang Atoll, 50 km NE of Tarawa, for the ocean nursery culture.

Results and discussion

Only one female and five male oysters spawned, yielding 12 million fertilised eggs. On the following day, 6.6 million D-stage veligers were obtained and subsequently reared in the three outdoor tanks (one 1000-litre tank and two 500-litre tanks). The 59 broodstock used for this run were apparently largely spawned-out, and therefore at least 100-150 oysters should be secured for a hatchery run in one season.

The D-veligers were reared using a standard stalic batch culture method. The initial larval stocking densities in the 1000 litre and 500 litre tanks were 4.1 larvae/ml, 2.4 larvae/ml and 2.4 larvae/ml, respectively. These were similar to those employed for commercial hatcheries of the silver lip pearl oyster (*P. maxima*) (Ito, unpublished data; Rose, 1990). Then the densities were gradually reduced to 0.2-0.1 larvae/ml. The larvae reached the umbo stage on Day 9 (120 μm) and the eyed veligers were first found on Day 17 (240 μm). Size selection was conducted at each tank draining. Selected larvae were then combined into one tank mainly to conserve space, equipment and labour.

The percentages of living larvae in samples taken from each tank at tank drainings were high, ranging from 100% to 85% up until Day 18 (Table 1). Spat (plantigrade) were found on Day 20, measuring 280 μm to 300 μm in shell length. Some spat showed remarkable growth, and on Day 25 ranged from 300 μm to 830 μm in shell length.

On Day 36, about 20,000 spat attached on the collectors were transferred to the neighbouring Abaiang Atoll, 50 km NE of Tarawa, for the ocean nursery culturing in plastic cages, suspended from submersible longlines. Growth and survival of the spat are being monitored for assessment of future farming sites.

This trial demonstrates that it is possible to produce a significant number of pearl oyster spat in a small and inexpensive hatchery (a total equipment cost of about A$ 40,000) in outdoor conditions. This is with careful handling of the target animals, an appropriate feeding strategy and committed hatchery staff.

The larval rearing technique itself is not as difficulty as with other aquaculture species, such as spiny-lobster larvae, and may be acquired with training. In most cases, pearl oyster hatchery failures come from human errors, even employing sophisticated equipment. Thus, a key to success depends on an appropriate hatchery staff-training.

Through appropriate hatchery facilities, along with staff training, even small island nations of the South Pacific, which are not blessed with abundant wildstock pearl oysters, might enter into the industry of culturing black pearls in the future.

Table 1: Percentage of living larvae in samples of *P. margaritifera* between tank drainings

Tank no.	Day 5	Day 9	Day 13	Day 15	Day 18	Day 21	Day 25	Day 28
1 (1000L)	100	95	98	99	89	–	88	–
2 (500L)	100	99	99	100	85	70	–	25
3 (500L)	100	100	100	100	85	–	–	–

Acknowledgements

I would like to express my thanks to the staff of the Fisheries Division, the Republic of Kiribati, for their support. This work was funded by ACIAR Pacific Island Pearl Oyster Resource Development Project No. 9131.

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Progress of research on the potential of farming blacklip pearl oysters in Solomon Islands

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In late 1993 the Australian Centre for International Agricultural Research (ACIAR) provided ICLARM's Coastal Aquaculture Centre and the Ministry of Agriculture and Fisheries, Solomon Islands, with funding to assess the feasibility of farming blacklip pearl oysters *Pinctada margaritifera* in Solomon Islands. The title of the project was "A Collaborative Investigation of the Options for Spat Collection and Hatchery Production of Pearl Oysters in the Central-Western Pacific".

The aims of the project were to:

1. Test the availability of pearl oyster spat in Solomon Islands waters using a variety of spat collectors;
2. Develop cultivation techniques for pearl-oysters in coastal villages; and
3. Induce spawning and rear larvae and spat of pearl oysters.

The emphasis of the project over the last two years has been placed on the first of these aims, through a sampling programme designed to yield reliable information on spatial and temporal availability in the abundance of spat of the blacklip pearl oyster.

Spatial and temporal variation in the availability of spat of blacklip pearl oysters over a 21-month period was assessed initially by deploying spat col-

lectors at three sites in each of five regions. These regions spanned 500 km of Solomon Islands. Every three months, commencing in January 1994, 50 spat collectors were deployed at each site, to be harvested six months later. Five different types of collectors were tested. The collectors were made of either plastic sheeting or shademesh, but varied in structure. Two types of collectors were placed in protective mesh bags to assess the effects of this measure in reducing predation of spat.

Live spat attached to the collectors were removed and placed in lantern nets at village sites for grow-out to the size suitable for "earhanging". The growth and survival of these juvenile oysters was monitored every three months. The data were used to construct a growth curve for *P. margaritifera* in Solomon Islands.

In collaboration with staff from James Cook University, preliminary experiments were run on the larval rearing of blacklip pearl oysters. Wild broodstock were collected from a variety of locations around Solomon Islands and induced to spawn using heat stress. The larvae were reared both in static and flow-through systems, and using diets ranging from 100% live cultured algae to various blends of live algae and microcapsules.

Results, conclusions and assessments

This project demonstrated that, in Solomon Islands, spat of the blacklip pearl oyster were most abundant on collectors deployed in October and January. On collectors put out in October 1994, spat settled at an average rate of 3.0-4.5 spat per collector at two sites in the Gizo region (Western Province). In addition, average settlement rates in excess of 1.0 spat per collector were recorded at another ten sites from collectors deployed in October or January. The rates of spat collection at the two sites in the Gizo region are considered by sources in the industry to be economically viable for the culture of blacklip pearl oysters by village growers.

In addition to identifying major trends in seasonal availability and location of spat, the project refined methods for collecting spat. There were two main findings in this regard. First, collectors made of shademesh attracted at least three times as many spat of blacklip pearl oysters as those made of black plastic. Second, the cost of shademesh collectors can be reduced by halving the amount of material used (from 1.6 m^2 to 0.8 m^2) without affecting catch rates.

The project also demonstrated conclusively that protective mesh bags around spat collectors did not improve the harvest of spat by protecting them from predators. On the contrary, protective bags became fouled heavily, reducing the water flow to the collector. They were also colonised by predatory gastropods (Cymatium) and crabs (Portunidae and Xanthidae) which settled to the collectors from the plankton. As these predators grew, they were trapped within the protective bags and caused heavy mortality of juvenile oysters.

Growth rates of juvenile *P. margaritifera* held in lantern nets were high when compared to rates recorded from other areas in the Pacific. A Ford-Walford plot of growth of oysters held in lantern nets shows a mean annual increment of over 58 mm for juveniles less than 60 mm, and a mean annual growth increment of between 40 and 55 mm for larger juveniles. On the basis of the data presented here, village farmers can expect to harvest spat at approximately 30 mm DVM and grow them to a minimum size of 80 mm DVM in 12 months.

In contrast to the encouraging rates of growth found during the study, survival rates of *P. margaritifera* spat in grow-out were generally low (38%). The high rates of mortality were due to predation by Cymatium, crabs and fish, but also to inadequate husbandry of the spat due to the infrequency of visits by ICLARM and lack of attention given by village growers.

Attempts to rear the larvae of blacklip pearl oysters were only marginally successful. Although a handful of spat were reared during each of two trials, the mass mortalities that occurred indicated that considerable progress needs to be made before the production of spat in hatcheries can be considered an economically viable way of supplying spat to village-based pearl oyster farmers.

Follow-up

The relatively high rates of spat collection at two sites in the Western Province of Solomon Islands indicate that it could be possible to establish economically-viable farming of blacklip pearl oysters in some of the "open" coral reef habitats in the central-western Pacific. This encouraging result was followed-up by a further request to ACIAR from ICLARM and the Ministry of Agriculture and Fisheries, Solomon Islands, for additional two years of funding to carry out Phase Two of the project. The aims of the continued research are to:

1. Scale-up the collection of spat at the most promising sites in the Western Province to confirm that spat can be collected in commercial quantities;

2. Confirm that the best time to deploy spat collectors is between October and January;

3. Refine the design and deployment of spat collectors to maximise the cost-effectiveness of collecting spat;

4. Develop grow-out methods to overcome the high mortality of spat caused by predators; and

5. Establish pearl oyster farms in villages, using spat collected from the wild.

In November 1995, ACIAR approved a further two-years' funding for a project entitled "Development of Small-Scale Village Farms for Blacklip Pearl Oysters in Solomon Islands Using Wild Spat". As part of the new project, 30 longlines, each holding 100 collectors, were deployed at two of the most promising sites identified over the past two years.

We deployed collectors to coincide with the main period of spawning activity identified during Phase One and are continuing to monitor spat collections over time to confirm findings of seasonality. In addition, refinements made to spat collectors have been incorporated into the new collectors. Spat rope, which is increasingly becoming the collector of choice in Cook Islands, is being used for a proportion of the collectors in Solomon Islands.

Once spat are collected, we will investigate grow-out methods to decrease the high rates of mortality experienced in Phase One. An important question in this context is whether survival of spat can be increased by removing them at an earlier stage from collectors, and placing them in a grow-out system which more effectively excludes predators.

We have seen some of the shortfalls of the lantern net system for the grow-out of juvenile *P. margaritifera* and will be testing a new system based on panel nets. Grow-out will be concentrated in only two areas for phase two of the project. This will allow more regular husbandry checks on the juvenile spat, than was possible during the first two years work.

This project is run in cooperation with village communities who are trained in the culture procedures and who are set to receive any financial returns if the project is successful. The new project provides funding to pay a technician for the seeding of spat held by the villagers. This component of the work offers participants a real possibility of taking the first steps into farming production.

Data collected on the variables associated with farming (e.g. survival of spat) will be used in an economic analysis of potential returns from farms within open reef environments.

First pearl harvest in Marshall Islands

Black pearl industry on its way in Marshall Islands

Roberts Reimers Enterprises (RRE) in the Marshall Islands is now successfully producing gem-quality black pearls—the same pearls of South Pacific fame that come from the black-lipped oyster.

In Majuro, in August 1995, RRE's pearl project coordinator Tim Seitz and Reimers' family members harvested a small number of pearls from a batch of oysters brought in from the RRE pearl farm in Arno, an atoll some 10 miles away.

Ramsey Reimers, CEO for RRE, said the project has progressed in a low-key way over the past two years. Production to date shows that pearl farming will work in the Marshalls, and the firm intends to vigorously increase the growth of its Arno farm to bring it up to a commercially-viable level. The farm, on one of Arno's small islands, was chosen for its nutrient-rich lagoon and shelter. It is being developed similarly to RRE's giant-clam farm on Mili Atoll, which is powered primarily by solar panels and a wind generator. Reimers and Seitz agree that pearl production is very complicated and risky.

"It takes about two years for an oyster to mature to the size when it can be "seeded" and, from that point, it takes yet another two years to produce what one hopes will a high-quality pearl," Seitz said.

Reimers said the company is taking a long-term view to developing the business and anticipates doing it over the next 10 years.

"It's definitely not a get-rich-quick scheme," Seitz said. He pointed out that the Marshall Islands doesn't have a large population of black-lip oysters, in contrast to some atolls in French Polynesia and the Cook Islands.

"In fact, naturally occurring black pearls are virtually nonexistent in the Marshalls", he said.

There has been some discussion of establishing an oyster hatchery, but "l00 per cent of the successful oyster farms in the world depend on collecting "spat" (newly spawned oysters) from the waters where the mature oysters naturally exist," said Seitz.

"There is no successful commercial saltwater pearl farm I know of that can supply its present or future needs from a hatchery. Natural spat collection is necessary to supply the needs of any oyster farm."

Now that the company has demonstrated it can produce pearls, "our first priority is to devote our efforts to our Arno farm to firmly establish a properly managed, commercially-viable enterprise," Seitz said. "From there, we will be in a position to assist others to develop this natural resource in a responsible and ecologically-sound way."

Source: *Pacific Magazine*, Nov. – Dec. 1995.

Marshall Islands farm on-line: exploring Hawaiian farming options

By: Neil A. Sims and Dr Dale J. Sarver
Black Pearls, Inc., P.O. Box 525, Holualoa, Kona, 96725, Hawaii

Black Pearls, Inc. (BPI) continues work to expand commercial pearl farming in the Marshall Islands, as well as conducting trials for pearl culture and stock re-establishment of the Hawaiian black-lip pearl oyster, and projects in Kiribati and the Philippines.

Commercial farm in the Marshall Islands

Expanding on the early successes in the remote-hatchery production and grow-out trials in the Marshall Islands (RMI), Black Pearls, Inc. has established a commercial pearl farm in the Majuro lagoon.

A private company, Black Pearls of Micronesia, Inc. (BPOM), has been set up in the Marshall Islands in conjunction with local land-owners, and with collaborative assistance from the Marshall Islands Marine Resources Authority (MIMRA) to help develop the farm. Initial round pearl seedlings of the first hatchery-produced oysters are scheduled for late 1996. Field trials presently continue, through a NMFS Saltonstall-Kennedy Grant, to find ways to mitigate the impacts of predatory gastropods, and to identify site-specific variability in growth and survivorship inside Majuro lagoon.

Spat-collector trials

Trials in Namdrik Atoll, supported through an earlier NMFS Saltonstall-Kennedy Grant, had demonstrated that spat-collector returns were not sufficient to support commercial farm operations in

Namdrik, and probably not in other Marshalls lagoons. It was hypothesised that this was due to the extensive tidal flushing of these open lagoons, with spring tidal ranges of over three metres.

Survey of stocks in Namdrik

A survey of stocks in Namdrik lagoon estimated the total population at around 20,000 oysters.

Most of these are larger, older oysters, with very little recruitment occurring. The existing stock obviously is unable to support any heavy commercial exploitation.

These older wild oysters are also less suitable for pearl culture, with poorer nacre quality and lower pearl-retention rates.

Namdrik lagoon reportedly has the greatest number of wild oysters of any of the Marshalls lagoons, and so collection of wild-collected oysters for commercial farming was also not considered feasible.

Remote-hatchery production

Hatchery-produced stock therefore offers the only realistic option for large-scale development of pearl farming in the Marshall Islands. With an increase in hatchery capacity in early 1995, BPI was able to ship over 150,000 recently-settled spat from a single larval run.

An additional 100,000 spat were shipped early this year. Further hatchery expansions currently under way should see a substantial increase in production capacity.

Growth of the oysters has been encouraging. Some mabe pearls seeded in wild-collected oysters in the Marshall Islands have also generated considerable interest among jewellers in Honolulu and Kona, indicating excellent pearl-quality potential for the Marshalls.

Hawaiian pearl-farming trials

The Hawaiian trials have focussed on the feasibility of a stock re-establishment programme and commercial pearl farming.

These two goals could well be met by the same means: results have shown that the most effective stock re-establishment plan would place large numbers of older, densely-aggregated oysters in protected bays or lagoons, and rely on natural spawning to produce a continuous rain of recruits onto the surrounding reefs.

Over a dozen grow-out sites were tested around Hawaii Island, Molokai, Oahu and Midway Atoll. Oysters at five of these sites showed excellent growth under long-line culture conditions, with minimal mortalities among adults. At most sites, spat and juvenile oysters suffered Cymatium snail predation, at a level similar to that encountered in the Marshall Islands.

Regular inspection of spat bags and lantern baskets is necessary to prevent serial predation by snails. An innovative holding system has also shown some promise in minimising serial predation in untended oysters.

Several sites apparently have no snail problems, but we are presently unable to explain this anomaly.

Constraints to commercial farming

Obtaining exclusive ocean leases in Hawaii has constrained commercialisation of Hawaiian pearl farming. Nevertheless, the results of these trials (supported to date by a US Department of Agriculture, SBIR grant and an ongoing NMFS SK Grant), have been sufficiently encouraging to warrant further efforts aimed at offshore culture, land-based farms, or some combination of the two.

Kiribati trials

Attempts to replicate the Majuro remote-hatchery successes in Kiritimati Island (Christmas Island) in Kiribati have so far been thwarted by the outright refusal of the animals there to spawn. Spawning induction has presented little problem for oysters from other locations. Even the remote-hatchery work for the Marshall Islands usually results in over 90% of the animals successfully spawning.

Perpetually spent?

For the Kiritimati trials, however, four spawning induction attempts have been made in both Kona and in Kiritimati, over a full year, without even a single male spawning.

We hypothesise that this oyster population is perpetually spent, with spawning occurring almost continuously.

Most of the stock in Kiritimati is found in the passage opening to this vast, shallow lagoon, and is therefore subjected to extreme tidal fluctuations in salinity and temperature. On several occasions we have observed other oyster species and other benthos spawning on the late afternoon ebb tide.

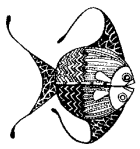
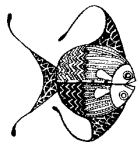
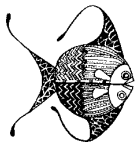
Continued attemps

The most recent induction attempt therefore used over 20 oysters which had been held on the outer reef slope, as well as another 70 oysters collected from inside the lagoon — still to no avail.

Trials will continue, with an attempt to condition oysters in isolated pockets on the outer reef slope of the island, where they are not subject to effluent lagoon water, as well as with attempts at on-land conditioning of Kiritimati oysters under quarantine conditions at the Kona facility.

Philippines hatchery

Black Pearls, Inc. has also begun work under a commercial contract to design, build, operate and train the staff for a *P. maxima* hatchery, which will be used to supply an established pearl farm in the Philippines.

Round pearl seedings in Nukuoro, FSM

The first Polynesians came to Nukuoro Atoll, now part of Pohnpei State (Federated States of Micronesia), many years ago by canoe from Samoa, some 2,000 miles away.

Nobody quite remembers exactly when the first Polynesians landed. All they know is that it was a long time ago. But the latest arrival, pearl technician John Lyons, probably will command greater attention in local history because he is a man with the long-awaited skills to help the island become the Pacific's newest producer of black pearls.

Nukuoro is geographically isolated from the rest of the FSM. It is the second southmost atoll in the country (Kapingamarangi is 185 miles farther south). Its land area is just sixteenths of a square mile, formed in a near-perfect circle around a lagoon that is four miles in diameter.

The black oyster (*Pinctada margaritifera*) has grown naturally in Nukuoro's lagoon, which locals call **Loteloda**, for as long as anyone can remember. It coexists with sponge, clams and many other kinds of marine life.

The chief magistrate (equivalent to mayor), Hosea Fred, is 52 and can remember learning about the value of the oysters early in life. The people eat the meat and use the mother-of-pearl shells for making knives, fish hooks and lures and jewelry.

Seafarers from Yap, more than 1,000 miles away, sailed their boats to Nukuoro to trade for the shells, which they took home to use as currency.

In the 1800s, German divers plundered 50 tons of oysters from Nukuoro's lagoon. Fred was told by a Danish pearl farmer a few years ago that one of the black pearls netted from that haul made its way to England and is now one of the crown jewels in the Tower of London.

Lyons and his family operate Pauveva Pearls and Services Ltd. The Pearls farm is in the lagoon of Manihiki Atoll, which bears a great similarity to Nukuoro. It, too, is just a speck on the map. But Lyons calls it home, his island.

Son George manages the farm, while daughter Carlene Hendricks runs the wholesale outlet in Rarotonga, capital of the Cooks. Lyon's Wife, Gienice, runs another wholesale outlet in Hawaii. Lyons divides his time between the farm, which he hopes will produce 2,500 pearls next year, and travelling the Pacific seeding pearls for the other farmers.

There is about a 75 to 80 per cent success rate in seeding oysters, he said. That means, in about 18 months, Nukuoro should have at least 3,000 pearls ready for market. At today's depressed prices, they should net US$ 50 a piece.

"The way I look at it," said Fred, "the pearl project is essential for our future. It's our most important resource, aside from copra and fish. But, we also want to look at other things, such as sponge, clams, making jewellery, fishing lures and buttons from the pearl shells, and preserving bread-fruit. And, we want to increase our oyster numbers. In the long term, we want between 10,000 and 15,000 oysters."

The idea for the pearl farm sprang from a failed attempt by the FSM government, through Marine Resources, to start a similar operation on the island in the late 1980s. Despite much expectation, the project only ever yielded about 300 pearls before it was abandoned in 1992.

In 1994, Fred made four trips to Pohnpei to get information about how to revive the project. Another Nukuoroan, Herman Herman, 38, who had been away from the island for 20 years and now held the job of assistant manager in one of Pohnpei's hardware stores, joined the crusade.

Together, they lobbied for funds and eventually secured financial help from the Pohnpei state government, the Australian government and their local island municipal government.

Finally, in March 1995, Herman gave up his hardware job and returned to Nukuoro. So did his former schoolmates, Enok Benjamin and Senand Leopold, who both worked for an oil company in Pohnpei.

With three other local men, they set about collecting the wild oysters, checking them, cleaning them and preparing them for seeding. They worked 10 1/2 hours a day, five days a week for US$1.50 an hour paid out of island council funds. On 15 October 1995, Lyons left Pohnpei aboard the patrol boat, *FSS Micronesia*, together with Steve Lindsay, Virgil Alfred and Herman Herman. Lyons planned to remain for six weeks, seeding the existing oysters and laying plans for expansion.

When Lyons began pearl farming in the Cook Islands, he had to pay a Japanese pearl seeder two oysters for every shell he seeded. He had to give away 4,000 oysters. The next year, he paid an Australian to seed them. It was cheaper, but not cheap enough.

"After watching him, I thought: I could do that. Blow it! I'll learn," Lyons said. He did and now he is a role model. Is it any wonder, then, that Herman Herman, perhaps his keenest student, now says: "I know I can learn it too"?

Iranian research efforts

Persian Gulf Molluscs Research Center

By: Mehdi S. Doroudi and Paymon Roustaia
Persian Gulf Molluscs Research Center, P.O. Box 1416, Bandar Lengeh, Iran

Starting in 1982, attempts were made in Iran to develop pearl culture, and in this regard, some pearl culture farms have been established in different areas of the Persian Gulf. Systematic research on pearl oysters (*Pinctada margaritifera* and *Pinctada radiata*), however, was initiated five years ago in the Kish Island by Persian Gulf Molluscs Research Center (PGMRC). In order to expand the Center's facilities in Kish Island, the Center was temporarily transferred to Bandar Lengh. At present it operates with a staff of 30, among which are eight research personnel undertaking research activities.

PGMRC consists of three departments, namely biology, aquaculture and oceanography. The objectives of the Center concerning pearl oyster are to achieve the following:

- Pearl oyster stock assessment;
- Culture and farming of pearl oysters; and
- Providing solution and assistance to problems raised by private enterprise.

The department of biology is carrying out some major studies related to the biology and ecology of local pearl-oyster populations, which are critical to any culture plans. The most important activity in this department is determining the extent and status of natural stocks of pearl oysters, including abundance and oyster-size distribution and density. Biometry and growth, age determination, reproductive cycle and diets of pearl oysters are also being investigated at this department.

Application of current techniques in culture and farming of pearl oysters, as well as enrichment of natural stocks, are one of the principal objectives here at PGMRC. In this regard, the department of aquaculture is carrying out research activities both at indoor laboratories and also by establishing farms in various locations in the Persian Gulf. Research

activities include induction of gonadal maturation and spawning fertilisation, larval rearing and spat production as well as plankton culture for feeding.

In this regard, with the financial assistance of the Iranina Fisheries Research and Training Organization, a pearl oyster hatchery will be established in 1995 at Farour Island with the aim of producing pearl oyster spat on a commercial scale.

There are some research projects in this department entitled:

- Production of *P. margaritifera* spat from hatchery-reared larvae;
- The spatial and temporal variation of intensity of spat settlement to artificial collectors of different materials, placed at different depths;
- Pearl cultivation; and
- Site selection for pearl farming in Booshehr province.

As a branch of this department, the disease unit works on development of diagnostic methods, and currently its activity is focused on identification and controlling of fouling and boring organisms in the pearl oysters.

The department of oceanography provides basic information about the physico-chemical nature of water in different areas of the Gulf. Identification of pollution sources and their effects on pearl oyster, characteristics of pearl oyster habitats and locating stations for long term bio-monitoring programmes are also under this department.

One research project has been conducted, entitled:

- Effects of crude oil on the pearl oyster *Pinctada radiata*.

Fouling organisms

The project on infection of pearl oysters was carried out by Dr Mehdi Saveh Doroudi, in the Persian Gulf Molluscs Fisheries Research Center in Bandar Lengeh from 1992 through 1993. In this study, infection of pearl oysters in the culture ponds and natural habitats was investigated. Also, the relationship between cleaning intervals of oysters and growth rate was surveyed.

The main fouling organisms in the culture ponds were found to be barnacles, spat of edible oysters, and Tobiculous polychaete.

In the natural habitats, fouling organisms invading the oysters belonged to Sponges, Algae and Ascidians. *Cliona carpenteri, C. margaritifera* and *C. vastifica* of the boring sponges, and *Lithophaga malaccana* and *L. hanlyana* of the boring mussel caused the most damage to the oyster shells.

Amongst the oyster species studied, *Pinctada margaritifera* showed the greatest extent of infection with fouling organisms. Based on the acquired results, it can be said that the high rate of mortality among *Pinctada radiata* is related to the attack of predators cited above.

Dr Doroudi took part in the First International Conference of Pearl Oyster held in Honolulu from 12–15 May 1994 and presented the results of his study to the gathering.

Source: *IFRTO Newsletter*

Oman Sea Fisheries Research Center

E. Kamrani, Head of Stock Assessment, P.O. Box 1597, Bandar Abbas, IRAN. (Phone: (0761) 29365, 29444, 21134), writes:

I am presently involved in a research project on stock assessment and population dynamics of pearl-oyster beds of the Iranian Coast in the Persian Gulf. I have succeeded in collecting some literature on this subject, but unfortunately, the related references and literature are rare. Since all the literature on this subject in our libraries and elsewhere has not been computerised, it has not

been possible to survey it all. Hence, I request you to kindly send me literature (papers, articles, reprints and other relevant documents).

Also I will be glad if you could inform me of other scientists who are working on stock assessment of pearl oysters.

Colombian progress

Francisco J. Borrero, Cultimar Ltda, Investigacion, Promocion, Mercadeo, Calle 59 #3A-24 (Of. 403), Santa Fé de Bogota, Colombia, South America (Phone/Fax: (57-1) 249 6739), writes:

We are working on growth of *Pinctada imbricata* (perhaps the same as *P. fucata*) and *Pteria sterna*. Among the various aspects we are covering, we have just finished a first piece of work on nursery and intermediate growth of *P. Imbricata*, and we are now close to submitting a manuscript for publication. Other works (spat collection, conditioning and spawning) are being submitted soon.

I continue to work with INVEMAR at Santa Marta, but now as an advisor; we have submitted a new grant which will fund us for three more years.

On my own, I now work with two new, private, colombian mollusc an aquaculture companies (CULTIMAR Ltda and CICA Ltda), which together are in the process of building a commercial aquaculture facility in the Guajira Peninsula (Colombia's northernmost region). CULTIMAR works in close cooperation with government agencies, and aims at promotion of invertebrate aquaculture and fisheries in Colombia.

Our activities range from basic and applied research, to promoting and fostering the sustainable utilisation of aquatic products. Unfortunately, library facilities in our country are poorly funded, which means that we have no access to a great deal of important information, both published in journals, and in other formats.

Margaronics sponsors joint-venture in Venezuela

By: Gary Kraidman, President, Margaronics Inc., 8 B Taylor Avenue, East Brunswick, NJ 08816-1435, United States of America. Tel: (908) 937 8997, Fax: (908) 390 3335.

Margaronics Incorporated, a New Jersey (USA) company, has established the Margaronics Incorporated Cultured Pearl and Pearl Oyster Research Grant for 1995–1996. Margaronics is working on the creation of the first saltwater cultured pearl in Venezuela from the indigenous pearl oyster *Pinctada radiata (imbricata)*.

Margaronics Inc. will supply funding, technical know-how, supplies, and other support to the grant. The grant will be administered and supervised by the Fundacion La Salle de Ciencias Naturales, Isla de Margarita, Venezuela. Specific areas of pearl oyster studies will be carried out under provisions of the grant.

There is an ongoing joint-venture relationship between Margaronics and the Fundacion La Salle de Ciencias Naturales. Work sponsored under the Margaronics grant began in the fall of 1995.

Mr Gary Kraidman, President of Margaronics, gave a course on 9 May 1995, at the Fundacion La Salle. Attendees received a certificate and included students, staff, faculty, as well as other Venezuelans not associated with the school. The course, copyrighted by Gary Kraidman, is titled "The pearl of Venezuela: past, present and future" and parts of it have been videotaped during the presentation.

There was very positive feedback to the course, which also included slides, transparencies, shell and pearl specimens as well as commercial videotapes. The course will be updated and repeated to reflect changes in the pearl market and new technologies.

On 12 May 1995, Gary Kraidman was appointed an Associated Researcher and Visiting Lecturer to the Fundacion La Salle de Ciencas Naturales.

Mexican mabes

Enrique Arizmendi Castillo of Perlas de Guaymas, Apdo. postal #484, Guaymas, Sonora 85400 Mexico, writes

We have adapted pearl oyster culture and cultured pearl production for native pearl oysters *Pinctada mazatlanica* and *Pteria sterna*. We worked with pearl oysters while doing our Master's (Sergio Farell as thesis director and Douglas McLaurin and myself as students) in the ITESM (a private education institute) and upon seeing our advances, they decided to start a commercial-demonstrative farm (ITESM-Perlas de Guaymas) which we operate. At this moment we are harvesting our first crop of approximately 4,000 mabes and exactly 16 pearls, all from *Pteria sterna*, pearls of unusual dark colors including purple, blue, gray, gold, black and green with various over-tones in the best pearls. Round pearls are still at the research stage, as you can see from the numbers. This is also the case with *Pinctada mazatlanica*, but projections for this farm include 40,000 for next year and 100,000 mabes for 1998.

Resolving the etymological mystery of *Pinctada*

Dr Henk K. Mienis, National Mollusc Collection, Department of Evolution, Systematics and Ecology, Hebrew University of Jerusalem, 91904 Jerusalem, Israel, writes:

I have read with interest the remarks by Beatrice Burch concerning the etymology of *Pinctada* (see *Pearl Oyster Information Bulletin*, 8: 10–11). Pinctada is indeed neither of Latin nor of Greek origin, but has to be considered a corruption of the French word "Pintade", which again is derived from the Portugese "Pintada", and which means originally "spotted" or "stained". However, in our case it might have a double meaning.

When Röding introduced the generic name *Pinctada*, he listed several species. The first among them was *Pinctada margaritifera*, with reference to Gmelin and Chemnitz. Gmelin still referred to the pearl oyster as *Mytilus margaritifera*. Chemnitz did not use a Latin name at all, but mentioned it under several common names like "La Pintade: la coquille de nacres de perle" (French) or "Die gefleckte Henne" (German). Both "La Pintade" and "Die gefleckte Henne" refer in principal to guinea fowl or pearl hens: common African game-birds. This is not so strange, since the shells of pearl oysters are very close in colouration to the feathers of numerous species of guinea fowl. These birds are characterised by a dark grey or black plumage, heavily spotted with "pearls".

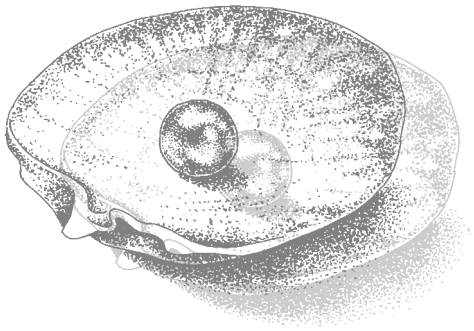
According to the "Petit Robert", a well-known French dictionary, guinea fowl have been called "Pintade" or "Pintarde" since the first part of the 17th Century, both words being derived from the Portuguese "Pintada". Only in 1776 was the name "Pintade", and later on also "Pintadine", (1842), used to indicate pearl oysters.

Röding was probably aware of the double usage of "Pintade" for both guinea fowl and pearl oyster. When he latinised that name, he probably changed it intentionally to *Pinctada*. However, Gray (*Proc. Zool. Soc. London*, 1847: 199) has supported a different opinion: *Pinctada* is a misspelling for "Pintada". Gray even tried, in vain, to replace the former by the latter.

Whether Röding changed "Pintade" into "*Pinctada*" intentionally or by error does not alter the etymology of the word.

Incidentally, the pearly colouration of guinea fowl is well-characterised by such specific names as *Agelastes meleagrides* (white-breasted guinea fowl) and *Numida meleagris* (helmeted guinea fowl).

EXCERPTS AND ARTICLES



PEARL WORLD

The following excerpts were taken from recent issues of "Pearl World, The International Pearling Journal". Note Bo Torrey's new address:

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Hong Kong: where the action was

The 12th Annual Hong Kong International Jewellery Show, the 10th Anniversary of the Hong Kong Diamond Bourse, a special Kobe Earthquake Charity/Paspaley Pearl Auction, and an exhaustive Executive Committee convocation of the South Sea Pearl Consortium all came together during one week in March 1995, and on the heels of one another, to keep attendees scurrying about Hong Kong Island from venue to venue...

Some 357 Hong Kong companies were scheduled to exhibit at the 12th International Jewellery Show from 8 to 11 March, eighty or more other companies from Australia, Belgium, Canada, China, Denmark, Germany, India, Indonesia, Israel, Italy, Japan, Lebanon, Lithuania, Malaysia, Poland, Switzerland, Taiwan, Thailand, the United Kingdom, the United States of America and Vietnam had also signed up to participate. But there had to be many, many more in actual attendance.

The SSPC Meetings

Two meetings scheduled at the Otto Gerdau offices in the Central District of Hong Kong Island were the first convocation of the founding principals of the South Sea Pearl Consortium (SSPC): Cogent Trading Company (three Leungs: Messrs Sik Wah, Yuen Wang and Lawrence); Nippo Pearl (Messrs Kuribayashi and Uchida); Hamaguchi Pearling (Mr Hamaguchi); Assael International (Mr and Mrs Assael and Mr Noguchi); Broome Pearls (Messrs Kailis and Norman); and Paspaley Pearling Ltd. (Nick Paspaley and several of his staff).

Their mission statement: "the SSPC was formed as an umbrella organisation to project, protect and reinforce the image of the South Sea Pearl—a pearl singular in its nature, value and heritage. The mission's scope is worldwide, as the SSPC seeks to cultivate loyalty to the quality and unvarnished beauty of South Sea Pearls among the leading distinguished pearl jewellery retailers and their discriminating clientele."

Their vision statement: "Like a snowflake or fingerprint, each South Sea Pearl is unique-the precious result of an organic, biological process not unlike a birth. The SSPC will lift the South Sea Pearl to its rightful pinnacle of recognition, thus leaving a legacy of lasting splendor, quality and elegance to be worn and treasured generation after generation."

The June 1995 JCK Show in Las Vegas

The gigantic Jewellers Circular Keystone Show at the Sands Convention Center attracted some 2,300 exhibitors (many with multiple booths)... and an estimated 16,000 registered buyers, media, gawkers and strollers-by. According to the JCK Show Guide there were some 160 companies displaying a wide spectrum of the goods from the cultured pearl industry. Despite the massive throngs of visitors, many pearl dealers expressed general disappointment with the results of the four-day show.

The main culprit seems to be the unfavourable yen/dollar ratio. Other accomplices included the overall poor times the cultured pearl industry seems to be encountering worldwide, overcrowded facilities which forced more than a few exhibitors into unfavourable locations, and the state of ennui many buyers seem to have as the US economy continues to slide into what experts feel is a genuine recession.

Prices at the wholesale level have tumbled elsewhere, too. Some South Sea goods are being sold at 20-25 per cent below the levels they were at even three or four months ago, and overproduction by the Tahitians has made that a buyers' market, too. This is most noticeable with commercial goods at the lower end of the spectrum. Top quality goods in the larger sizes are still in short supply, and continue to command virtually unchanged high prices.

Indonesia's future: looking up

New producers are historically loathe to talk about their operations until they actually have a harvest or two under their belt. In a nutshell, pearl farmers in the northern portions of Indonesia are faring well, whereas some farmers in the south are still encountering problems which are constricting their growth.

One producer reports that his shell growth continues to be excellent, with shell spawned in November 1993 reaching operable size by July 1995, with spat of 3 to 4 mm in size and mortality averaging 1 to 2 per cent. Another producer reports essentially the same positive results, though not in any greater detail. Another reported that their trial harvest averaged 10.5 mm in size, and that nacre development was 3 mm per year with good luster. The recent formation of the Indonesian Pearl Producers' Association is hopefully the first step in consensus, agreement and the beginning of a modicum of self-regulation for the region.

Atlas Pacific, an Australian company operating in Indonesia, is reported in the press to be expecting earnings in July when its 75 per cent owned Kupang Pearling Project produces its first commercial harvest. Leases and licenses for the farm and hatchery were first acquired in 1990 by Nusanquata, a Singapore-based company, with control being transferred to Atlas Pacific towards the end of a pilot project in 1992.

Company General Manager Lucian Petersen said the South Sea pearl produced at the farm was relatively scarce, found only in northern Australia, Indonesia and parts of the Philippines and Vietnam. The production cost for each pearl in Australia was about $175 compared to his hatchery's expected cost of $80. Atlas Pacific chairman Tony Trevisan reported that shareholders would be "very well rewarded with 2500 shells harvested in July", and twice that number of shells is anticipated for the next harvest.

The WPO gets under way with a new name

The first full-fledged World Pearl Organisation (WPO) meeting, after the preliminary organisational one held in November 1994, took place at the Hotel Okura in Kobe on 31 May and 1 June 1995. Members from seventeen countries attended. According to reports in the Japanese press, the regulations concerning the Board, the establishment of committees, the action plan and the budget (which had been previously sent out to prospective attendees in *The WPO Gazette* no.1, April 1995) "were agreed upon with not many changes".

The WPO (renamed the WCPO—World Cultured Pearl Organisation, primarily due to the prevalence of imitation pearls in the European market) planned to collect some US$ 11,200,000 for pro-

motional funding in its first two years. .. primarily from the imposition of one per cent surcharge on exports.

As reported earlier, this plan has been met with stiff resistance, especially by the Australians and Tahitians. The WCPO is still a long way from satisfying its constituency. Attendee after attendee complains about the rigidity of its organisation and its functioning to date.

The hope is that, perhaps over a period of time, the WCPO will mature into what the international cultured-pearl industry really wants and needs, with greater measures of equality, shared responsibilities, and harmony amongst the parties.

Particularly welcome was the addition and participation of the new Indonesian association, along with delegates from the Cook Islands.

PEARL WORLD

The 1995 Australian pearl harvest, "perfect today. ..better tomorrow"

In mid-August 1995, a small band of jewellery trade magazine journalists (myself included [Bo Torrey]) were privileged to be the first of our kind to witness first-hand pearl harvesting in Western Australia. "You should feel extraordinarily lucky," a veteran SSP dealer told me. "You'll acquire in a few days the knowledge that most of the rest of us took decades to gain." He didn't know how right he was.

Industry overview

Western Australia's sixteen pearl farmers produce, on average, about US$175 to US$ 200 million worth of primarily silvery-white (and a small percentage of golden) South Sea pearls annually. To compare the nacres: a 15 mm Australian pearl will often have a nacreous coating of 4 mm around its nucleus, more than ten times the thickness of the average *akoya* pearl (according to experts).

The Australian pearl is also much scarcer. Last year's (1994) production of round Australian pearl was estimated to be about 318 kan (± 1,193 kg), an increase of some 36 per cent compared to the 1993 figures (somewhat inflated above normal due to one farmer's crop not being harvested in 1993 because of a legal dispute). The value of the 1994 Western Australian crop of rounds, halves and keshis has been estimated at A$ 196 million, up from 61 per cent over the previous year.

Tahiti

It has been reported that better production methods have seen a higher percentage of Tahitian pearls exceed 10 mm. This factor, plus a more concentrated effort on marketing and promotion, both domestic and international, is thought to be why black pearl exports increased some 56.4 per cent in value to approximately US$ 117.89 million in 1994, and reached a total export volume of 2,184 kg.

The average price per gram of unworked pearls reached US$ 41.42 (a 16.5 per cent increase), reversing a trend of falling prices over the past four years due to overproduction of poor-quality pearls. For unworked keshi, unworked mabe and worked mabe, these figures are US$ 17.92 (+13.6 percent), US$ 7.50 (+673.1 per cent) and US$ 10.20 (+75.5 per cent) per gram.

There still remains the basic problem of exporting of low-quality pearls. A quality inspection commission to regulate this matter is still under consideration, most likely to be accomplished jointly by pearl producers and dealers who sign on to a quality-standard agreement.

But pear ling matters are in such turmoil at the moment (September 1995) due to the unrest in French Polynesia that many are predicting slightly-rising prices across the board for Tahitian black pearls as goods in the pipeline begin to thin out.

The 1994 Cook Islands pearl exports

1994 pearl export figures published by the Cook Islands Customs and Statistics Department reveal that the average price for unworked Cook Islands pearls was NZ$ 33.75 per gram.

1995 first quarter figures total 32 kg worth of exports, valued at NZ$ 961,275 (NZ$ 30.04 per gram).

Caution must be taken in comparing reported Cook Island prices to reported Tahitian prices. Sizes, shapes and grades are not detailed.

The Tahitians separate out unworked keshis and mabes, whereas the Cooks do not; and skewing all figures to an unknown degree is the fact that significant amounts of harvested pearls from both locales are, in all likelihood, not being reported at all.

1994 Cook Islands pearl exports

Country	Weight (kg)	FOB (NZ$)	Price/g (NZ$)
Germany	33	595,757	18.05
Japan	27	1,159,326	42.94
Australia	8	896,300	49.79
Hawaii	16	790,319	49.39
USA	13	429,494	33.04
New Zealand	1	151,410	13.76
Hong Kong	1	64,542	64.54
India	1	7,113	7.11
Singapore	1	44,000	44.00
Sweden	1	26,000	26.00
Vanuatu	1	5,043	5.04
UK	0	2,500	n.a.
Totals	**124**	**4,184,394**	**33.75**

Japanese pearl licence exports

Japanese pearl licence exports, January – October 1995

Country	Year	Weight (momme)	% of total	Amount US$	% of total	Average per momme (US$)	Comparison Weight (%)	Comparison Amount (%)
Total	1994	5,733,229	100.0	322,360,907	100.0	56.23		
	1995	5,141,357	100.0	328,778,679	100.0	63.95	-10.3	+2.0
Excluding	1994	5,385,001	93.9	233,477,578	72.4	43.36		
S.S. pearls	1995	4,788,274	93.1	228,989,484	69.7	47.82	-11.1	-1.9
South Sea	1994	348,228	6.1	88,883,329	27.6	255.24		
Pearls	1995	352,983	6.9	99,789,195	30.3	282.70	+1.4	+12.3

South Sea pearl campaign kicks off

The consumer education programme funded by the South Sea Pearl Consortium kicked off in December 1995 to better inform the buying public, retailers, the fashion industry and the media about South Sea cultured pearls.

Other goals are to increase the gem's visibility and sales volume worldwide. In December 1995, the SSPC has launched an international consumer advertising campaign, and will start developing retailer education programmes.

All the ads include the tag line "South Sea pearl—gem of a lifetime". The budget for the campaign is targeted through March 1996 at US$ 1.5 million.

The Japanese *hama-age* blues

The news from Japan is that excessive stock on hand, low demand and lack of money are combining to paint a gloomy picture for the upcoming akoya raw material auctions. It is once again being said that the upcoming quality of the harvest will be poor, mainly due to the preponderance of thin nacre coatings.

18th Annual Tahiti Pearl Auction

The 18th Annual Tahiti Pearl Auction, organised by the GIE Poe Rava Nui in Papeete, French Polynesia, and held in October 1995, attracted some 67 local and international buyers with an offering of 184 lots of goods.

Ninety-nine lots (54 per cent of those offered) of some 56,899 pearls sold for US$ 4.9 million—40 per cent above the reserve price; however, the number of pearls sold dropped some 38 per cent from 1994. The average piece price was US$ 86.11, some 13.5 per cent lower than at the 1994 auction.

One interesting note about last year's auction was that, unlike previous years when Japanese buyers took home 80 per cent or more of the goods sold, they accounted for only about 55 per cent. The doldrums in which the Japanese domestic market finds itself and current exchange fluctuations account for some of this downturn. As we all continue to hear, top-quality Tahitian goods remain good sellers: supply cannot meet demand.

However, with the amount of pearls sold, total sales and the average price per pearl dropping precipitously from the auction of a year ago, the overall outlook is not particularly sunny. Eighty-five lots of 55,899 pearls, ranging from 9 mm to 18 mm, valued at US$ 3 million, are left over from this most recent auction—not a particularly happy harbinger of times to come for the Tahitian cultured-pearl industry.

Akoya problems continue

A dependency on overprocessing to counter legendary surface blemishes and discolorations is having an extremely negative effect on the finished product.

"All this is doing to us, and others like us in the region, is turning us more and more to SSPs", said one major Akoya buyer. This is good news for the Australians, Tahitians and Chinese in particular. But any turn of events which could cause consternation to the general pearl-buying public is neither wanted nor warranted in these times.

The *Nihon Keizai Shinbun* (the *Wall Street Journal* of Japan) of 9 December 1995 reported that profits for Tasaki Shinju dropped a whopping 43 per cent for their fiscal year, some ¥ 1.250 million.

The Tucson Show

The Tucson Show has traditionally marked the new year's kickoff for the US jewellery industry's competitive slate of shows and exhibitions. The 'old faithful' pearl dealers who attended were generally slightly disappointed at the show traffic, which appeared to be noticeably slower and sparser than in past years. One reported 'no movement of akoya at all so far during the show' and told me that in 1995 his firm had purchased, exhibited and sold about 70 per cent akoya and 30 per cent SSP... but that this year his inventory had moved to approximately 50–50, and that this greater volume of SSP goods was pretty evenly split between white-lip Australian goods and black-lip Tahitian goods.

Other participants were Sergio Farell and his assistant from Ferias de Guaymas who were displaying their goods cultivated in the *P. mazatlanica* and *Pteria sterna* oysters, including their very first round bronze-coloured "baby".

Tahiti bounces back

The world market price for Tahiti's cultured pearls has nearly completely recovered all the ground lost during the late summer through early autumn. The GIE Perles de Tahiti, created in 1993 for the overseas promotion of Tahitian pearls and their by-products, reports that the value of Tahiti's natural-coloured cultured black pearls fell some 53.8 per cent in the period from June 1995 through September 1995. The main causes were felt to be the heavy disruption of the Japanese domestic market caused by the January earthquake in Kobe, the large drop in their domestic consumer spending, and a fall in the value of the Japanese yen.

But the world market price for Tahitian goods reversed itself between October and November 1995, regaining 49.4 per cent of the 53.8 per cent loss reported in the four prior months.

Three factors contributed to this rebound:

First, there were the positive results of the efforts by the Japan Black Pearl Promotion Association, one of the GIE's five overseas promotional operations. Second, there was a stabilisation of pearl production in Tahiti. And finally, there was a steadying in the value of the Japanese yen.

Nucleus quality = harvest quality

Many factors can combine to alter the size, shape, color and luster of a cultivated pearl. Yet, as with natural pearls, one of the major components in the formation of cultured pearls is its nucleus. It has been proven time and time again that the size and quality of the nucleus inserted into the oyster will dramatically affect the pearl which is ultimately produced. This is true not only for the akoya, but also for white, gold and black South Sea cultured pearls.

Most neophytes would consider that shape is the most obvious consideration: a less-than-perfectly-round nucleus (that is, off-round by less than five-to-eight hundreds of a millimetre) will often result in an off-shaped pearl. What really bears more importance on the potential for producing a high quality pearl is the surface smoothness of the nucleus itself.

The platelets of calcium carbonate which are secreted by the oyster to form the pearl are microscopic and, as they are laid down, they will follow the contour of the surface of the nucleus. A nucleus with a surface that bears pits, holes or deep scratches due to low-quality processing techniques may very well result in a pearl with pin holes, hammering, marks or defects.

This is why more attention must be placed upon the techniques employed in nuclei processing. By increasing the quality of the nucleus used in the grafting operation, the pearl farmer can be assisted in maximising his yield of saleable pearls from each harvest.

The final polish of the nucleus must also be of high quality to enable the smooth flow of nacre in order to evenly cover the nucleus.

Scanning the pearl world (February – March I 996)

Tahiti

Gaston Flosse, President of French Polynesia's Territorial Assembly, recently assured his constituents that French President Chirac has promised 990 million francs (some US$ 193 million) a year over ten years to compensate for lost investments in the region. This works out to about 4,500 francs (US$ 880) a year for each of the 212,000 inhabitants of French Polynesia who are scattered across about 130 islands and coral atolls. France is also expected to sign the Rarotonga Treaty before summer, making the South Pacific a nuclear-free zone.

Indonesia

Conflicting reports are still coming out of this region. The traditional producing area around the Aru grounds has had well-documented problems in the past, and is continuing to deteriorate. The oyster fishing season which began in October has seen a very considerable drop in shells. The numbers keep getting lower and lower, and mortalities keep rising and rising.

Australia

White-lip SSPs at this point in time are reportedly getting scarcer and scarcer due to a strong buying frenzy which has persisted since last year's harvest came on the market. This has quite naturally elevated prices across the board (that, and the general feeling that there is a massive turn continuing towards SSPs and away from the akoya).

With more and more dealers looking for better quality in lower price ranges, there is the report that—with Australian goods pretty well picked over and spoken for—Tahitian goods present a very attractive alternative (Tahiti, naturally, is taking full advantage of this situation and reports indicate huge increases in their export statistics).

As for the coming year, Nick Paspaley reports that "the climate in the Australian pearl industry is very calm at the moment. Production is almost completely sold out. The industry is now concentrating on production of the 1996 crop which will be out around July. The 1996 crop is expected to be similar to the 1995 crop. From all indications, it would appear that the 1996 crop will sell out quicker than in 1995, with many of our 1995 customers now being short of stock."

All indications are that the current predilection for black goods over white is only a small blip on the scope, caused by the current shortage of white-lip goods at hand.

Japan

In a major move reported in the *Nihon Keizai Shinbun* dated 31 January 1996, Tokyo Pearl is opening a joint wholesale operation in New York City with the world's largest jewellery whole-saler, M. Fabricant and Sons, Inc. "We hope to sell mainly Japanese pearls in the United States, but we will also be dealing in Tahitian and Australian pearls", a spokesman said.

This marks the first time in the Japanese pearl industry that a domestic company will establish an entity in Europe or the US dealing exclusively in the wholesaling of cultured pearls.

Jumbo jets

By: David Federman

Although grown in French Polynesia since the early 1960s, black pearls only became an important export in the late 1970s. In no time at all, however, "expansionists" in the government were issuing pearl farm permits like they were door prizes at a church bazaar.

It is easy to understand their zeal. French Polynesia is blessed with an abundance of black-lipped oysters called *Pinctada margaritifera*, which grow the world's finest black pearls. Given the plenitude of these molluscs, and the dearth of industrial opportunities, Tahitians started to grow pearls. Indeed, the rising tide of bootleg pearls from wildcat farms helped depress prices when recession hit America in 1990 and Japan a year later.

Before those downturns, French Polynesia's waters were the most crowded ever with nucleated oysters. Indeed, the largest and most famous farm on

an atoll named Manutea had put 150,000 seedlings in its lagoon in 1990.

Ironically, Manutea marketed its harvests through New York dealer Salvador Assael, a very vocal conservationist and the man generally credited with popularising the Tahitian black pearl in the late 1970s. Despite his warnings, overproduction dealt the reputation of the Tahitian black pearl a black eye, and capsised prices up to 40 per cent.

Now conservationists have gained the upper hand and persuaded French Polynesia's government to put pearl prestige ahead of production. To stabilise prices and restore market confidence, a coalition of big growers, small farm cooperatives and government officials hammered out a five-part market-rescue programme last summer.

That program, reports Pearl World, involves the following:

(a) Halting new farm permits;

(b) Requiring pearls to be exported through Customs in order to stem the outflow of bootleg goods;

(c) Creating an inspection office, similar to that in Japan, with the power to embargo poor-quality merchandise;

(d) Taxing exports based on weight rather than value to prevent oversupply; and

(e) Actively promoting the Tahitian black pearl in Amesrica, Europe and Asia.

Like central bank intervention to prop up currencies, this show of strength by the Tahitian pearl industry has reversed the free-fall of black pearl prices. According to Assael, prices for goods from his 1994 bumper crop rose as much as 25 per cent before being completely sold out within one month of arrival in New York City late in August 1995. "Customers flew in from all over the world and I had nothing to show them," he says. "It's incredible, because we're talking about 80,000 pearls."

Although there are several hundred licensed farms, those of businessman Robert Wan, who bought the Manutea operation from its founder Jean-Claude Brouillet in 1984 and started others, remain the most important, responsible for at least 50 per cent of Tahiti's annual pearl crops.

But it wasn't Wan alone who put Tahiti's pearl industry on the fast track. In just 20 years, exports rose from 800 grams worth US$ 23,528 to 2.1 tonnes valued at US$ 77 million in 1995. These are mega-exponential increases that have made French Polynesia the South Seas' third largest pearl producer after Indonesia and Australia, the latter two producers of white and golden pearls.

Sizes tend to be 9 to 12 mm, with rare larger sizes up to 16 mm usually coming from oysters that have been nucleated a second time. Once in a blue moon, pearls over 18 mm have been harvested, and recently one pearl, with an astounding diameter of 19 mm, was grown at the Marutea farm. This beautiful behemoth will be the center of a Tahitian showcase necklace being prepared—for exhibition purposes only—by Assael.

According to Assael and Martin Coeroli, manager of Perles de Tahiti, a trade group composed of French Polynesian growers and government people, 40 pearls are obtained for every 100 oysters nucleated.

Of these, four tend to be junk, one round, five semi-round and drop, 20 semi-baroque and 10 baroque. From a standpoint of quality, for which French Polynesia uses a three-grade ranking system for salable pearls (quality A, B and C), A grades generally account for 6 per cent, B grades 60 per cent, and C grades 34 per cent.

Source: *Modern Jeweller*

Australian pearling articles

God's little nacre

By: Don Townshend

When Nick Paspaley talks about his glistening gems of the sea, he simply can't help romancing the stones.

"Australia's South pearl is the queen of all pearls and the most desired—the most elegant pearl in the world. String a strand of fine pearls around a graceful neck and, as a piece of jewellery, it's peerless," says Paspaley, who heads a family that produces a major amount of the prized South pearl.

World demand is growing but the industry—unlike gold and diamonds—lacks advertising dollars to educate the market and boost the pearl's profile, he says.

"Apart from being very beautiful and discreet as jewellery, pearls are also affordable," Paspaley says. "Sure, there are particularly exquisite strands, such as one of ours which was reputedly bought for $ 3 million at a New York auction by Frank Sinatra, but this is rare. Unfortunately, the market is uneducated about pearls and most people don't know a real South Sea pearl from a Japanese cultured pearl".

Paspaley says recent "misleading comment" about the economic health and destiny of Australia's pearling industry is mischievous. "It isn't vulnerable to overseas competition, it's not about to collapse and it's not reluctant to embrace new technology to lower costs and boost production," he says.

Showrooms

He ought to know. Paspaley employs more than 400 workers, operates nine pearls farms between Broome and Arnhem Land and has seven pearling vessels. The company also has the only three South Sea pearl retail showrooms in the world, in Darwin, Broome and Sydney.

"Our turnover has been increasing over recent years through continual improvement in our pearl farm methods and technology", he says. "In fact, this company pioneered the pearl farming methods which are now widely employed by other producers around the world."

"Australia's shell beds", he adds, "are the world's largest and supply 250,000 pearls a year—half the world production of South Sea pearls." Indonesia produces virtually all the rest, with insignificant volumes coming from Burna, Thailand and the Philippines.

Australia's export income from pearls is worth about $150 million wholesale. And, of the dozen or so local producers, Paspaley is the biggest, accounting for 60 per cent of domestic production.

There are only about twenty Australian operators. Most are small companies, dwarfed by the Paspaley concern. Western Australia's Kailis family, which has farmed pearls in Broome since 1976, is the second largest.

Indonesia's large production and low labour costs don't worry Paspaley. "We produce a better pearl and providing we continually improve technology and contain costs, our industry won't be threatened," he says. He recently invested $ 9 million in a floating unit he calls "a state-of-the-art lab unrivalled by any other pearl producer in the world".

Spat

Paspaley dimisses as fanciful claims that South Sea pearls can be produced more cheaply from shell grown in hatcheries (called spat)—rather than taking mother-of pearl off the sea floor and transferring it to farms.

While spat is grown in Indonesia and northern Australia, he says it is irrelevant to the Australian industry.

"It takes two years to obtain a pearl from mother-of-pearl shell and four years if you use spat—and the product is inferior." Only if disaster struck our natural beds—in the form of disease, cyclones or pollution—would spat be in demand.

"The greatest threat to Australia's pearl beds has been overcome by government shell quotas," says Paspaley. "In the early days, the industry was almost wiped out by overfishing on more than one occasion. But quotas, which can be bought and sold on the open market, have saved the industry."

Divers

George Kailis calculates that his company produces about 10–15 per cent of Australian pearls,

with divers catching "wild" off ocean shell beds for farming.

He has been investigating hatchery-grown spat for years but acknowledges that research is unlikely to affect current farming methods for many years—if ever.

"Pearl farming is still labour-intensive but methods developed by the company since the '70s have dramatically cut manual input," Paspaley says. For instance, each shell used to be cleaned and have barnacles removed by hand every few months; Paspaley has developed a machine to do the job.

And, as farming has become more sophisticated, productivity has increased tenfold since 1980. Pearl quality also has improved significantly.

Costs

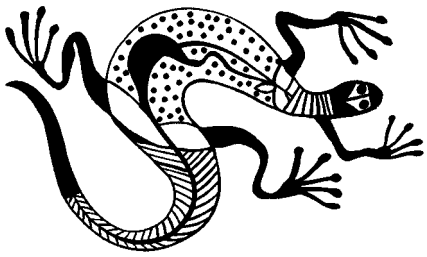
Kailis agrees with Paspaley that the industry has a sound future providing costs are minimised and technology enhanced. "There's no doubt the future of our industry revolves around the continued production of hight-quality pearls, which is precisely what our company and Paspaley are doing," Kailis says.

Paspaley—who each year spends months at sea with his fleet—says the size and quality of his crop enables the company to tailor supply to specific markets. Major South Sea pearl buyers are the Japanese, who take 40 per cent, followed by US, Hong Kong and European dealers.

"We never sell raw pearls to the market but we add value by mixing and matching product and designing strands, which means sorting through tens of thousands of pearls to find the right colour, size, shape and lustre", he says.

"No other firm in the world has the quantity to do this. Even though Australian has high labour costs, high regulation and high tax, we're still the best producers in the world, and that won't change".

Source: *The Bulletin*, 8 December 1992.



Bynoe Harbour Pearl Farm moving to hatchery-reared stock

By: David "DOS" O'Sullivan

The Bynoe Harbour Pearl Farm (BHPF) is situated in the major inlet of the same name about 1.5 km drive south of Darwin. The farm is a jointly-owned operation of ex-pearl diver Adam Miocevich, John Arrow and Steve Arrow, who also has shares in a Darwin pearl hatchery.

The farm was started in 1987, and is spread out over several square kilometres of Bynoe Harbour.

The base of its operations is at Ranking Point, which overlooks the three cultivation areas.

BHPF use the longline system to grow their pearls. These consist of 28 mm medium-lay polypropylene surface lines supported by buoys every two metres. The surface line runs for 100 m and is held in place by a 70 m anchor line at each end. Concrete blocks or train wheels are used as anchors. According to farm manager Wayne "Mango" Mangan, the 800 kg train wheels are the best as they sink into the mud bottom for a metre or so. "They have a lip around the edge of them, and when this drops into the mud it forms a suction. This makes them very difficult to move".

Wire-framed net panels of Nylex plastic mesh are used, built with pockets to hold the shells. The mesh is cut to form an envelope around the wire frame.

Plastic twine is used to form sections in the mesh. Stainless steel Maspo clips are used to hold the mesh onto the frame. These clips are also used to patch up any holes with small pieces of mesh.

Once the shells are in the panels they are too large for any predators to eat them. The only losses are due to old age, although there can be probems with worms which burrow into the shells.

There is also a burrowing sponge (called "redarse") which eats away the shell making it brittle. Any shell that fallout of the net panels are lost in the mud. For these reasons plastic ties are used to close the pockets in the panels.

The panels are suspended about 1.5 m below the surface. Usually six larger shells are held in each panel which are spread 1 m apart along the lines. Smaller hatchery reared shells can be held in specially made inserts in lots of 15 or 24 depending on their size.

The average spring tides in the Harbour are 7.1–7.2 m although the highest can be 7.8 m. This means that there is very strong tidal movement. The longlines have always been run along the currents. However one line has been set across to current to see how well it gives.

Mango said that the net panels holding the shell can become tangled. "With the tides the panels can be pushed up in the water towards the next one in line. If they swirl around they can become entangled. The line across the current means that the panels all are pushed up in parallel lines so hopefully they won't tangle."

Hatchery seeds

Rather than paying for divers to collect the shell for seeding, BHPF has been buying hatchery reared seed for the past three years. These are provided from the Darwin Hatchery Project at Stokes Point.

The 1–2 mm seeds are transported from the hatchery in crates. At the farm they are placed in small mesh envelopes or pockets and held inside a 4 m x 4 m x 5 m deep cage. This cage floats in water and provides protection for the divers from sharks and crocodiles which are common in the area.

The seeds are regularly checked and graded. As they increase in size they are transferred into larger mesh holders. Mango said that the majority of their losses occur in the first few weeks on the farm. "The oysters have a foot and are quite mobile," he said. "We call them escape artists as they are very hard to keep in the pockets. This is a problem until they are about 5–6 mm."

In addition to losses from seeds escaping, the seed can also be eaten by small crabs which crawl into the pockets. If the pockets are not correctly maintained then all the seed can shift into one area, causing some of the oysters to suffocate from lack of oxygen or starve from lack of food.

At 20 mm the oysters can be transferred into the net panels. These are also held in the cage until the oysters have reached about 40 mm, by which time the panels can be moved onto the longlines. It normally takes about two years for the oysters to grow to a size large enough for seeding.

The small oysters are regularly cleaned with a deck hose and a scrubing brush to keep the shells and ponds free of mud and fouling organisms such as barnacles, sea squirts and seaweeds.

Once they reach about 40 mm the shells are strong enough to be cleaned by machine. Net panels are placed onto a conveyor belt which takes them into the centre of the machine to be blasted by high-pressure water jets.

The panels can then be returned to the water. At BHPF they have set up a series of granty cranes to enable the panels to be lifted out of the water and put through the washer while still attached to the longline.

After washing, the panels are checked and any holes are fixed. If there are barnacles or other fouling organisms which have not been removed by the washing process, hand chisels are used to knock these off.

The main barnacle-fouling period is during the wet season, when the cleaning programme switches into action after each full moon. During the dry season the farmers don't need to clean for about three months. For the cleaning, which takes about five days, there are two shifts.

The first is from 7 a.m. until 1 p.m., the second from 1 p.m. until 7 p.m. For each shift, three workers are on the cleaning barge.

All the longlines, floats and droppers are checked during cleaning, and any damaged equipment is fixed. Dead shell is removed, and counts are kept for each line to maintain an accurate inventory.

According to Mango the cleaning can be done even in bad weather. "When storms move up the Harbour, the swell can rise to 1.5-2 m. If it gets too rough, we just tie alongside the line and wait for it to blow over."

Seeding

At BHPF, both cultured (round) and half pearls (mabe) are produced. The cultured pearls require skilled technicians, usually Japanese.

"A good technician can do around 500–600 shells/ day, so with three technicians around 1,500–1,800/ day is possible. The first operations take a little longer than re-operations, which involve the removal of the pearl, and insertion of a similar sized nucleus. August is the best month for seeding."

About two years are required to deposit 4 mm of nacre. The shape of the pearl sac is critical. If the pearl sac is round then the pearl will be round. So a special programme of turning (or tento) is used after the shells have been seeded.

The shells (six at a time) are held in mesh cages—similar in design to the Japanese lantern nets—hung below a longline. Every three days these cages are turned upside down. After 28 days the shell can be put into the net panels.

With good technicians, a well-run tento period and regular cleaning and maintenance, around 30–50 per cent of the seeded shell will produce pearls.

The move into the hatcher- reared seed will start to pay dividends in 1997 when the first crop of cultured pearls can be harvested. Not only will the numbers of shells held be able to be increased over the quota, but Mango says that the hatchery-reared shells are much easier to handle. "They get used to being handled every month or so."

Source: *Austasia AquacuIture:* 8 (4)

Shark Bay – Exmouth – Carnarvon pearl farming status

The Gascoyne region (Shark Bay, Exmouth and Carnavon) began its involvement with aquaculture in the 1850s, with Shark Bay becoming the site of Western Australia's first pearling industry. There are now only three working pearl leases in Shark Bay. This figure can be compared with the industry's peak period where in excess of forty leases were worked in the Bay.

Pearl culture was the only form of aquaculture in the region up until the mid-eighties, when an oyster hatchery and grow-out facility was established in Carnarvon.

Presently, the Gascoyne region is quite well represented by aquaculture with seven ventures operating within the region. These ventures include Western Sea Farms, located on Oyster Creek, Carnarvon. Originally, the farm concentrated on the production of edible oysters, but decreasing returns on oysters forced the company to diversify. The farm is now predominantly involved in pearl spat production (*Pinctada maxima*).

Exmouth's Wa Clams were involved in the culture and grow-out of giant clams until August 1993 when all the clams were mysteriously poisoned. The proponents have applied to the Fisheries Department for a licence to collect more broodstock from the wild. Heritage Pearls are located on Cape Rose, Monkey Mia. The company is involved in the seeding of adult Shark Bay pearl oyster *Pinctada albina*. Cultured pearls are then sold in their newly opened shop in Denham.

Peter Cope has Shark Bay's second pearl lease, which is situated near Herald Bight. Mr Cope is involved in the culturing of *Pinctada albina* pearls, but also has approval to place oyster spat collectors near Dirk Hartog Island, Shark Bay. These spat collectors will be used to collect juveniles of the blacklip pearl oyster *Pinctada margaritifera*, which produce the sought after black pearl. Collection of adult *Pinctada margaritifera* shell is restricted within the Bay as shell numbers are severely depleted. The only means of culturing this species in Shark Bay is by collecting the spat.

The Lagoon Pearl have the third pearl lease which is situated at Red Cliff Bay, Monkey Mia. The company also culture *Pinctada albina*, with the seeding operation currently performed on an off-

shore pontoon. Exmouth Gulf has several pearling leases, owned by two separate companies. Only one company, Exmouth Pearls, actually performs culturing operations in the Gulf. The other lease sites, owned by Morgan and Co., are farmed with the removed shell cultured at a site near the Monte Bello Island.

Opportunities

The Gascoyne region has been identified by several sources as an area suitable for aquaculture, so it is not surprising there are many proposals being evaluated.

Source: *Austasia Aquaculture* 8(6)

Pearlers face ruin

Queensland's pearl farming industry faced eventual collapse if pearl farmers did not start using new farming methods, industry leaders said in November 1995. Some in the industry also wanted protection and replenishment of natural pearl-shell beds to help save the Queensland industry.

"The industry has problems because the amount of wild shell in the Torres Strait is very limited," said the secretary of the Queensland Pearl Industry Association, Dr Bruce Stevens. "Very few boats are going out in the Torres Strait to collect shells this year because stocks are so depleted". In Western Australia, around 550,000 wild shells are collected each year. However, in Queensland this figure is "much less than 100,000", according to one farmer. Farmers said pearl shell beds had been depleted largely by trawling activities which had upset the sea bed. They said that natural pearl-shell beds had always been protected in Western Australia and the Northern Territory.

Hatchery shell had been farmed in the Fitzroy Islands for the past four years, but has only become viable in the past six months. Despite its use in other pearl-growing countries, like Indonesia and Japan, Queensland pearl growers had been reluctant to start using hatchery-grown shell.

"It's something new for Australia," said an officer with the Northern Fisheries Centre in Cairns. "Until now the supply of hatchery shell in Queensland hasn't been reliable. Then it usually comes to the farmer smaller than wild stock and farmers have to keep it for a year before they can use it. It has also been traditional in this industry for farmers to hold knowledge closely to themselves because of the high costs of research and development to the individuals."

"This has also slowed the adoption of hatchery shell, although this tradition is breaking down with the formation of the Queensland Pearl Industry Association six months ago. But we can't rely entirely on hatcheries. We also need wild stocks." One farmer said there had been problems in Japanese hatcheries caused by inbreeding. He said this was adding to some Queensland operators' reluctance to use hatchery shell despite a lack of this problem in Queensland.

Source: *Sunday Mail*, 12 November 1995

Bivalve broodstock developments in Japan

By: Kaysuhiko T. Wada, National Research Institute of Aquaculture, Nansei, Mie 516-01, Japan. Telephone: 05996 6 1830; Fax: 05996 6 1962.

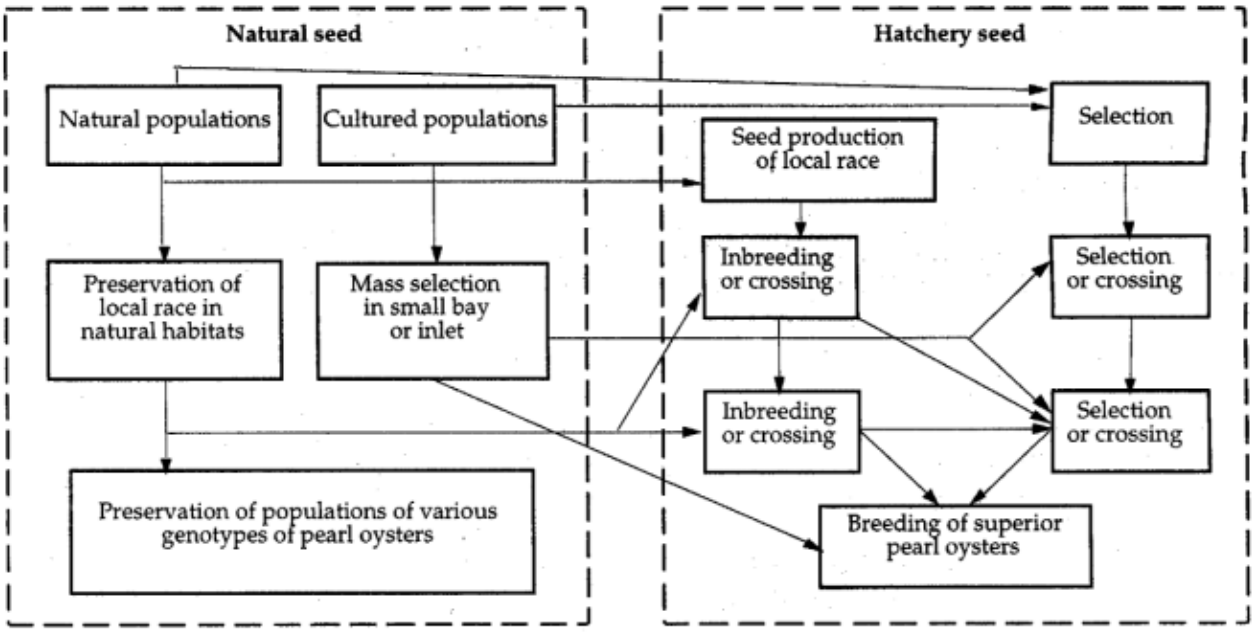
Bivalve mollusc production in Japan has come mostly from natural populations, so seed for fisheries has depended on natural sets. Transplantation of natural seed has been the principal method used to enhance wild stocks of oyster, scallop, clam and pearl oyster, the major bivalve species in Japan. Clams and oysters have been transplanted for centuries to enhance the wild stocks, and unexpected fluctuations in wild spat production have occasionally motivated the development of hatchery techniques.

Recent development of techniques for genetic improvement has provided further motivation for the artificial production of seed. Since the start of the Japan Sea Farming Association (JSFA—a government-supported organisation with many seed production centres and networks in Japan) the seed of many marine species has been produced primarily for stock enhancement.

Japanese species of peaneid prawn and red seabream were the first to be produced in hatcheries in this project, and now more than 50 species are being produced in the 15 hatcheries operated by JSFA. In addition, prefectural and local governments and fisheries cooperatives have started similar centres that now produce seed for local farmers and fishermen, and many private farms produce the seed of marine fish and shellfish for intensive cultivation in net pens, cages and rafts.

Most bivalve seed is currently produced in these local seed production centres or on private farms using methods similar to those employed in other countries. This paper reviews the present status and future of marine bivalve broodstock development in the hatcheries of Japan. Bivalve production comprises a significant component of Japanese aquaculture in both value and weight. In 1990, 260,000 metric tons of oyster (in the shell) and 18,000 metric tons of scallops were produced by Japanese aquaculture.

Scallops are also harvested by the capture fishery (an additional 19,000 metric tons in 1990). In value, pearls and pearl oyster were the most important (736,000 million yen in 1990), followed by scallops (363,000 million yen), and oysters (312,000 million yen). Clams from the capture fishery were worth 232,000 million yen. Seeds of nine species of marine bivalves have been artificially produced for intensive culture and eight species have been produced for enhancement of wild stocks.



Proposed diagrammatic schema of breeding or preservation of pearl oyster (Wada, 1984)

The average number of spat produced by hatcheries annually between 1984 and 1989 for intensive aquaculture was: Japanese pearl oyster *Pinctada fucata* (61.8 million); the noble scallop *Chlamys senatoria nobilis* (5.5 million); ark shell *Scapharca broughtonii* (5.0 million); the penguin wing oyster *Pteria penguin* (1.0 million); silverlip pearl oyster *Pinctada maxima* (0.9 million); and blacklip pearl oyster *Pinctada margaritifera* (0.3 million). Genetic research programmes such as selective or cross breeding and chromosome manipulation are being conducted in pearl oyster, noble scallop, ark shell and cockle. The feasibility of producing triploid animals in the Japanese environment is being studied in most of these species, particularly oysters.

Selective breeding is being done with the pearl oyster and noble scallop. The noble scallop has many heritable variations in shell color, and local farmers are producing different colored strains for the seafood gourmet. Many traits of the pearl oyster have been studied through selective breeding and crossbreeding. Most are shell traits considered to be important in the consistent production of high grade pearls. Recently, a broodstock development strategy was proposed for seed production of the Japanese pearl oyster (see diagram on facing page).

Source: *World Aquaculture* 24(3), September 1993

The museum on Mikimoto Pearl Island

By: Tom Wray

Mikimoto Pearl Island, at Toba on the Pacific coast of Japan's main island of Honshu, is the place to go to find out all about pearls and their culture. The place is a monument to Kokichi Mikimoto (1858–1954), who devoted his life to producing cultured pearls and, after irritating a lot of oysters with a variety of objects, finally succeded in the late 19th century. He went on to build a world famous business based on cultured pearls.

Mikimoto Pearl Island is a tourist attraction connected to the mainland by a bridge. A museum on the island demonstrates all the oyster culture techniques. These include growing and seeding of mother shells, culture, harvest and processing of cultured pearls. Also demonstrated are the selection, drilling, and threading of finished products.

The main variety of oyster cultivated for pearls is *Pinctada fucata*, but there are several others, the life histories of which are all detailed at the museum, which also shows what can be done with pearls. It contains a large number of items of jewellery, as well as larger works such as a reproduction of the Liberty Bell, using 12,000 pearls, exhibited at the New York World Pair in 1939.

Mikimoto Memorial Hall, built on the island in 1993 to commemorate 100 years of cultured pearls, details Kokichi Mikimoto's life and interest. The exhibition traces the 96 years of his life against the background of the times in which he lived and the wider world around him.

Pearls had long been a speciality of shima province. The large ones were scarce, and most were small seed pearls called "keshi". Because powdered pearls were used as medicine in China, seed pearls were traded at high prices and the stock of natural pearls began to decrease due to over fishing.

Persisted

Kokichi experimented through trial and error, trying to find out for instance what to put in the oysters to seed them. After inserting a nucleus into a shell, he would return it to the sea. On retrieving it three months later he would open it only to find it unchanged. But he and his wife persisted. One day on Ojima Island, as they worked under the hot sun opening oysters, his wife, Ume cried out "At last".

A pearl glittered in one of the oysters, in her hand. It was 11 July 1893 when the world's first five cultured pearls were obtained. Those pearls were hemispherical in shape, attaching to the inner surface of the pearl oyster shells. Kokichi obtained the patent for hemispherical pearl culturing in 1896. He then applied himself actively to the business. He harvested his first pearls in 1898, and his second harvest two years later yielded 4,200 hemispherical pearls.

Around the turn of the century, there were many pearl specialists, all searching for a method of raising perfectly spherical pearls. Kokichi was

assisted in his research by a former dentist, Otokichi Kuwabara.

In 1905, the dreaded red tide occurred again in Ago Bay, destroying all 850,000 oysters at the Tatokujima Island site where Kokichi had taken a lease. He nevertheless opened every one of the dead oysters, and found five round pearls among them. The destruction of the oysters was a disaster, but the five spherical pearls taught him where to place the nucleus. Kokichi had earlier opened Japan's first pearl dealer's shop in Tokyo, and within a few years had moved to the fashionable Ginza.

In 1919, Kokichi sent round pearls raised at one of his farms to London for the first time, selling them at 25 per cent less then the price of natural pearls. European jewellery dealers, afraid of pearl devaluation, instituted a lawsuit claiming that cultured pearls were imitations. But they were proved to be essentially the same as natural pearls by eminent English and French scholars, resulting in the worldwide spread of the name Mikimoto Pearls. Meanwhile, as the number of dealers increased, inferior pearls began to appear on the market, resulting in complaints from overseas customers.

Farms closed

In 1932, Kokichi, who had assumed office as the President of the Japan Marine Pearl Association, burnt 720,000 such pearls in front of the Kobe Chamber of Commerce in order to re-establish the international reputation of the cultured pearl. In 1940, the pearl-culturing business, together with the sale of jewellery, was banned. In 1941, with the outbreak of war against the USA, overseas shops were closed and Kokichi retreated to Tatoku.

The pearl culturing business was slow to pick up after the war, but before he died in September 1954, Kokichi witnessed the rebirth of an industry in which Japanese producers led the world.

Source: *Fish Farming International*, March 1995

Pearly shells

Beatrice Burch, of the Bishop Museum, has just completed a series of articles in the Hawaiian Shell News *on pearl oysters. To follow are excerpts from the first four articles. We will publish the excerpts from the remainder in the next issue of the* SPC Pearl Oyster Information Bulletin. *For those who simply can't wait that long, you can write to Beatrice at: P.G. Box 309, Kailua, HI 96734, USA, Fax: (808) 263640 or e-mail <tab@hits.net>. See also Beatrice's contributions in the Abstracts section, page 43.*

Living bivalves: origins and relatives

Pearly shells have been around for a long, long time. Geological time scales are determined by the fossils found in rock layers in mountains or in layers in deep-sea sediments. Especially in the last twenty-five years, new techniques for both geologically-recent and fossil shells have used shell structures as seen using scanning electron microscopes which have photographed the amazing microstructures.

By analysing these microstructural characteristics, researchers have refined relationships between families and superfamilies, and traced back in time how earlier groups gave rise to more modern species. Although shell microstructure was known to palaeontologists in the early and middle 1800s, the newer scanning electron microscopes with their photographs have shown even more detail than was possible before.

There are about 8,000 living bivalves. Of these, about 2,500 species are nacreous, forming an interesting sub-group of bivalves. However, nacreous bivalves are rarely found outside the shallow tropical marine environment, although some live at great ocean depths, and a number are restricted to cerain areas.

Nacre is formed by one variety of organically-formed calcium carbonate which, with a few minor chemicals, composes the shells of mollusc. Geologically speaking, crystals are formed in certain shapes specific to the chemical bonds of the combined elements forming the minerals.

Calcium carbonate is intriguing mineralogically, as it appears in shells or in nature in the form of two shapes of crystals, one called aragonite (with orthorombic cleavage), which is of greater density

than the other form, which is calcite (with rhombohedral cleavage).

These two forms of calcium carbonate are distinguished readily by their crystal shapes. Only aragonitic layers are able to form in sheets that reflect and refract the pearly lustre, called nacre. Only nacreous layered shells are able to form pearls accepted as gems. All shells of aragonite are able to form concretions, sphericalor in other shapes, but without nacres, these do not have the luster and light that goes to make the beautiful pearl layers. "Pearls" are known from non-nacreous bivalves such as seen in *Mercenaria mercenaria*, a venerid, and the amorphous immense masses found in *Tridacna*. These latter are zoologically interesting, but are not the gemstone "pearl".

Aragonite crystals in bivalves occur typically in three layers: the innermost layer is in sheets of spheroid forms of nacre, or mother-of-pearl. The outer aragonitic layer is usually arranged as crossed lamellae, and the middle layer is usually complex-crossed lamellae crystals. Each layer is distinctly different in shape, and the nacreous layer in some bivalves is thin, so that the layer is only subnacreous. Some of the oldest known bivalves belong to these purely aragonitic families.

The order Palaeotaxodonta is known from the early Orodivician (see Table 1), but may have originated in the Cambrian. It is the oldest group of nacreous bivalves known, but also includes the non-nacreous Solemyidae and the subnacreous Nuculanidae. As geological time moved along, some shells were no longer composed just of three hard layers of aragonite but, under the ever-present outermost horny layer (epidermis), the outer shell layer was calcitic, leaving the two inner layers still aragonitic. These were not nacreous, only subnacreous.

The next oldest order is the Pteriomorphia, which is known from the middle Ordovician, but also may have originated in the Cambrian. Until recently, Pteriomorphia included the superfamily Mytilacea, but this has now been separated from Pteriomorphia. The order Pteriomorphia is composed mostly of shells with the outer layer being calcitic, and though some have aragonitic middle- and inner-layered shells, the middle layer is separated from an inner nacreous layer.

The superfamily Pteriacea originated in the middle Ordovician, and includes today's heavily nacreous pearl oysters, Pteriidae. The thin, pearly-layered Pinnidae are in the superfamily Pinnacea, which branched from the Pteriacea in the Silurian. The calcitic Pectinacea, which once in the geological past were nacreous and had pearls (Waller, personal communication), branched from the Pteriacea in the upper Ordovician.

Table 1: Origins of known living nacreous bivalves

Epoch	Million years Ago	Orders	Superfamilies
Cretaceous	145.6	Pholadomyoida	Poromyacea Clavagellacea
Jurassic	208	Pholadomyoida	Pandoracea
Permian	290	Heteroconchia	Unionacea
Silurian	439	Isofilibranchia Pteriomorphia	Mytilacea Pinnacea Pectinacea
Ordovician	510	Pholadomyoida Heteroconchia Pteriomorphia Palaeotaxodonta	Pholadomycea Trigoniacea Pteriacea Nuculacea
Cambrian	570	?	?

Note from the publisher: The final report in this series will be an annoted bibliography of all papers used in the series. Therefore, references were not attached to the texts.

Modern nacreous bivalve families are all aragonitic, mostly thin-shelled species with two-to-three layers of simple or complex aragonite as an outer layer protecting the inner nacreous layer. Most are small bivalves, but vary in size from the giant two-foot *Pinna nobilis* to the minute 1 mm Pristiglomidae, which are also nacreous. Not all are thin-shelled. Some are heavy shelled such as the 15-inch pearl oyster and some heavy Unionidae, Amblemidae, and Margaritiferidae. The 27 nacreous and two subnacreous bivalve families contain over 2,800 species out of about 8,000 bivalve species, according to Boss (1982).

Distribution of nacreous and subnacreous bivalve genera and species

Nacreous bivalves are found in as many environments as are non-nacreous species. They are found in marine, estuarine, and freshwater habitats around the world.

Commercial bearing bivalves include approximately 20 species of North American freshwater mussels, six freshwater mussels found in Europe, China, Japan, the Philippines and in Vietnam, and nine species of marine pearl oysters of the tropics and subtropics which are used for pearl culture. All of these have natural pearls or are used for mother-of-pearl in various objects of beauty which are used by many cultures throughout the world.

The table on facing page lists the numbers of genera and species in each of the nacreous and subnacreous bivalve families. This is taken primarily from Boss (1982) which deals far more intensively with the family characteristics of all molluscs, and from Morton (1985).

Pearly shells: *Monoplacophora, Gastropoda* and *Cephalopoda*

Runnegar and Projeta (1985) suggested that the ancient limpetlike, *Monoplacophora* gave rise to gastropods, cephalopods and the fossil *Rostroconchia* which, in turn, gave rise to bivalves and scaphopods during the later Pre-Cambrian or early Cambrian. Most Cambrian molluscs were minute to small. Runnegar and Projeta (1985) showed a steady size increase of molluscs through the Paleozoic and Mesozoic, from the minute sizes found in the Cambrian. Reasons for this have not been explained.

The class Cephalopods goes back at least to the Cambrian. All have nacreous representatives. The only nacreous cephalopods that are still living, however, are *Nautilus* in Nautiloidea and *Spirula* in Coleoidea. The pearly-shelled *Spirula* (Linnaeus, 1758) is a floating warm-water dweller, and its inch-long dead shells occasionally litter beaches in Florida, Africa and the Indo-West Pacific.

The nacreous shell of the Nautilus is as gorgeous as any white mother-of-pearl from *Pinctada maxima*. The shell itself has been made into beautiful modern jewellery, and has been used by the native peoples of Fiji and the Solomon Islands in inlay work. While the outermost coat of the Nautilus is color streaked, the comparatively thin aragonitic shell is beautifully nacreous.

Nautilus lives in the far western Indo-Pacific where it may be locally abundant in deeper water, but it does rise nocturnally to the surface waters during part of its life. Similar to the *Spirula*, its dead shell is buoyant, and drifts far from where the animals live.

Gastropods have only five families with nacre: Pleurotomariidae, Turbinidae, Trochidae and the large turbans and trochids in the western Indo-Pacific, which are used to make buttons and other objects as curios because of their lovely nacre. As well as *Haliotis*, both Turbinidae and Trochidae are being widely transplanted and successfully grown in areas where they formerly did not exist.

Gastropods, as well as bivalves, have pearls of great oddity and beauty. *Haliotis* may have baroque shaped pearls which are irregular, while another resembles an enormous canine tooth with brilliant greens, blues, and yellows. Some of these tooth-like "pearls" are so enormous that it is difficult to imagine the shallow-shelled, flattened, ear-shaped abalone containing them. Abalone seldom have spherical pearls, although they are known from the smaller subspecies of *Haliotis kamtchatkana* (Jonas, 1845), from off the Chinese coast. The abalone pearls from *Haliotis* off the west coast of North

Distribution of nacreous bivalve genera and species

ORDER SUPERFAMILY FAMILY	GENERA	SPECIES	EPIFAUNA OR INFAUNA	FOOD	HABITAT	AREA	DEPTH
Palaeotaxodonta							
Nuculacea							
Nuculidae	7	150	infauna	detritus	marine	temperate Tropical	shallow deep
Pristiglomidea	3	4	infauna	detritus	marine	cosmop.	deep
Isofilibranchia							
Mytilacea							
Mytilidae	52	250	epifauna infauna (boring)	filter feeder	marine brackish	temperate tropical cosmop.	shallow deep
Pteriomorphia							
Pteriacea							
Pteriidae	4	20	epifauna	filter feeder	marine	subtropical tropical	shallow
Malleidae	2	15	epifauna	filter feeder	marine brackish	subtropical tropical	shallow
Isognomonidae	3	20	epifauna	filter feeder	marine	temperate subtropical tropical	shallow
Pulvinitidae	1	1	epifauna	filter feeder	marine	Australia	shallow
Pinnacea							
Pinnidae	3	20	infauna	filter feeder	marine	subtropical tropical	shallow deep
Heteroconchia							
Trigoniacea							
Trigoniidae	1	7	infauna	filter feeder	marine brackish	Australia	shallow deep
Unionacea							
Unionidae	73	1,200	epifauna infauna	filter feeder	fresh water	temperate	shallow
Margaritiferiidae	11	11	infauna	filter feeder	fresh water	temperate subtropical	shallow
Amblemidae	60	100	infauna	filter feeder	fresh water	temperate	shallow
Hyriidae	16	?	infauna	filter feeder	fresh water	S. America Australia New Zealand	shallow
Mycetopodidae	9	?	infauna	filter feeder	fresh water	S. America Cen. America Mexico	shallow

From: Boss, K. (1987). Molluscs in Parker, S., editor, Synopsis and Classification of Living Organisms, vol.1: 945–1166, McGraw Hill, New York

Morton, R. (1985). Adaptive radiation in the anomalodesmata, in Trueman, E.R. & Clarke, M.R. editors, The Mollusca vol.10, Chapter 9: 405–459. Academic Press.

America seldom have spherical pearls, as they enlarge rapidly into bizarre shapes. Those pearls are scarce, maybe one in 10,000 shells that divers find while collecting abalone for food.

Shell concretions are also found in the non-nacreous but highly porcelanous shells of *Strombus gigas* (Linnaeus, 1758) of southern Florida and throughout the Caribbean low water. The interior of the shell varies in pastel colors, ranging from white, to tan, beige, pale green, salmon pink, and rose pink, and secretes concretions that are usually ovoid, and with amazingly different "flammules" in the interior of the pearl.

Exquisite conch "pearls" (the term pearl is restricted by the American Gemological Society to pearl from shells with nacre (Federman, 1992)), contain visible rows of tiny flammules. The flammules are primarily visible in the pink or salmon shades, from 1-4 mm, with a few larger sizes of 6-12 mm. One 25 mm specimen has been reported (John Garcia of Key West, Florida, personal communication).

Modern jewellery made with conch pearls is lovely and deeply treasured, as these "pearls" are uncommon, being found one in every 15,000 shells. According to Kunz and Stevenson (1993), this jewel was also immensely popular during the Edwardian years with European royalty and other wealthy collectors.

Sadly enough, this gemstone should be worn primarily at night, as it is unusually sensitive to ultraviolet light and will fade with prolonged exposure to sunlight.

Because *Strombus gigas* has been overfished in the United States, they are now considered threatened, and fishing for them in Florida has been closed. All conch pearls now come from conch meat canneries in the Bahamas, Bermuda and other Caribbean countries.

Source: *Hawaiian Shell News*, February 1995, March, April and May 1995

Production of black pearls in Vanuatu commences

After three years of work and planning, a local company, South Seas Pear ling, has commenced a pilot project for the production of black pearls in the waters of Vanuatu. Currently, no pearls are grown here, though the species of oysters does exist.

Black pearls are a major source of income in French Polynesia and the Cook Islands, second only to tourism, and so this project is seen as having the potential to assist in the long-term development of Vanuatu's economy. The project is the result of a collaboration between Gavin MacSporran, joint-owner of the La Villa shops and member of the International Pearl Association, and John Williams, an investor from Australia. It is the "flagship" of a series of aquatic-based industries the company intends to develop.

The project brings together the expertise of the operators, the communities around Sunai and Moso, on Efate, though some four other island sites have been identified and will be surveyed shortly.

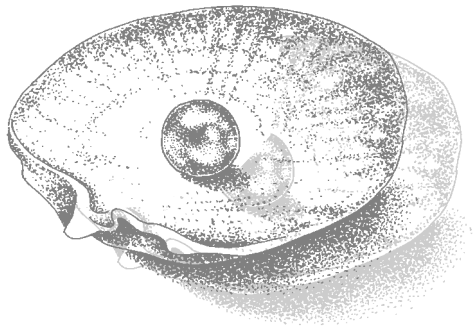
A major feature of this project is that it seeks to involve the communities in an opportunity to develop, with assistance, this natural resource, thus keeping both employment an income at an island level. Further, the company will manufacture and wholesale finished jewellery, thereby increasing skill-based employment and keeping a significant value-added component in Vanuatu. The project has the support of, and a close working relation-ship with, the Fisheries Department. The intention is to exchange data gathered by South Seas Pearling to determine later if a pearl oyster industry is viable in the country.

The research base will be developed near the first farm and nursery. In Vanuatu, much of the wild stock of oysters has been fished out. As a result, the major part of the project is directed to restocking the reefs and the growing out of the young oysters in "farm environments".

It is the company's intention to survey the waters of Vanuatu's Islands, and they will welcome any interest the island communities may have in being involved, and can be contacted at Box 1099, Port Vila.

Source: *Vanuatu Trading Post*, 11 April 1996.

PEOPLE, PRODUCTS AND PROCESSES



Philippines query

Daisy Ladra (C/o BFAR, 860 Arcadia Bldg, Quezon Ave, Quezon City, Philippines) enquires:

"I would like to enquire if you can link me up with some scientists involved in pearl oyster diseases. I am currently doing a project along this line, and it is something very new. Is there any potential for collaborative work between other laboratories and scientists such as myself from developing countries?"

Chipping through the ice

A final note from the Leetown Science Center Newsletter *(14 February 1996), which reports on freshwater-mussel research. A short article on holding riverine mussels in ponds give pause for us, tropical-bivalve biologists, to appreciate the ambience of our working environment:*

In cooperation with the Virginia Cooperative Research Unit, West Virginia DNR, and the Ohio River Islands NWR, we are holding approximately 3,000 freshwater mussels from the Ohio River in 25-acre ponds. Species include *Elliptio crassidens, Amblema plicata, Quadrula pustulosa, Obliquaria reflexa, Potamilus alatus,* and *Pleurobema cordatum.*

During the summer, a quarantine site was established at the refuge on Middle Island where the animals were held before transporting to Leetown. There was good survival for all species during the summer quarantine, and survival in the ponds through November was high. Like other parts of the country, Leetown is experiencing extremes in weather conditions this winter.

Along with sub-freezing temperatures, we have had a 36-inch snowfall and a major flood. I hate to think what will come next. Though we have maintained a steady flow of reservoir water through all the ponds this winter, ice cover on the ponds has prevented us from checking survival of animals for the past two months. The floating units, made out of PVC pipe, appear to be holding up well so far, even with a coating of 4-5 inches of ice.

Source: US Department of Interior, National Biological Service, *Leetown Science Center Newsletter*, Aquatic Ecology Laboratory, 1700 Leetown Road, Kearneysville, WV 25430.

Red Sea pearl culture studies

Mr Mohammed Hamed Yassien from the National Institute of Oceanography and Fisheries (Suez Branch, P.O. Box 182, Suez, Egypt), is interested in contacting other scientist working on the biology of pearl oysters. He is currently working on species identifications, reproductive biology, and age growth and mortality of pearl oysters for his Ph.D. thesis.

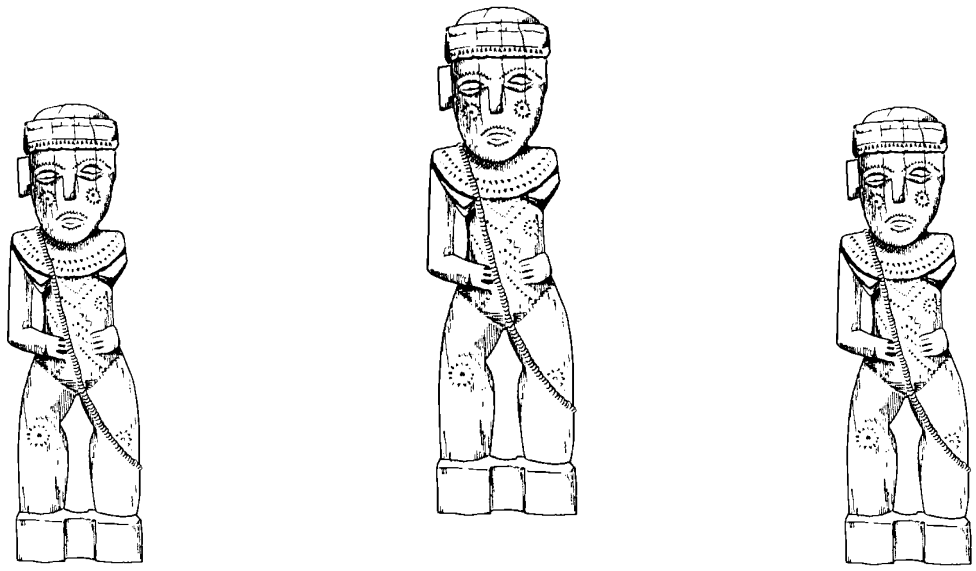
POSITION AVAILABLE

Philippines Pearl Oyster Hatchery Manager

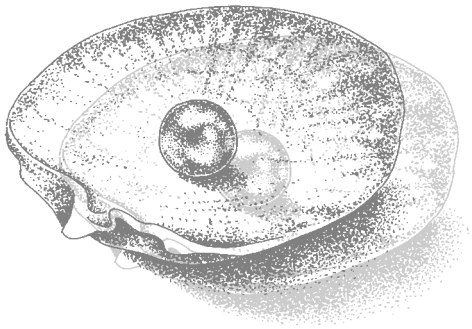
Black Pearls, Inc., a Hawaiian company, has a position becoming available in early 1997 for a pearl oyster hatchery supervisor to work in a remote location in the Philippines. We are looking for an individual with an exceptional commercial hatchery background, with developing country experience, and with a demonstrated ability to keep a team working together under challenging conditions. Experience in a commercial Pinctada hatchery is preferred, but a background in other bivalve hatchery operations will also be considered.

Duties will involve start-up, operation, and trouble-shooting of the hatchery, and training of local staff in all aspects of operation and maintenance of the facility. An attractive compensation package is offered, with potential for bonuses for attaining performance targets. Interested individuals should send a resume, with contact numbers for three referees, to:

Hatchery Manager Position
Black Pearls, Inc.
P.O. Box 525, Holualoa, Hawaii 96725



ABSTRACTS, REVIEWS AND CURRENT CONTENTS



Pearls, pearl oysters and pearly mussels in world literature

Beatrice Burch (see contact details on p. 36), of most prolific pearl penmanship, is compiling a series of reviews of books, highlighting the role of pearly mussels, pearl oysters and pearls in world literature. We present the first two of these reviews in this issue. More to follow.

Introduction

This is a series of essays united by the theme of pearl shells or pearls and the authors who wrote so eloquently on these subjects. The writings range from legends of American Indians, prophetic French science fiction, a modem orientalist from The Netherlands writing on an actual Chinese magistrate of the Tang Dynasty in China, other modem Americans who lived and wrote on Polynesians, a very modem grandmother writing on the southern Tennessee poor during the Great Depression, a late Nobel prize winner relating a Mexican folktale and a contemporary teller of adventure tales. What these authors share is an expression through pearls and pearl shells as symbols of beauty and of the hopes and dreams of the people and their families who come into contact with the pearls and the effects of struggle towards a goal in their lives.

The Pearl, by John Steinbeck, Penguin Books, 1992 edition, US$ 4.95. 90 pages, New York and London

Kimo, a poor Mexican pearl diver, found a gigantic pearl the size of a sea gull's egg in the old worked out pearl beds near La Paz. Knowing that it could bring him wealth to supplement his family's meager living, he was at first thrilled, then dismayed at what transpired when news of his discovery spread through the small town. After running away from the town, Kimo and his wife lost their baby son who was shot by thieves coveting the pearl. Kimo eventually finds a solution to the evil aroused by possession of the pearl. The lives of people in this area of former pearl richness, the country and the people are portrayed in the desert area of lower California in the very enjoyable non-fiction work *Sea of Cortez*.

This novel seems to be a true story, but it is so much like a parable that it almost can't be. This Indian boy is too heroic, too wise. He knows too much and acts on his knowledge. In every way, he goes contrary to human direction. The story (as told to the Sea of Cortez Expedition) is probably true, but we don't believe it, it is far too reasonable to be true. Folk tale or not, this simple story of good and evil is told powerfully in the Gulf of California setting, an area that the author knew well.

John Steinbeck lived from 1902–1968 and was author of 19 fiction works, 8 non-fiction works, 2 plays and 2 movies. He knew the La Paz area from his first book written in 1929, and again when he and Ed Ricketts collaborated on the writing of *Sea of Cortez* in 1941, an enjoyable account of their chartered expedition for collecting marine specimens for the Ricketts biological Supply Company in Monterey, California. These two Californians in the Monterey area were long time friends. Steinbeck's best known books were first on the Central California themes: *Tortilla Flat* (1935), *Of Mice and Men* (1937) and the widely admired *Grapes of Wrath* (1939). These were followed by his war non-fiction, then back to the Monterey setting with *Cannery Row* (1945), and *The Pearl* (1947). He received a Nobel Prize for literature in 1962.

The Black Pearl, by Scott O'Dell (1977) ed. US$ 3.50, Bantam-Doubleday-Dell Publishing Group, Inc., 1540 Broadway, New York, New York 10036. 96 pages.

This brief and satisfying version of a legend of pearling at La Paz, Mexico differs from John Steinbeck's *The Pearl* in mood, but with the uncanny still present.

Sixteen year old Ramon Salazar is the son of a captain of a five-boat fleet of pearling boats and divers. The legend unfolds with Ramon diving in the cave of the mythical giant manta ray where pearl oysters are found. The huge Manta Diablo with "eyes of the colour of ambergris and shaped like a sickle moon" and far bigger than the usual manta with wing span of 10 ft, was not just a superstition.

In the lagoon seven leagues from La Paz was the cave of this Diablo Manta of enormous size, appearing to be more than 10 paces across from wing-tip to wing-tip, and to weigh more than two tonnes. In the cave, Ramon took a pearl oyster as long as his arm and thick as the boy's body, with several pearls the size of a pea and the great pearl of Heaven which turned out to weight 62.3 carats. A terrifying wind storm called chubascos (these occur in the northern part of the Gulf of California with tornado-like strength) later wrecked the fleet, and all were lost but one man from Culiacan, who forced Ramon to return to the cave for more oysters. Upon harpooning the Manta Diablo, vengeance is dealt to the villain. Ramon saves the pearl and replaces it in the cave. He then wonders what to tell his mother.

This popular book is on many award booklists, and is suggested for early teen reading. Reviewers for the *New York Times Book Review* also gave it fine reviews for the style, beauty of the writing and suspense-building as the plot unfolds. This Californian author is highly praised for his many delightful stories set in California and about Mexican people.

Australian fisheries research and development corporation: final reports available, and research projects funded

Automatic grading techniques for pearls are feasible, says Applied Sorting Technologies Pty. Ltd. It recommends a machine which would quickly pre-sort cultured pearls according to shape, colour and size, leaving the more difficult lustre and blemish measurements, initially at least, to a human grader. (FRDC 93/194 A$ 20)

The price of final reports within Australia, including postage, is between A$ 10 and A$ 40 a copy, depending on size. To order: phone (61 06) 285 4485—quote your Bankcard, Mastercard or Visa number—or post your cheque to: FRDC P.O. Box 222, Deakin West, ACT 2600.

Project funded from the Northern Territory Trust Fund: 95/131, Dr J. Luong-Van, Northern Territory University (Phone: 089466718). Tropical Australian microalgae as live food for the pearl oyster *Pinctada maxima*—end date: Nov. 96.

Project funded from the Victoria Trust Fund: 95/041, Dr L. Joll, Fisheries Department of Western Australia (Phone: 09 246 8444). Growth of pearl oysters in the southern and northern areas of the pearl oyster fishery and examination of environmental influences on recruitment to the pearl oyster stock—end date: June 98.

Abstracts

Electron microscope study of tissues which produce pearl-shell organic matrix, *by B.J.A. Vance, Marine Biology Department, James Cook University.*

Pearl oysters of the species *Pinctada maxima* (silverlip or goldlip pearl oyster), *P. margaritifera* (blacklip pearl oyster), and *Pteria penguin* (batwing pearl oyster), are all used in the Australian cultured-pearl industry, but *Pinctada maxima* is by far the most important economically. *Pinctada fucata* is of very little commercial interest in Australia, but was included in this study for comparative reasons.

While this project was specifically the study of the "electron-microscopy of tissues which produce pearl-shell organic matrix" it is part of a much larger study of these tissues, their secretions and the shell parts formed by their secretions. Also, it is an extension of several previous years' work on the light microscopy of decalcified pearl shells, and the tissues of the external mantle and mantle margins which produce them. To make this report intelligible, some of the results of previous work are included. Similarly, since this work has continued and is continuing, results obtained subsequent to the period of the grant are added where a more complete picture is achieved by their inclusion.

Pearl shells consist of two types of crystalline calcium carbonate. In both cases, the individual crystals are enclosed in organic matrices. These consist largely of sclerified glycoproteins. The pearl shell has three layers - an outer prismatic layer, and inside this, two nacreous layers. The outer prismatic layer consists of microscopic polygonal prisms, the long axes of which are normal to the surface of the shell. The calcium carbonate here consists of calcite crystals in the form of thickish tablets, whose largest parallel planar surfaces are normal to the plane of the long axis of the prism in which they are enclosed. The calcite tablets are separated from each other medio-laterally by lace-like sheets of organic matrix.

The outer nacreous layer lies against the inner surface of the prismatic layer, and the inner nacreous layer lies between the outer nacreous layer and the external mantle of the oyster. The calcium carbonate in both nacreous layers consists of orthorhombic prisms of aragonite twinned to form secondary shapes. These are invariably in the form of flat nacre tiles which lie in nacre sheets. Viewed medially, they may be of various geometric shapes, e.g. regularly hexagonal, diamond-shaped, etc. Each nacre tile is enclosed by organic matrix, and may also have an internal organic matrix.

The type of calcium carbonate crystal (aragonite or calcite), the type of aragonite crystal in the nacre tile, and even the direction of the crystallographic axes of the aragonite crystals are all determined by the organic matrices. The organic matrices are formed extracellularly by the combination of precursors secreted by the pearl oyster's external mantle and mantle margin. The isthumusistic epithelium supplies most (if not all) of the precursors of the protein rubber of the hinge. The various tissues of the external mantle supply the precursors for the organic matrices of the inner nacreous layer.

The precursors of the organic matrices of the outer nacreous layer are supplied by the tissues and glands between the distal folded regional and the pleated secretion of groove F1F2. The precursors of the organic matrices of the outer shell layer-the prismatic layer-are supplied by the secretory structures on the mantle margin between the pleated secretion of groove F1F2 and terminal F3.

The American mussel crisis: effects on the world pearl industry, *by C. Richard Fassler, Economic Development Specialist, Aquaculture Development Programme, State of Hawaii Department of Land and Natural Resources, 335 Merchant Street, Honolulu, Hawaii 96813.*

This paper was presented at:

- The Conservation and Management of Freshwater Mussels II: Initiatives for the Future, 16–18 October 1995, St. Louis, Missouri, USA;
- The Pearl Society, 22 October 1995, Chicago, Illinois, USA;
- World Aquaculture 96, World Aquaculture Society's annual meeting, 29 January to 2 February 1996, Bangkok, Thailand.

History and crisis

The success of the world cultured-pearl industry can be attributed to the discovery by Japanese pearl farmers in the early 1950s that the American freshwater mussel was ideally suited for making the bead nucleus they needed for culturing. Since then, farmers have tried other molluscan species from other areas of the world (giant clam, abalone, pearl oysters) and synthetic materials (glass, ceramics), but nothing has equaled the effectiveness of the American mussel in producing the finest pearls.

The Japanese discovery led to a multi-million dollar shell-export industry in the midwestern United States, employing some 10,000 people. However, such factors as damming, gravel dredging, stream channelisation, and more recently, an infestation by zebra mussels, have resulted in a substantial reduction in populations of those mussels that have traditionally been used for nuclei. American mussels and the American mussel export industry are, therefore, at a critical stage, where experts are now predicting such a drastic decline in the mussel resource over the next seven years that the industry will be close to extinction. The large and expensive washboard mussel, the source of nuclei for the 10 mm plus South Seas pearls (*P. margaritifera* and *P. maxima*) is most likely to be imperiled.

The world pearl industry has responded to the crisis through such means as:

(a) Re-exploring the use of a synthetic nucleus (the Japanese have, reportedly, applied for 5–7 patents).

(b) Experimenting with non-mussel species for nuclei, such as the Giant clam and *P. maxima*.

(c) Utilising the freshwater-mussel resource of other nations, principally China. The Chinese have produced pearls that contain no shell nuclei.

The American mussel industry has, likewise, reacted by instituting such measures as:

(a) Restricting the harvest of mussels in such bodies of water as the Illinois River; and

(b) Investigating the possibility of aqua-culturing certain mussels. For example, discussions are underway with the US Fish and Wildlife Service for the utilisation of Federal hatcheries.

Effect on quality

The utilisation of lower-quality nuclei could result in lower-quality pearls. There is evidence to suggest that imperfections in the nucleus surface will lead to imperfections in the pearl surface.

Profound changes are likely to occur within the next 10 years that will greatly effect the quantity and quality, hence value, of American mussels and pearls throughout the world.

With no viable solutions yet proposed for halting the zebra-mussel onslaught, the creature will continue to decimate native mussel populations. Aquaculture could provide some relief, but farming mussels is not likely to be cost-effective, particularly when one considers the fact that it might take a decade to achieve mussels of sufficient size. By the time a crop is ready for nuclei harvest, bead makers will have turned to other sources of supply.

Certain measures to assist mussels have been introduced in Congress, but these are unlikely to be effective. Moreover, there is a rising awareness of the plight of this native American resource that has already resulted in calls to reduce their harvest and exportation overseas. A total ban on the taking of mussels is not inconceivable. When American mussels are no longer used to produce nuclei, a significant decrease in pearl quality could result.

Another profound effect on the world pearl industry will be Chinese massive pearl production and utilisation of no-shell nuclei. If Mikimoto and his cultured product made pearls affordable, the Chinese have made pearls downright cheap.

And as people once resisted cultured pearls, but eventually accepted a shell nucleus center, it is likely that the world will someday accept a reconstituted nucleus, as long as the raw material is shell. Pearl quality is likely to suffer; however, lower-priced, more affordable product could greatly expand the pearl market. A major exception to this scenario will be South Seas pearls. To date, no non-American shell has been discovered that will produce a suitably large, quality nucleus for this product. Until the acceptance of a reconstituted nucleus, or the discovery of a large substitute shell, the washboard will remain the shell of choice.

Importantly, the pressure on America's washboard resource will result in increasing scarcity and demand; hence, higher prices for South Seas pearls.

Conclusion

There will be two distinct markets for pearls:

(a) Plentiful, inexpensive, small, low-quality pearls, containing lower-grade, synthetic or reconstituted nuclei, or with no nuclei at all. China will be the major supplier.

(b) High-priced, large, quality South Seas pearls; marketing efforts will attempt to differentiate these from the lower-priced product.

In sum, as a result of the American mussel crisis, the world pearl industry will experience profound changes in the years ahead.

Settlement of *Pinctada maxima* (Jameson) and other bivalves on artificial collectors in the Timor Sea, Northern Australia, *by Ian A. Knuckey, Fisheries Division, Northern Territory Department of Primary Industry and Fisheries, GPO Box 990, Darwin, NT 0801, Australia.*

The type, abundance and growth of tropical bivalves that settled on artificial collectors in the Timor Sea off northern Australia was investigated. Collectors made of used monofilament net were set and retrieved over five periods between June 1993 and June 1994. A large number of bivalves were collected, encompassing 47 species from 14 families. Thirteen species from six families comprised over 90% of the total numbers, and included various species of commercial importance such as pearl oysters, fan shells and edible oysters. The silver lip pearl oyster, *Pinctada maxima*, was the most valuable of these, and accounted for 2.4% of total numbers. It had highest settlement rates during the wet season, between October to January, and a mean estimated growth rate of 5.8 mm/month. Settlement rates, examined for commonly-collected species, tended to be highest during the wet season. Length-frequencies and growth rates of species with commercial potential are presented. Considering the number and type of species collected, there is potential for use of artificial collectors in tropical waters, either for aquaculture or as a stock-assessment tool.

Growth and physiological condition of the Japanese pearl oyster *Pinctada fucata martensii* (Dunker, 1850) in Ohmura Bay, Japan, *by Katsuyuki Numaguchi, National Research Institute of Fisheries Science, 2 Fukuura, Kanazawa-ku, Yokohama, Kanagawa 236, Japan.*

Growth and physiological condition of the Japanese pearl oyster, *Pinctada fucata martensii* were investigated from May to December 1984 and 1985 in Ohmura Bay, Japan. Mean growth rates (whole weight) of one- and two-year-old pearl oysters were 138–157 mg/ day and 68–69 mg/ day, respectively. These growth rates were comparatively low as compared with a good growth pearl farm. The slow growth of pearl oysters in the Ohmura Bay pearl farm has been caused by low food concentrations as indicated by phytopigment concentrations, which reflect food quantity. Red-tide occurrences (*Heterosigma* sp. or *Prorocentrum* sp.) in 1985 may have slowed the recovery of meat condition and glycogen stores in pearl oysters after spawning. It is also possible that the temperature stress (above 28–30°C) in the summer may have contributed to the decline of physiological conditions and the cause of mortality of pearl oysters weakened by spawning.

The effect of antifouling paint on the fouling organisms in the pearl oyster, *Pinctada fucata*, *by Dong Yeub Lee (*In*: Bull. Nat. Fish. Res. Dev. Agency, 46, 1992).*

The settlements of the fouling organisms on the net tray and shell of pearl oyster (*Pinctada fucata*) were investigated in the commercial pearl-oyster farming ground at Punghwa and Yomho during the period from April through September 1988.

The dominant group of fouling organisms in this research were algae and Bryozoan (*Bugula neritina*). The highest appearance of fouling organisms occurred in August, especially at the water depth of 1.5 m.

However, the biomass of mussel (*Mytilus edulis*), which is one of the major fouling organisms, sharply increased in June and July. The antifouling paint used in the study seemed to be very effective in preventing the fouling organisms on the culture tray and pearl shell. The total biomass of fouling organisms attached on the painted tray was only one fifth of that of the controlled tray. In addition, the fouling organisms on the shell of pearl oyster in the painted tray were less abundant than those of the controlled tray.

Titles

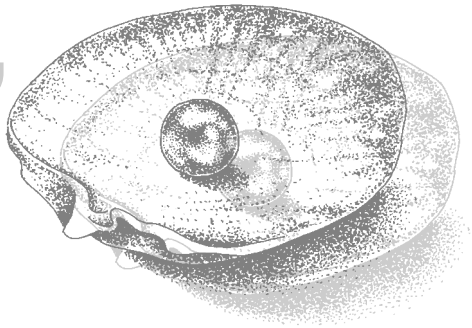
The eighth (volume 3, no. 3) issue of *Iranian Fisheries Scientific Journal* is published in Persian with English abstracts.

- Report on the mortality of the pearl oyster, *Pinctada fucata*, due to invasion of predators in Bandar-Lengeh;
- Preliminary survey of length correlation in *Pinctada fucata* pearl oyster and evaluation of its muscle.

The tenth (volume 4, no. 1) issue of *Iranian Fisheries Scientific Journal* is published in Persian with English abstracts.

- Infestation of the pearl oysters by the boring and fouling organisms in the northern coast of the Persian Gulf.

CONFERENCES, MEETINGS AND WORKSHOPS



Pearl session at aquaculture '96, Bangkok, Thailand

Reviewed by C. Richard Fassler, Chairperson, Pearl Session, World Aquaculture Society Conference, Bangkok, Thailand.

An all-day session devoted entirely to pearl culture was held at the World Aquaculture Society (WAS) conference in Bangkok, Thailand (29 January to 2 February 1996).

This was only the second such session at a WAS meeting (the first was last year in San Diego) but, judging from the strength of the presentations and the size of the audience (approximately 75 people) pearls have become a permanent part of the Technical Session programme.

As in San Diego, the papers presented at the Pearl Session showed a wide variety of activity throughout the globe, with topics centering on pearl production in Mexico, the United States, India, the Cook Islands and French Polynesia.

With Japanese and Australian representatives absent, attention was directed to *P. margaritifera* (French Polynesia, the Cook Islands and the United States) and *P. mazatlanica* and *P. sterna* (Mexico). Two papers (India, the United States) focused on nuclei—an increasingly important subject. The highlights of the presentations follow.

Dr Mario Monteforte, substituting for his wife, Dr Micheline Carino, provided an account of the work of Mr Gaston Vives in Mexico (1903–1914). The remarkable and generally unacknowledged Vives attempted to raise natural pearls in *P. mazatlanica* by culturing thousands of the oysters in selected ocean locations in Baja California. Dr Monteforte's other papers reported on the meticulous experiments of his research team at the Centro de Investigaciones Biologicas del Noroeste in La Paz. He has launched a commercial venture (Perlamar) and intends to begin mabe production as soon as capital investment is secured.

Mr Terii Seaman from EVAAM, a government organisation in French Polynesia that assists pearl farmers, described successful experiments with an on-land hatchery for *P.margaritifera* using rectangular tanks.

Of interest and concern were his remarks concerning disease problems with *margaritifera* in the Tuamotuan Islands, which were more severe than most persons in the audience realised.

In another on-land experiments—this time under laboratory conditions—Dr Jaw Kai Wang of the University of Hawaii also reported success in raising *P. margaritifera*. He concluded that given the right diet, the production potential can be profitable.

The Chair joined with Dr Dan Emery to present the results of Dr Emery's experiences in black pearl farming in Takaroa, French Polynesia (1994), and Manihiki, Cook Islands (1995).

Dr Emery, most likely the only American freelance grafter in the world today, discovered significant differences both in farming techniques and in socio-cultural attitudes to farming. He believes that more attention needs to be devoted to local traditions and concerns before the pearl industries in both locations can expand.

In one of the more interesting papers of the day, Mr Ajai Kumar Sonkar of Allahabad, India, presented the results of his investigations to find a nucleus that would be suitable for implanting into domestic freshwater mussels for pearl production.

After experimenting with ceramic, reconstituted-shell beads, and marine gastropods, Mr Sonkar concluded that a species of the freshwater *Parreysia* shell produced the best results.

Finally, the Chair discussed threats to the American freshwater mussel resource, which has supplied nuclei for the world's pearl industry. He predicted that various environmental problems in the US midwest, including accelerating zebra-mussel devastation, will lead to a scarcity of shell product for nuclei and increased efforts to locate substitutes.

One result will be a flood of low-priced Chinese pearls, either un-nucleated, or nucleated, utilising the inexpensive Chinese mussel. Another result, reflecting a particular scarcity of large American mussels, will be escalating prices for large (12 mm plus) nuclei and, consequently, a rise in the cost of *P. margaritifera* and *P. maxima* pearls.

The discussion period that followed the formal presentation of papers revealed that many members of the audience were deeply involved, or strongly interested, in the subject of pearl aquaculture.

Many took the opportunity to exchange information and addresses, and promised to get together at the next WAS meeting, scheduled for Seattle in early 1997. The 1998 conference is set for Las Vegas.

SPC Fisheries Information Adviser attends Pearls '95

Pearls '95 followed on from Pearls '94, which took place in Hawaii in May 1994. Five hundred participants came from throughout the Pacific region and all over the world to participate in this event, sponsored by the International Pearl Association (IPA).

The International Pearl Association was set up in November 1993. Its purpose is

- to serve as an international forum for scientific, technical and business leaders in the world pearl industry and to coordinate their consideration of problems and issues affecting pearl production;
- to establish an international grouping within which to exchange ideas and information to provide a showcase for the various pearl products from all pearl-producing nations;
- to develop trade and consumer education and promotional programmes to improve the image of pearls to rival other gems; and
- to increase public awareness, interest and demand for pearls.

Following the success of Pearls '94, Pearls '95 was supposed to be held in Hawaii on the island of Maui in May 1995. However, the Conference had to be cancelled at the last minute, and the exhibitors who had already registered (at least those who were informed) were invited to come to Las Vegas in June for the holding of Pearls '95.

It seems that the last-minute postponement of the conference did not go down at all well with the exhibitors, and less than ten people registered. In fact, Pearls '95 turned out to be much more than an auction sale.

About US$ 15 million of pearls were to be sold, but the insurance companies only insured the lots for about US$ 2 million. According to Richard Torrey, editor of *Pearl World magazine*, organising an auction may not be the best way to promote the pearl industry; it lowers the quality of the pearls and gives the impression that producers simply want to get rid of their pearls at any price (especially when the prices are artificially "inflated" in relation to market prices, in order to allow large discounts to be offered). Pearls '96 is supposed to be held in Hong Kong, and we hope that this time exhibitors will show up, and the quantity and quality of pearls presented will be satisfactory.

But all is not bleak in the kingdom of the pearl. At the same time as Pearls '95, the gigantic Jewellers Circular Keystone (JCK) Show was held.

Among the 2,300 exhibitors, there were 160 companies displaying pearls. According to Richard Torrey, wholesale prices have dropped 20 to 25 per cent in relation to prices three or four months ago. This tendency is especially marked for the lowest-quality products; the high-quality products are still only available in limited quantities and, as demand is high, prices do not vary.

Some exhibitors were a bit disappointed by the lack of enthusiasm on the part of some buyers, but as one of them pointed out: "The point of the game is to be there and to show your best-quality pearls; if people don't buy now, they will remember us and, later, they will become our clients." One of the exhibitors who attracted my attention was displaying very high-quality fresh water pearls from China in the 3.5 to 4 mm diameter range. These pearls are obtained without inserting a nucleus (only a piece of the tissue from the mantle). The final product is a pearl made of 100 per cent nacre.

The price, however, is slightly higher than that of traditional freshwater pearls (with nucleus) from China. It should be noted that the technique of producing 100 per cent nacre pearls is just beginning (this year 200 momme were produced, accounting for about 750 g), but experts predict a bright future for this type of product, even if they think that the maximum size of such pearls will remain limited in the immediate future.

Although Pearls '95 was disappointing, the JCK Show allowed me to meet the major players in the area of distribution and sales. The contacts made there will, I hope, allow us to have more detailed information about the pearl industry and to understand the world pearl market better.

Source: SPC Fisheries Newsletter #73

Conservation and Management of Freshwater Mussels II: Initiatives for the Future

"The Conservation and Management of Freshwater Mussels II: Initiatives for the Future" was held from 16-18 October 1995, at the Embassy Suites Hotel, St. Louis, Missouri, USA, and was sponsored by the Upper Mississippi River Conservation Committee.

Now, as perhaps never before, individuals involved and concerned with the wise utilisation and management of aquatic resources are aware of the tenuous condition of mussel stocks and the challenges facing their continued viability.

Paper presentations were devoted to the exchange of information, ideas, and opinions on the major session topics. We wish to encourage a broad spectrum of subject matter and discussion with emphasis on timely application, problem identification and solution, and proactive management.

Fourth International Congress – Malacology, Medical and Applied

Fourth International Congress – Malacology, Medical and Applied, Santiago – Chile, 7 to 11 October 1996

Invitation

The response to our first circular was excellent, with people from more than 23 countries wishing to attend and present communications. The congress will take place in Santiago City. The sessions will be held at the Universidad de Chile and at the Centro de Conferencias Diego Portales, Av. Libertador B. O'Higgins 233, Santiago de Chile.

Objectives

The principal objectives are:

- To promote the interchange of malacological information arising within the centers of the highest level of excellence in the world;

- To enhance and extend the knowledge of many aspects of medical and applied malacology;
- To establish and consolidate relationships with scientists, professionals and producers that work in these topics.

The scientific activities will consist of:

(a) Oral presentation sessions

It is anticipated that time allowed for each paper will be 15 minutes, with five minutes of discussion at the end of each session.

(b) Poster presentations

Discussion on poster presentation will be held between 1430 and 1600 hrs.

(c) Review lectures

By invited speakers—topics will be decided according to the availability of speakers.

(d) Pre-congress courses

Three courses will be offered on Sunday 6th and Monday 7th. US$ 40 for each.

The scientific programme

1. Molluscs as resources

   1.1 Aquaculture
   1.2 Farming terrestrial snails

2. Medical and veterinary aspects of parasites transmitted by molluscs

   2.1 Biology of parasites of host molluscs
   2.2 Biology of host molluscs and their susceptibility to parasites

3. Pathology and toxicology of the molluscs

4. Management of reproduction and development of molluscs of economic importance

5. Molluscs and biotechnology

   5.1. Molluscs as therapeutic agents
   5.2. Other industrial uses of molluscs

6. Impact of man on natural populations of molluscs

   6.1 The biodiversity and the effects
   6.2 Effects on behaviour changes of molluscs
   6.3 Biological control

General information

The official language of the Congress will be English, with simultaneous translation to Spanish. The abstracts will be published in a supplement of *the Journal of medical and applied malacology*. Registration fees:

International participant:	US$ 250
Member ISMAN:	US$ 200
Nacionales:	$ 50,000
Students:	$15,000 (or US$49)

Send registration form and a cheque to:
Cecilia Osorio R., Universidad de Chile, Casilla 653, Santiago, Chile

PIMRIS is a joint project of five international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the Secretariat of the Pacific Community (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission (SOPAC), and the South Pacific Regional Environment Programme (SPREP). 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