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PEARL OYSTER

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INFORMATION BULLETIN

Editor: Neil Sims, Black Pearls Inc., P.O. Box 525, Holualoa, Hawaii 96725, USA. [Phone: +1 808 3256516; Fax: +1 808 3253425; e-mail: nasims@aloha.net]. **Production**: Information Section, Marine Resources Division, SPC, B.P. D5, 98848 Noumea Cedex, New Caledonia. [Fax: +687 263818; e-mail: cfpinfo@spc.org.nc]. **Printed with financial assistance from the Government of France.**

Note from the editor

We have recently had the pleasure of travelling through several of the Pacific Island countries, looking at joint-venture development opportunities for pearl culture within the Small Island States on behalf of the Forum Secretariat. Part of this work involved examination of various tax and investment regimes, as they apply to pearl culture. The results were surprising for the dramatic differences in receptivity to foreign investment expressed in the different countries' codes. These ranged from an outright ban on any foreign ownership in any pearl culture-related enterprise in one country, attempting to protect local ownership in existing farms, to attractive tax incentives in island countries seeking to jump-start outer island economies (have you noticed the price of copra lately?). There were also many countries that seemed lost in the muddle in between.

The conflicting attitudes to foreign investment were perhaps best exemplified in a draft fisheries development plan that we recently offered comments on, for a country with a nascent industry. The plan called for foreign investment to help get pearl culture moving, but stated the express intention, once the industry was up and running, of eliminating all foreign ownership and turning pearl culture over to exclusively local ownership. This seems hardly a persuasive argument for someone to plonk his money down!

We must, of course, declare an interest here: we are intimately involved in the argument, with our Marshall Islands subsidiary being largely financed by overseas investment. We are ourselves an 'overseas partner' in this and other ventures. So it is not appropriate for us, or for anybody else, to tell any Pacific Island nation how they should develop their pearl culture industry. It is not appropriate for anyone to tell any prospective farmer in the Pacific how he should raise his capital. It is, most definitely, his own business.

Inside this issue

Foreign investment is a double-edged sword, and is not always needed. French Polynesia and the Cook Islands have both been able to bootstrap their pearl farming operations, with extended family co-operatives using spat collectors to raise farm stocks. Spat collecting may also work in some open reef areas of the Pacific (note the recent work in Solomon Islands by the ICLARM-CAC: see p. 14 inside), and farming there may follow a low-capital, labour-intensive path.

However, where hatcheries or other capital-intensive investments are needed, then foreign investment is a logical source to tap. There simply is not enough capital available in the Pacific Islands to warrant its venturing this far out on the 'risk-to-return' scale.

Finding investment is perhaps a little like fishing: you have to be in the right place at the right time, and you have to have good fresh bait. Prospective farmers that are seeking foreign investment should therefore make sure that they know what precisely is offered in the tax and investment codes in their countries (and in their competitors'). Who would an interested investor first contact? Where would they be steered towards? What tax, duty, or other breaks are offered? Are there supporting, binding documents to this effect? The desire for foreign investment and/or technical assistance in pearl culture also needs to be clearly stated somewhere. The Fisheries Sector Development Plan is a good place to start.

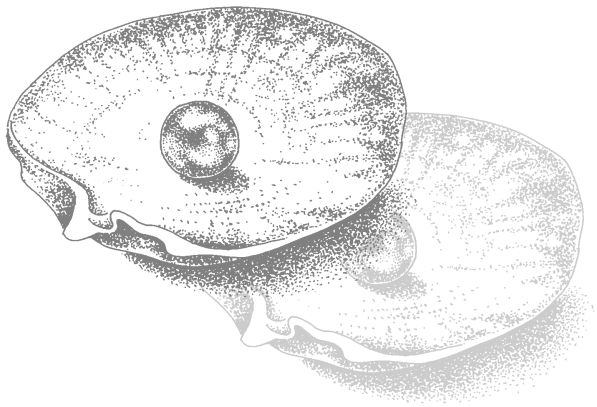
If there are few or no incentives, it is probably time to call your friends in the political and bureaucratic arenas. Yes, there may be more biologists than businessmen amongst our readership, but the two interests intersect very sharply, at precisely this point. If you are wanting to grow an industry, you must ensure that it is given the proper nutrients to nourish it.

My trip also enabled me to spend some time at the Tahiti pearl auction in April. This was an epiphany, an eye-opening experience. The marketing efforts of M. Coeroli et al., should be resoundingly applauded by us all.

Another recent event (actually an obvious step to improve seeding techniques, once you think about it for more than a minute) has been the increasing use of antibiotic-coated nuclei for seeding. We found many folk in French Polynesia using these nuclei, and we include here an abstract from a recent paper announcing some early results on trials (see p. 32).

Our trip also enabled us to meet with many of you—farmers and prospective farmers, fisheries department folk and pearl marketers. It has been pleasing to hear how well received the POIB is, and how useful most of you seem to find it. Thank you. Suggestions or contributions are always welcomed, as you are all well aware. And if you mention your appreciation to the SPC staff or the French Ambassador next time you run into them, it would ensure that your message is received in the right circles.

Neil A. Sims



RESEARCH NOTES AND REPORTS

Myanmar pearling: past, present and future

by Tint Tun[1]

Introduction

Myanmar cultured South Sea pearls (SSP) have been put on sale at successive emporiums held in Yangon, Myanmar, and they were praised as among the world's finest. Three decades after starting pearl cultivation, it is sad to hear different views expressed on Myanmar pearling—'Burma (Myanmar): pearling hits rock bottom',—'Burma (Myanmar) is almost zero factor in South Sea pearls'. Has Myanmar pearling really hit rock bottom? It is an interesting question.

Myanmar has valuable mother-of-pearl shells, ideal places for pearl cultivation, strong and special technology developed by Myanmar for its pearl oyster, prestigious gem emporiums and sound economic reform. Nowadays, pearl cultivation in Myanmar is conducted by not only the state-run enterprise but also joint ventures between foreign and local companies. If Myanmar pearling has hit rock bottom now, it will float again and will prove to be a strong swimmer in the course of time.

Pearl culture in Myanmar

Pearl culture in Myanmar commenced in 1954 after the establishment of a private Japanese–Myanmar joint-venture farm. The joint-venture farm, Burma Pearl Fishing and Culture Syndicate, started pearl cultivation at Domel Island. Then, about two years later, they moved from Domel to Sir J. Malcolm Island (later, it was named Pearl Island) which has more favourable conditions for pearl culture. These two islands in the Myeik (Mergui) archipelago which is located in Taninthayi (Tenasserim) Division, off the coast of southern Myanmar, about 400 miles (644 kilometres) away from Yangon (Rangoon). Divers equipped with the most modern diving gear of that time collected pearl oysters, and joint-venture could successfully cultivate Myanmar pearls. Seeding technicians were, of course, Japanese. Since they were operating a socialist economy system, the Revolutionary Government nationalised the joint-venture farm on 16 August 1963.

After nationalisation, the Syndicate, People's Pearl and Fishery Board tried to produce pearls using Myanmar citizens. It became the People's Pearl and Fishery Corporation under the Ministry of Agriculture and Forests and later, under the Ministry of Livestock and Fisheries. Pearl cultivation was undertaken by the pearl culture branch of the corporation. At that time, the pearl culture branch was temporarily attached to the Salt Industry, and it was finally transformed into a separate enterprise in 1989, Myanmar Pearl Enterprise (MPE), under the Ministry of Mines.

In 1988, Myanmar reformed its socialist economy to become a market-oriented economy, and a total of three joint-venture companies, both local and foreign, are now undertaking Myanmar white South Sea Pearls production. Pearl Island became the main station, as pearl cultivation has been expanding to some other islands of Myeik (Mergui) archipelago, conducted by state-run and joint-venture pearl companies.

1. No. 69, Room 3, Sanchaung Street, Sanchaung, Yangon, Myanmar

Current cash budgets of the Myanmar Pearl Enterprise (MPE) are described in the table below.

Gold-lipped pearl oysters, *Pinctada maxima* , have been used as mother shells in pearl production and were collected from the seabed by divers in heavy, massive helmeted diving suits. Small diving boats equipped with much the lighter hookah diving gear are now used in pearl oyster collection by a joint venture.

Hatchery trials on *Pinctada maxima* have been conducted since 1987, but satisfactory results have not yet been obtained to get the desired size and quantity for seeding. Experimental freshwater pearl culture was started in about 1978 at the Kandawgyi (Royal Lake) in Yangon by the People's Pearl and Fishery Corporation, but later it was terminated as it could only produce small seed pearl (*keshi*).

Joint ventures

The significant fact is that the People's Pearl and Fishery Corporation or Myanmar Pearl Enterprise (MPE) was the one and only pearl producer in Myanmar since 1963. Foreign interest and investments have been flowing into various sectors of the Myanmar economy since Myanmar reformed its system to become a market-oriented economy. Both local and overseas (Japanese, Australian, Tahitian, Thai) companies have made enquiries to invest in Myanmar for South Sea pearl cultivation. With the covetous glances from investors, the pearl culture section is also expanding by forming joint ventures between MPE and both local and overseas companies.

Nowadays a total of four companies, the state-run MPE and three joint ventures, are undertaking Myanmar cultured pearl production. MPE is the main partner in all those three joint ventures: two foreign and one local.

The first venture was established in August 1993, with Niino International Corporation of Japan forming the Myanmar–Niino Joint Venture Company Limited. In January 1994, the second joint venture was formed between Ocean Pearl Company Ltd of Myanmar and MPE. The latest partner is a giant Japanese pearl company, Tasaki Shinju, with which they formed a joint venture in March 1997.

Except at Tasaki, seeding is done by Myanmar technicians at all companies. At first, the Myanmar–Niino joint venture used a Japanese technician, but later Myanmar technicians for MPE have been seeding there on loan.

A proposal to form a joint venture between MPE and an Australian company, Atlantis, was submitted to the Ministry and Commission concerned. This latest joint venture is waiting to take part in Myanmar cultured-pearl production.

The Andaman Club, which runs a big resort hotel at Thahtay Island in the southern Myeik (Megui) archipelago, has also prepared a proposal for a permit to cultivate pearls at a nearby island using Myanmar technicians. Overseas interests are witnessing steady improvement in the pearl culture sector, with reforms initiated in accord with the new economic policy.

Technology

When the Japanese started a joint venture in 1954 with Myanmar, it was agreed on both sides that, under what had been called the 'Diamond Policy', the entire know-how of pearl cultivation was not to be given to Myanmar. Seeding was done by Japanese only, and they concealed their seeding technology very carefully. Even windows were curtained off. However, after nationalisation, the Japanese asked to be allowed to take away the cul-

Cash budgets of the Myanmar Pearl Enterprise (MPE)

Year	Receipts (Kyat millions)	Expenditures (Kyat millions)	Surplus (+) or deficit (-)
1989–90	10.2	13.2	– 3.0
1990–91	30.9	27.3	+ 3.6
1991–92	21.5	16.0	+ 5.5
1992–93	5.5	17.8	– 12.3
1993–94	9.2	21.2	– 12.0
1994–95	15.5	29.7	– 14.2

1 US$ = 6 kyats (approx.)

tured pearls, and lieutenant Commander Maung Aye of the Burma Navy was allowed to be with the Japanese when the oysters were opened for pearls. Seaman Hla Win of the Burma Navy was also present there and, for the first time, Myanmar citizens had a chance to see how Japanese harvest cultured pearls.

The Union of Myanmar takes pride in having developed seeding techniques and successful pearl cultivation conducted exclusively by Myanmar citizens. It should also be recognised that the whole process of pearl cultivation could be undertaken successfully by Myanmar citizens. For decades, it was probably the only country that could produce pearls without assistance from any foreigners.

Myanmar seeding techniques were developed by university teachers in biology. After nationalisation, four teaching staff, U (=Mr) Hia Aung, U Myint Tun, U Htia Aung and U Khin Nyunt from the Rangoon (Yangon) University were transferred voluntarily to Pearl Island to produce pearls successfully. They were the first Myanmar technicians in the history of Myanmar pearl cultivation.

It would seem ridiculous to use a sauce in seeding, but it was tried then. Since the Japanese had not disclosed seeding techniques, the Myanmar technicians made every effort to succeed in seeding. They found some left-over Japanese sauce bottles in the operating (seeding) theatre, but they did not understand the Japanese language. So they thought those bottles were chemical bottles, and that the Japanese may have used them in the seeding operation. They worked out how to use them, and they tried. Then they realised what kind of bottles they were: sauce bottles!

The Myanmar seeding technique is indigenous and can assure the quality of pearls but it is not quantitative. Therefore, it can be called metaphorically, the 'Rolls Royce' technique. The Myanmar technique is applied at MPE, Myanmar –Niino and Ocean Pearl, but Tasaki Shinju still uses its own technicians in both hatchery and seeding carried out in Myanmar.

Production

The British showed interest in exploiting Myanmar pearls and pearl oysters after the first British–Myanmar war in 1824. Reference to this can be found in correspondence in the office of the Commissioner for the Provinces of Tavoy and Mergui (Myeik) in the 1820s. Pearl oysters were not fished under any organised system and pearling grounds were not particularly known till the late 1800s, but oysters containing the pearls were obtained at low water during the spring tides. Mergui and Mergui archipelago became prominent in 1890 as they produced, mostly due to adventurous Australians, consistent quantities of pearls and mother-of-pearl shell. Before 1912, about 1400 *viss* (2286 kg) of pearl oysters were fished in a diving season between September to April. There was the chance of finding pearls of price—some worth several thousand dollars had been discovered.

No statistics on pearls and MOP shell production by Burma Pearl Fishing and Culture Syndicate are available. However, it was found that the Syndicate collected 29 347 pearl oysters in the 1957–58 fiscal year; 34 124 in 1958–59; 29 231 in 1959–60; 43 495 in 1960–61; and 35 340 in 1961–62 from Myanmar waters.

A peculiar mass mortality of pearl oysters has been observed in some stations since it broke out in 1983 and, consequently, it has undoubtedly affected both the quality and quantity of Myanmar cultured pearls. Myanmar's production of mother-of-pearl oyster shells (MOP) and cultured pearls are shown in Figures 1 and 2 (see next page).

World production of South Sea pearls in 1995 was estimated at 2025 kg (540 Kan). 1995 production of South Sea pearls by the strong producers, Australia and Indonesia, was estimated at 1125 kg (300 Kan) and 562.5 kg (150 Kan) respectively. Myanmar's production of pearl in 1995/96 was 3.446 Kan. 1983–84 was the most productive year for the Myanmar pearl culture industry with 17.84 Kan produced.

Myanma Gems Emporium

During the era of British colonisation, pearls were put on sale at some jewellers' show rooms in Yangon (Rangoon), such as Combes Co. Before the introduction of the gems emporium to the world in Yangon (Rangoon) in 1964, Myanmar gems, jade and pearls entered the international market through various channels and their Myanmar identity became lost, hidden or neglected.

As in other parts of the pearl world, the Japanese partners practised 'Diamond Policy' and Myanmar pearls cultured by the joint venture, Burma Pearl Fishing and Culture Syndicate, were introduced deliberately to the market as South Sea Pearls.

The first Myanma (Burma) Gems, Jade and Pearl Emporium was held in 1964, with the aim of properly channelling the previously loose trade and putting Myanmar and Myanmar gems, jade and pearl squarely on the map of the world gems trade. The emporia were held once a year until 1991 but since 1992, they have been held twice a year as the

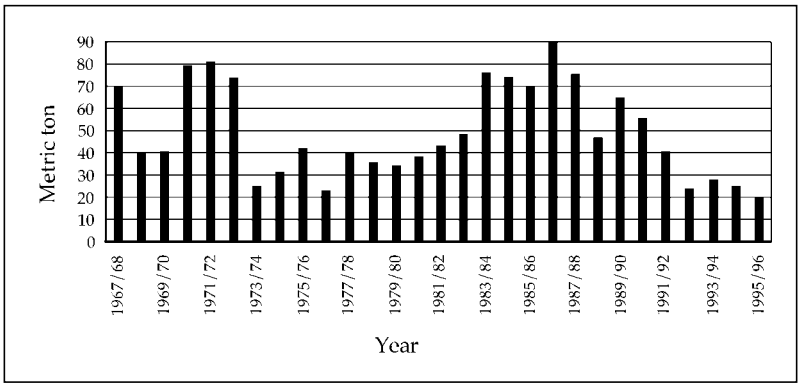


Figure 1: **Myanmar's production of MOP shells**

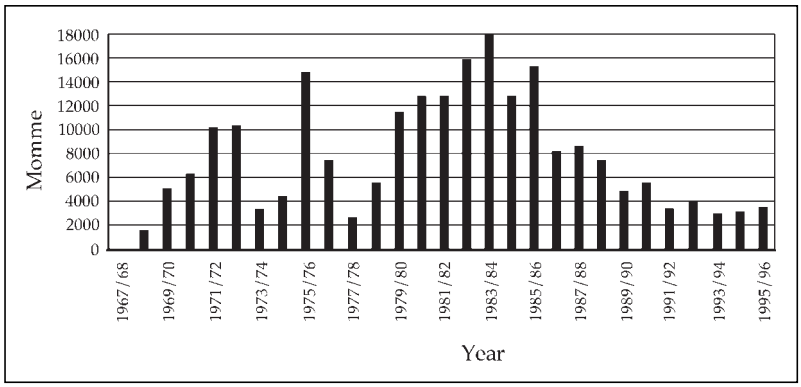


Figure 2: **Myanmar's production of cultured South Sea Pearls**

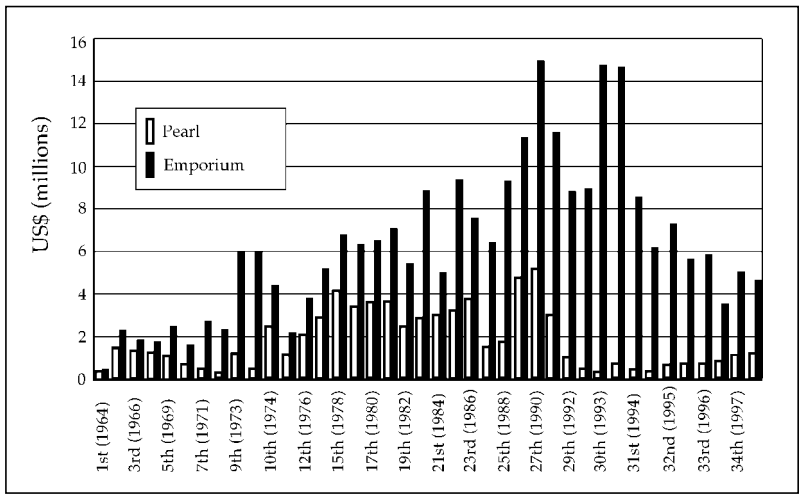


Figure 3: **Sale proceeds from Myanma Gems Emporia and Pearls**

annual and mid-year emporia. The emporia made Myanmar pearls well-known in the world. The newly built, three-storey Myanma Gems Emporium Hall was commissioned in September 1993. The aims for construction of the hall were: to be able to hold gems emporia in a separate modern building instead of at Inya Lake Hotel, and to be able to extend gems trade at the emporium hall in addition to holding two emporia each year.

Mr Salvador J. Assael's comments on the first Myanmar Gems Emporium reflected very well the quality of Myanmar pearls at their first appearance in the international market identified by their country of origin (in 1963). He recalled, 'The goods were extraordinary in quality. They were, without a doubt, the finest goods that had ever been produced anywhere in the world, and even today, the finest of Australian or Indonesian goods cannot compare with what was shown in 1963.'

A comment on the quality of the Myanmar pearls was also made by a very regular Swiss customer of the Emporia, Mr B. Zaleman of Samourai S.A., Switzerland. He told journalists in an interview at an emporium in 1990, '. . . You have got the most attractive and beautiful pearls. You are the best in the world. In fact, everything you have got is the best. The best jade, the best ruby, the best sapphire, the best pearls, . . . Your quality is the best. Very often people show me the Australian pearls and Myanmar pearls and ask me "Do you see any difference?" I say yes, a little. I want to tell you this. The Australian pearl is like a beautiful lady but she is sad. The Myanmar pearl is like a beautiful lady with a smiling face.'

Sales of pearls at the Thirtieth Emporium held in February 1993, showed a sharp decline. Other comments highlighted the marketing of pearls at the Emporium. They said, '. . . Pearl lots were of mixed quality and we couldn't find what we wanted. Floor prices fixed were high . . . Low quality pearls were mixed in lots with good quality pearls and it was very difficult for us to make our selections. . . It will be difficult for us to come again if sales are going to be in mixed lots of different qualities.'

The 23rd Emporium was designated as Pearl Special Year but the biggest amount of earnings

from pearls was observed in 1990 at the 27th Emporium—US$ 5 159 195. Sale proceeds from the successive emporia are described in Figure 3.

Research

Myanmar has an advantage over the others in terms of pearl seeding technicians because all are graduates in zoology or marine biology. Their educational backgrounds can, more or less, help in further attempts to develop the technology at hand. However, systematic research on pearl oysters and pearl culture has not been conducted for many years. Just monitoring some oceanographic parameters such as temperature and salinity of seawater, and weather conditions, is not enough for development of the industry. Basic and applied research are essential to develop not only cultivation but also hatchery technology. Here is an expert's opinion concerning research: 'Professional research done by experts on pearl shells is to be encouraged as it often benefits the industry by helping to improve the product quality'.

Future outlook

Myanmar has a long coastline of more than 1,700 miles (2,734 kilometres) stretching from north to south and it can be divided into three main areas: the Rakhine, Ayeyarwaddy and Taninthayi coasts. All kinds of pearl oysters are in cultured production—*Pinctada maxima*, *Pinctada margaritifera*, *Pinctada fucata* and mabe, *Pteria penguin* are present in Myanmar waters. Rakhine and Taninthayi are candidates for pearl culture, as they can provide some suitable places for expanding the Myanmar pearl culture industry. Myeik (Mergui) archipelago is situated on the Taninthayi coast, and has some geographic advantages over Rakhine. As it can provide a number of ideal places for pearl oysters and pearl cultivation, many of its member islands will become pearl culture stations.

The expansion of Myanmar's South Sea pearl cultivation created many new farms on the Mergui archipelago. A large number of matured pearl oysters are cultured in close proximity of farms, and this can increase the reproductive efficiency of the pearl oysters. Synchronised spawnings on the farms can maximise the fertilisation rates of eggs resulting in more oyster recruitment in the wild. Therefore, establishment of new pearl farms is virtually providing natural hatcheries for oyster repopulating. Systematic studies on the stock assessments and natural spat collection of pearl oyster are also essential for conservation.

Research and development are inseparable, and they are the only way to keep the 'smiling face' of Myanmar pearls. The Pearls Sub-Committee Director of the Thirtieth Myanma Gems Emporium said in an interview with journalists in 1993, 'we must try to improve our production methods.'

In the future, more and more pearl oysters can be provided from hatcheries by developing proper grow-out techniques. In line with expanding pearl cultivation in Myanmar, a new generation of culture technicians have been trained to meet the future developments in the pearl culture sector.

Production figures of pearls and MOP shells indicate improvement in both pearl and MOP shells production. Sale proceeds of pearls at emporia also indicate that sales of Myanmar pearls will revive in the world pearl market again. It should be noted that Japan has been producing tons of cultured pearls using *P. fucata* as mother shells for many decades. *Pinctada fucata* can be collected from oyster cages as nature's gift or they can also be collected easily by spat collectors in the Myanmar waters.

Myanmar has a vast amount of freshwater resources, many rivers, lakes and reservoirs. Freshwater pearl culture is also a potential industry in Myanmar. By searching suitable freshwater bivalve mollusc species or introducing exotic species already used in world freshwater pearl production, it is possible that Myanmar can become a producer of freshwater pearls.

Endowed with natural resources and equipped with traditional skills and intelligence, Myanmar has proved that it is a land of many attractions. In line with the new economy, Myanmar still has much room for both fresh and sea water pearl production.

John Dryden, a famous British poet and writer said 'He who wishes pearls must dive deep'. Myanmar starts deep-diving again.

Acknowledgements

Heartfelt thanks are due to Mr Khin Nyunt, General Manager of Myanma Pearl Enterprise; Mr Martin E. Coeroli, Director of GIE Perles de Tahiti; Mr C. Richard Fassler, Economic Development Specialist of the Aquaculture Development Programme of Hawaii, Department of Land and Natural Resources, USA; and Mr Neil A. Sims, Vice President and Research Director of Black Pearls Inc., USA, for their information, references and encouragement.

References for this article are available from the SPC Fisheries Information Section (see contact on cover page).

ACIAR project enters second phase

From Tarawa (Pacnews)

The research on pearl farming in Kiribati for future commercialisation is now entering its second phase. A report from the Fisheries Division notes that the first phase, which involved spawning, was completed in December last year, Radio Kiribati reports. It said although spawning was a success, the farming of the juvenile pearls is a problem, because most of the oysters got killed by other marine creatures, fish and other predators. The report said that more than 2000 young pearls are now being cultivated inside tanks on land, and are reaching about 13 centimetres long. The second phase will now determine the best way to cultivate the pearls, and two options are to farm them in the sea inside iron cages or to nurse them in the tanks on land. Local fisheries officers involved in this project are now awaiting their consultants from the James Cook University, Townsville, Australia, who assisted in implementing this research, for the start of the next phase.

Pearling progress in Tonga

From the FAO/AusAID Review of the Fisheries Sector in Tonga, April 1998

Analysis of a number of aquaculture endeavours indicates that the pearl industry is the most promising aquaculture avenue.

It is therefore proposed that the Ministry focus on the following areas:

- improving inshore resource management,
- encouraging the growth of a tuna longline industry,
- helping the small-scale fisher,
- establishing stakeholder input into the Ministry, and
- encouraging the growth of a pearl industry.

Pearl industry to be developed

From Nuku'Alofa (Pacnews)

Tonga's pearl industry is being recommended as the most promising aquaculture venture to be developed. This is the outlook of consultants from FAO and the Australian aid agency AusAID who reviewed the fisheries sector in the Kingdom, Radio Tonga reports.

The eight consultants reviewed a number of aquaculture endeavours in the Kingdom and then recommended that the pearl industry should be developed. The Ministry of Fisheries has embarked on developing pearl farming in the country, with projects in Vava'u and other areas.

Pilot project on pearl farming begins

From Nuku'Alofa (Pacnews)

A Japanese pearling company has begun a pilot project in Tonga to determine the viability of farming blacklip pearl oyster in Tonga.

Tonga's Secretary for Fisheries, 'Akau'ola, says the government is interested in the proposal by Tahiti Shinju Company to set up the project in Tongatapu, Vava'u and Ha'apai, Radio Tonga reports.

'Akau'ola says Shinju Company wants to establish a branch in Tonga if the pilot project proves successful. Tonga's Ministry of Fisheries had embarked on a trial project on the winged oyster in Vava'u, which had shown some positive results. In addition, a recent joint FAO and AusAID review of Tonga's fisheries sector has recommended that pearl farming is the most promising aquaculture avenue.

Lessons learned in two years as a *P. margaritifera* farmer

by Jerry Myers

I gained most of the little I know from the daily operations and detailed record keeping at a 7000-shell farm in the Marshall Islands, and by reading pearl oyster reports.

Comparing statistics from other comparable farms would have made decision-making easier. My attempts have yielded:

Mortalities

A total population mortality rate of 10 per cent including, a 1.9 per cent rate for 50–100 mm juveniles in grow-out nets; a 29.5 per cent rate for older oysters or broodstock; and a wild stock transportation mortality rate of 1.2 per cent.

Spat collection

The most efficient spat collectors have been the grow-out panel nets, hung from a longline system, with a 33+ week cleaning interval, at approximately 3 m depth. They capture 2.3 to 3.0 oyster spatch per net, dependent on cleaning interval. In a 2 km diameter lagoon with a diurnal tide, 21 m depth and a fairly constant 29.4°C sea surface temperature, we had a June–August spawn and probably year round also.

The next most efficient collector is a one-metre long black polypropylene 'Christmas tree line', deployed at 1.3 to 3 m depth, averaging one spat per 2.8 units. All styles of collectors were similar, in that, the oyster spatch comprised only two per cent of all the bivalves caught and a tiny portion of the total marine growth. In two years, a total of six hundred odd oyster spatch have been harvested.

Predators

Damage by polychaete worms and boring sponge is the most prevalent. When an interval of more than 35 weeks between cleaning was practised, it resulted in heavy fouling, although the mortality rate was not affected and, only randomly, stunted finger growth. But the shell-damage rate from boring sponges increased greatly after a 14-week cleaning interval; a four per cent varying to 28 per cent live infestation rate occurred, depending on age, seeding category and the genetic characteristics of individual shells. A programme of an 11-week cleaning interval, a thorough shell cleaning to expose the sponge and a one-minute fresh water dip have produced about equal cases of 'new' versus 'in remission', in control groups. The search continues for a practical method of eradicating predators.

An open invitation from Kavieng

Dear Sir,

I wish to thank you for the *SPC Pearl Oyster Information Bulletin* No. 11 of May 1998.

Since I started receiving this information bulletin on pearl oyster, my interest has been aroused in tapping into this industry. Information extracted from the Fisheries Office here in New Ireland Province, confirms that a pearl farming industry is viable in this area of Mussau Island in the St Mathias Group.

Our island is rich with untouched marine resources and other available resources such as manpower, project sites and spat supply.

This project would not be a problem to undertake elsewhere. However, here in Papua New Guinea we have a common problem of lack of working capital and expertise in this field. Therefore, we cannot tap into this industry.

I would like to submit this information to be printed in the Bulletin for other readers or farmers who might be interested and might want to invest here in Papua New Guinea. We would welcome them utilising these resources, which lying idle now.

I would be glad to submit any further information in the future with the assistance of the Fisheries Department in this Province, regarding this request.

Yours faithfully

Tamalu Simion
P.O. Box 245
Kavieng NIP
Papua New Guinea

Research on *Pinctada radiata* in the Red Sea

Mr Yassein is currently working towards a PhD in the fishery and biology of *P. radiata* in the Red Sea. This study includes catch, effort and CPUE; and reproductive biology, including maturation stages, determination of spawning season and gametogenesis of this species. Further, Mr Yassein intends to use the complete ELEFAN or FiSAT to analyse age and growth data, mortalities, and yield per recruit.

For more information, please contact: Mohammed Hamed Yassein, National Institute of Oceanography and Fisheries, Suez Branch, P.O. Box 182, Suez, A.R. of Egypt

A letter from India: A plea for diversity, and a success story

by Daniel S. Dev

With reference to the publication of the *SPC Pearl Oyster Bulletin*, I hereby wish to submit my long-standing grievance. I find the Bulletin contains information exclusively on *Pinctada margaritifera* and *P. maxima* and sometimes on *P. mazatlanica* also. I feel no due consideration is given to small varieties, such as *Pinctada fucata* (= *P. martensii, P. radiata*) which contribute substantially towards world pearl trade and pearl culture. I request you to consider and include information in this regard to benefit Asian and African countries.

I have been a member of the Pearl Oyster Special Interest Group since May 1993. In your *SPC Pearl Oyster Bulletin* No. 7 of January 1994 (p. 5 & 6) I contributed an article on the status of Indian pearl culture and our only pioneering commercial venture. In that article I explained about our marketing difficulties and you readily helped me by advertising for the sale of 30 000 carats of pearls through your Editor's note. The problem of marketing persisted throughout, in spite of achieving targeted production. Ultimately the project has been leased out to a private entrepreneur with Japanese collaboration for a period of ten years on a renewable basis.

As far as the Indian scenario, here we have perfected the technologies of hatchery production of spat, farming, implantation, post-harvest techniques of drilling, and pearl treatment/processing, and have enough trained personnel in all the above.

GIA's new pearl programme offers students comprehensive pearl knowledge

Pearl seminar, class and course to extend worldwide

Popularity of the pearl has surged worldwide and the Gemmological Institute of America (GIA) has responded by developing new, extensively researched, in-depth information for its pearl programme.

The programme comprises a two-hour pearl seminar and a two-day pearl class, which have already begun, and an 11-assignment pearl course, currently in development and scheduled to begin in early 1999.

Since April, GIA's pearl seminar has been offered at various locations around the United States.

'So far, the response to the pearl seminar has been overwhelmingly positive with about 100 people attending each session,' said Eddie Decsi, G.G., GIA Manager of Gemmology Extension Education. 'The timing is perfect. This new information is coming out at a time when pearls are very hot in the industry. Consumers are buying more pearls and it's important for jewellers to know about the quality factors so they can buy and sell pearls more effectively.'

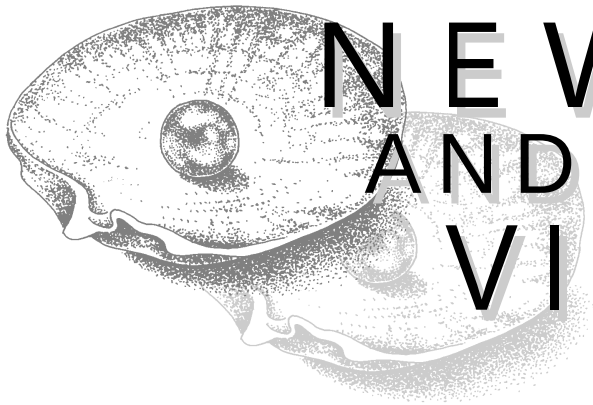
The pearl seminar covers different types of pearls including the Japanese and Chinese Akoya, Chinese and American freshwater, Tahitian and South Sea pearls. Also included in the seminar is information about pearl farming, pearl harvesting, and nucleation.

The programme also includes a two-day, hands-on extension class, which focuses on product knowledge of pearls, nucleation, farming, harvesting, market trends, pearl grading, and the seven quality factors that comprise GIA's Pearl Description System. The seven quality factors include size, shape, colour, lustre, blemish, nacre quality, and matching.

GIA's Education and Research Departments, and the Gem Trade Laboratory, worked closely with leaders of the pearl industry to ensure that the Pearl Description System is not only practical to use, but offers consistent results.

Also key were GIA benefactors South Sea Pearl Consortium, Perles De Tahiti, Japan Pearl Exporters, Salvator Assael International and Robert Wan. American Pearl Company and other individuals and organisations involved in the pearl industry contributed materials, images, expertise and funding toward the development of the class.

For more information and to enrol in any GIA extension class or seminar, please call toll-free 800 421 7250 ext. 4001. From outside U.S. and Canada call +1 760 603 4001; Fax: +1 760 603 4080.



NEWS AND VIEWS

'Pearl World' news update

The farming and marketing of Tahitian black pearls

Source: *Pearl World, The International Pearling Journal*, August/September 1998, Volume 6, Number 3

Everywhere you go these days, you see black pearls. At the JCK Show in Las Vegas in June, they were all over the place. Dark, lustrous strands and necklaces ranging from tens of thousands of dollars to hundreds of thousands. Rings, earrings and pendants varying in price according to size and setting. Buyers at top-tier exhibitors swarmed like honeybees around hives. One designer who'd just gotten into pearls from the black-lipped *Pinctada margaritifera* a scant three years ago had little time to talk to us, what with servicing virtually unending waves of lookers and buyers. 'Easily, half our sales today are in these goods,' he grins. And happy he ought to be: he's expanding his extremely successful business from one fashionable part of town, and opening up another outlet in an even tonier part of the city.

Production evolution

Pre-war production of cultured black pearls using *Pinctada margaritifera* oysters existed in locales such as the Ryukyu Islands around Okinawa, Palau and in the Marshall Islands. However, these efforts never really reached volumes suitable for broad, international commercialisation. Global exploitation started in Tahiti with the first serious trials beginning in 1961 by a Japanese pearl oyster technician, contracted under a project sponsored by the French Polynesian Administration. Four years later, the first 1000 black cultured pearls were harvested . . . and privately owned pearl farming was encouraged.

The next year, 1966, the first privately-owned pearl farm was established on the island of Manihi in the Tuamotu Atoll. 1972 saw the first recorded official export of Tahitian cultured pearls; it was not giant in size, a mere 1.5 kg (3.3 lbs.) which garnered a modest US$ 3663. 1983 saw exports jump to 37 *kan* (138.8 kg), valued at US$ 5 million; this impetus kicked the industry into high gear.

In 1992 exports exceeded one ton for the first time ever: 285 *kan* (1069 kg) valued at US$ 43.5 million. A short four years later, exports exceeded five tons for the first time ever (1360 *kan* or 5099 kg), valued at US$ 152.4 million; the Cook Islands, in second place as a producer of black pearls, produced a total of 53 *kan* (200 kg) worth a smidgen less than US$ 4 million in this same year.

From 1994 on, there were impressive leaps in exports. 1996 saw the highest volume of exported pearls (5.4 tons) to date, and last year saw the all-time highest value (14.6 billion CFP), although in

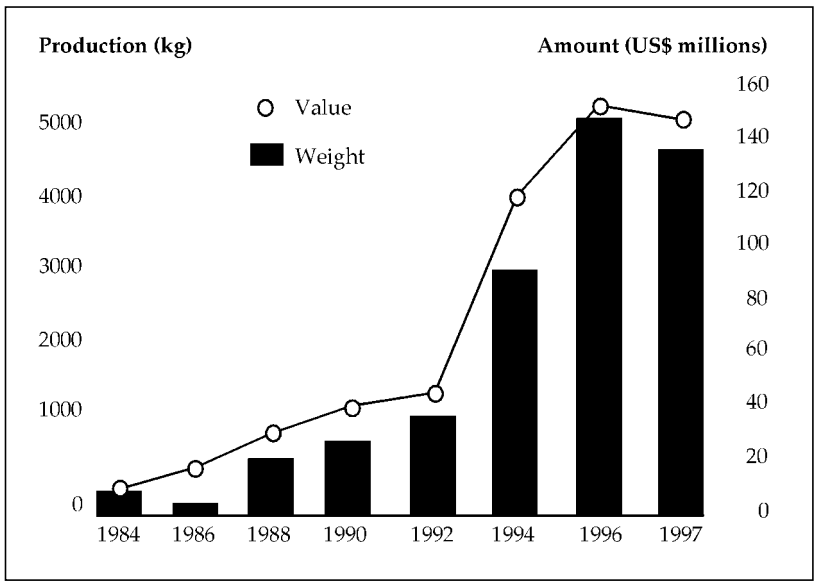


Figure 1: **Export growth of tahitian black pearls in volume and value**

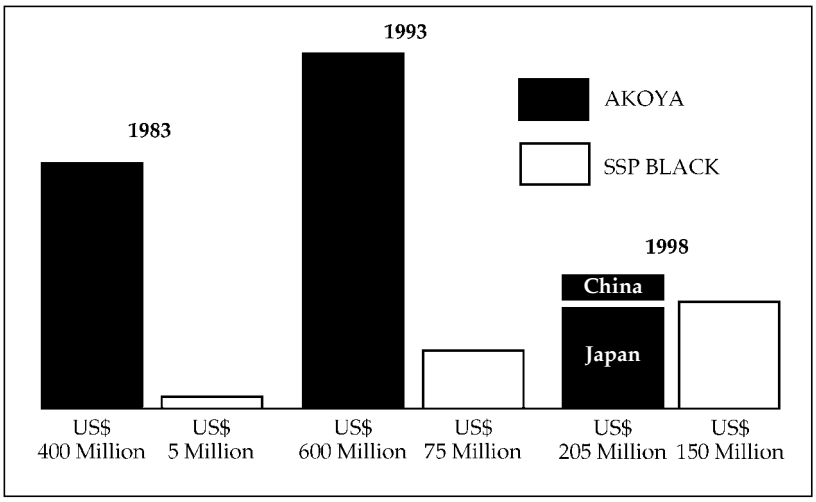


Figure 2: **Export valuation of South Seas black pearls vs. the Akoya**
Note: these are rough estimates by Andy Müller of Golay Buchel Japan KK. Accurate figure are not available; however, these clearly depict the prevailing trend

terms of the US$ it was slightly less than 1996's total (US$ 155 m vs. US$ 138 m), due to variations in currency exchange.

In the first quarter of this year, compared to that of last year, export volume was 12.5% higher . . . value was 36% higher . . . and the average price-per-gram was 22% higher. Mark this trend.

Overview

French Polynesia produces roughly 93 to 95% of all the pearls cultured worldwide in the black-lipped oyster, *Pinctada margaritifera*. The total pearl cultivation area of French Polynesia is vast, stretching over 2300 kilometres. There are over four hundred farms engaged in pearl culture here, but one company dominates by producing about half of the annual output, with four others producing about another 35%.

The sizes of pearls cultured in French Polynesia range from 7 mm to 14 mm (pearls larger than 14 mm are also produced, but their number is very limited), and the average size is 10 mm. The cultivation or breeding time varies quite considerably. Farmers concentrating on smaller pearls (below 10 mm in size) usually limit the breeding time to a period of twelve to fourteen months; for larger pearls, farmers often leave them in the oysters for up to two years. There is little downside to the shorter cultivation period of smaller French Polynesian pearls, as their coatings are relatively thick and healthy.

Spat collection

The most active spawning period in French Polynesia is during the warmer months of October–November to March–April. During this period, free-floating spat will attach themselves onto the collectors, and begin to grow. These baby oysters are left on their collectors for at least one full year; by that time, they will have reached about 4–5 cm in size. Some farmers, however opt to leave the spat on collectors for up to a year and a half (usually reaching 7–9 cm in size) . . . or even more, until they reach 11–14 cm. At this size, they are large enough to be seeded.

From a 200-metre longline with 500 to 800 collectors, a French Polynesian farmer can expect to collect approximately 15 000 to 20 000 baby oysters after one year. In very exceptional cases, he might get up to 30 000. There is an active trade in the selling and buying of oysters of all sizes. One year-old baby shells, 4–5 cm, are usually traded at around CFP 20 (US$ 0.20) a piece; 18-month oysters (7–9 cm), CFP 50–80 (US$ 0.50-0.80); and the larger oysters, ready to be seeded, are traded at around CFP 150 (US$ 1.50). In six months' time some families can earn US$ 100 000. There are

more families involved in spat collecting than in the raising of pearls.

While much of black pearl farming used to be a family occupation around a sleepy lagoon, the vast majority of pearl production today is coming from a handful of enterprises that are utilising and applying modern, foreign techniques and equipment. 'Mom and pop' pearl farms are on their way out. The emphasis on large-scale farming has necessitated the requirement of huge capital outlays. Starter money can now run into the millions to buy the latest equipment, hire a trained staff, and wait out the four-year period before the first harvest.

Big farms, big problems

Large-scale production may force the smaller and less efficient farmer out of business, but large enterprises have their own problems. Because oysters require constant attention, locating suitable personnel is a continual problem. There is a constant demand for divers, with the larger farmers hiring 20 or more. Cleaners and X-ray technicians are also needed. But the monthly pay at US$ 1500 or so, may not be enough to entice people into these hardworking and often dangerous occupations.

The large farms have been experimenting with Chinese grafters, and have been experiencing some success. It is a major cost-cutting move that may signal the end of the Japanese in Tahiti. The Chinese will work for US$ 1000 per month — a significant sum back home — while Japanese go for twenty times this sum. Granted, the overall quality of the Japanese work is superior, but the Chinese are learning fast.

Coated nuclei

The insertion of the nucleus often causes an infection in the oyster, which can result in the rejection of the nucleus and the death of the animal. Advances in Japanese biotechnology have resulted in nuclei that are coated with an antibiotic powder. The big farms are now routinely purchasing coated nuclei from the three Japanese producing companies. Each has its own colour: yellow, pink and red. Robert Wan, once again, was the pioneer . . . having used this type of nuclei for the past ten years. Now, all large producers are using them. With the regular, uncoated nuclei, the retention rate is roughly 50% to 60%. Coated nuclei increase this rate to 70–80%.

Marketing strategies

French Polynesia has moved aggressively forward in selling its product. Undoubtedly aware of the effects of drastically increased production on prices, the G.I.E. Perles de Tahiti has launched an outstanding marketing effort that bodes well for the future of the industry.

This organisation has taken a holistic approach to marketing and seems to be everywhere in the jewellery world; participating in trade shows; placing ads in trade journals; recording which celebrities are wearing black pearls; encouraging jewellery designers to work with the product; even coaxing countries to lower their tariffs against black pearls.

The man behind this effort is General Manager Martin Coeroli who, before assuming his present post, was one of the nation's leading pearl researchers. Coeroli, then, knows the industry from the bottom up. His chief vehicle for 'getting the word out' is the slick *Tahiti Pearl News*, an international journal published six times a year. Outsiders applaud the Tahitians' openness and candid reporting of relevant production statistics, and many wish that other major producing countries would be as honest and forthcoming in documenting their pearl harvests and sales.

Martin also was instrumental in opening up a website that attracts gadzillions of 'hits' world-wide. Log on to this excellent marketing vehicle and see for yourself: **http://www.tahiti-blackpearls.com**.

M. Coeroli is supervising a well-co-ordinated attempt to open up Mexico, Latin and South America to the reality of black pearls. He is also co-ordinating continuing efforts within the U.S. and European markets . . . quite likely a reaction to lower demand from Asian countries hard hit by the current economic crisis.

Scanning the pearl world

Source: *Pearl World, The International Pearling Journal*, April–May 1998, Volume 6, Number 1

Tahiti

Tahitian black pearl exports continue their growth, seemingly unabated. For 1997, the 10-month average price per exported gram ran to US$ 28.29, 19% above average price of last year. In terms of weight for the same period: 3804 kg (a gain of 4%); in terms of value: US$ 109.5 million (plus 23%). Martin Coeroli, General Manager of Perles de Tahiti, attributes these increases to Tahiti opening new export markets.

Some 75 000 Tahitian pearls will be offered at the Third Annual Tahiti Pearl Producers (TPP) International Auction to be held in early April in Papeete. This year's number of pearls for sale is some 12.8% less than the 86 047 pearls offered last year.

TPP GIE was formed in 1995 to allow farm owners to market their goods directly. The organisation is comprised of 50 small-to-medium size pearl farmers, which produce roughly 20% of French Polynesia's pearl production, and its traditional April auction complements the Poe Rava Nui Auction—Tahiti's major pearl event—held each October.

Black pearl farming in the open reef systems of Solomon Islands

Source: *Austasia Aquaculture*: 12(3), June/July 1998

Since 1993, Australia, through funding by the Australian Centre for International Agricultural Research (ACIAR), has assisted the efforts of several Pacific Island nations in collaborative research projects led by James Cook University (JCU) in Townsville and the International Centre for Living Aquatic Resource Management (ICLARM) in Solomon Islands.

Between 1994 and 1997, ICLARM, in collaboration with the Solomon Islands National Fisheries Department (SIFD), sought to assess the viability of collecting spat (juvenile oysters) in Solomon Islands by adapting collection techniques developed in French Polynesia. In the enclosed reef systems of French Polynesia and Cook Islands, spat are collected on substrates (spat collectors), which are deployed in the surface water of atoll lagoons. Spat collected on these substrates are then harvested and on-grown for use in pearl culture.

Whereas farms in the atoll lagoons of the eastern Pacific rely on closed or semi-closed lagoons to act as natural traps for the planktonic larvae of pearl oysters, most island nations in the western Pacific have more open reef systems—i.e. patch and barrier reefs. This is the situation in Solomon Islands and Australia, where reefs have numerous passages and openings linking lagoons with deeper areas of oceanic water. Because water movement in open systems is less predictable, it was believed that these types of reef systems were unsuitable for pearl farming, as it was not obvious where sufficient numbers of pearl oyster larvae would be concentrated to allow successful collections of spat.

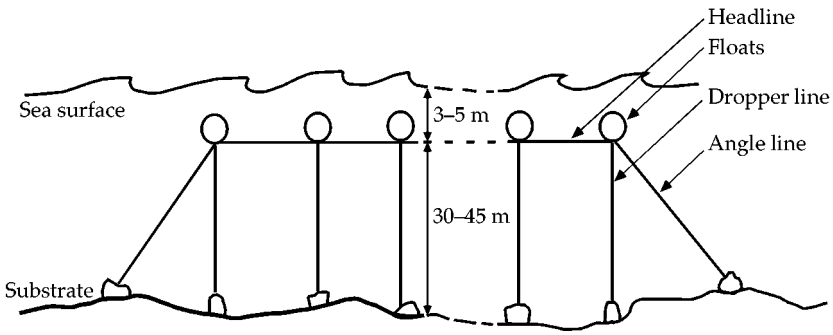
This article reports on research carried out over the last four years that has yielded commercial quantities of spat from the open systems of Solomon Islands. In the last two years alone, more than 12 900 spat were collected in the Solomon Islands, proving that there is potential for spat collection in open systems. This article highlights a number of subjects related to spat collections, including periodicity of collections, site selection criteria, collector types, and the adaptation of management practices. It also reports on subsequent growth and seeding trials carried out in the open reef systems of Solomon Islands.

Spat collection trials

These trials were carried out at fifty sites spread over 500 km of Solomon Islands between January 1993 and October 1997. Spat collectors were deployed on longlines 100 m in length, set at depths of 3–4 m below the water surface (Fig. 1).

Periodicity of collections

In order to make reliable predictions about the best times of year to collect spat, we monitored temporal collections from continuously sampled sites. From a total of four years' data on seasonal



Installation of longlines:
Longlines consist of a 100 m length of 12 mm polypropylene headline, supported every 25 m by two Casamar C6000 net floats (approx. buoyancy: 7.5 kg). Polypropylene dropper lines (10 mm dia.) were passed through the buoys and then attached to structures on the substrate, e.g. 'bommies' or concrete blocks. The buoys were then submerged and tied off at a depth of 3–5 m for spat collection and 9–10 m for growout. The longline had an angle line leading from both ends, for tensioning the headline. Longlines were installed with the aid of SCUBA and positioned in areas of clear water, at least 30 m from the substrate and and reef outcrops. Longlines for grow-out had extra buoyancy to compensate for the weight of intermediate grow-out units and chaplets.

Figure 1: Diagram of longlines and methods used to install them

variability in settlement of spat, it was found that patterns of settlement were not stable throughout the year. Collections made between October and May were greater than collections made in winter months.

Site selection

Fifty sites were sampled to assess which site characteristics were the most suitable for spat collection in open reef systems. Contrary to our initial thinking, collections were greater at offshore sites (i.e. reefs on the edge of lagoons, or enclosed sounds). This was because the more enclosed inshore sites were negatively affected by inputs of nutrient and particular matter in runoff from high island environments. In contrast to the low-lying sandy atoll environments of Polynesia, the reef systems of Solomon Islands were normally bordered on at least one side by high islands. The excess nutrient loading and turbidity seen after heavy rainfall in lagoons adjacent to high islands caused fouling of spat collectors and lowered survival of spat.

Longlines set further offshore were well flushed with clearer oceanic water. In addition, collectors placed in currents near lagoon passes or subject to longshore water movement on the outside of barrier reefs (currents up to 0.50 m/sec) were more likely to access spat carried from a number of locations. At inshore sites, restricted water movement may have limited passive movement of spat (currents up to 0.09 m/sec).

Collections were most successful when longlines were deployed at least 30 m above the substrate and > 40 m clear of reef. In addition, longlines set perpendicular to the reef and longshore currents were more successful than those set parallel to prevailing currents.

Variation in settlement of spat due to type of collector

In comparisons of various plastic collector substrates (shadecloth, sheeting and spat rope materials), black polypropylene shadecloth (55%) was the most suitable material for collecting spat.

Comparisons among various collector designs (Fig. 2 on next page) found that four strips of 0.2 m^2 shadecloth material, bunched and tied separately along 1.2 m of 37 kg fishing line, was the most suitable collector in terms of abundance of spat collected and cost of material. Also, fewer (20%) live spat and greater numbers of predators were found on collectors deployed inside fine meshed spat bags (2 x 5 mm mesh) than when collectors were left uncovered.

Management practices of spat collection

To further improve methods for collecting spat, three other adaptations to collection protocols were trialed: (1) survival of spat in relation to immersion time of collectors; (2) spat collection on redeployed (uncleaned) collectors versus new (cleaned) collec-

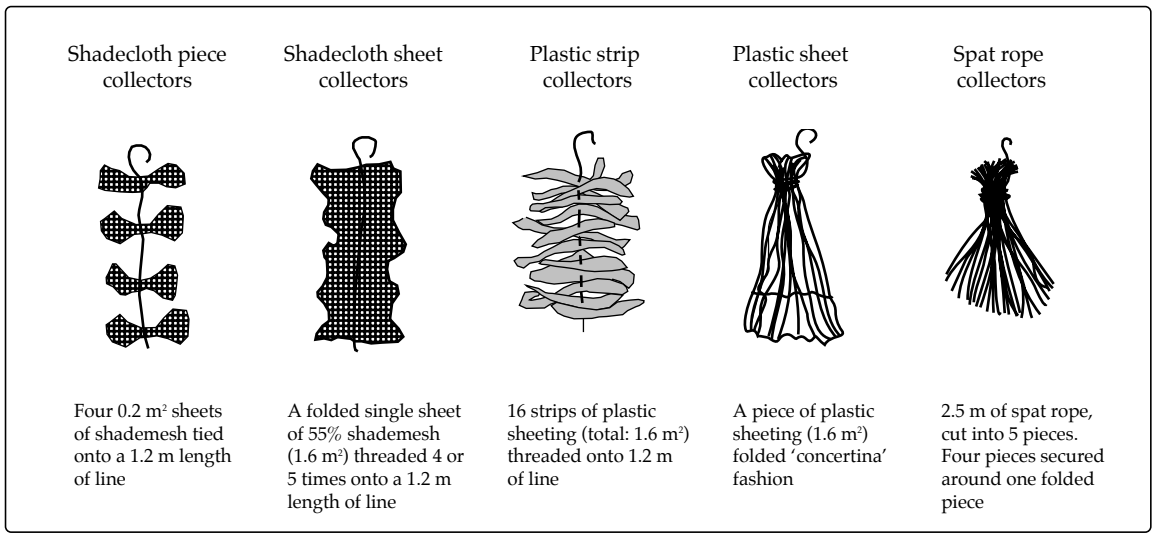


Figure 2: **Types of spat collectors used during the study**

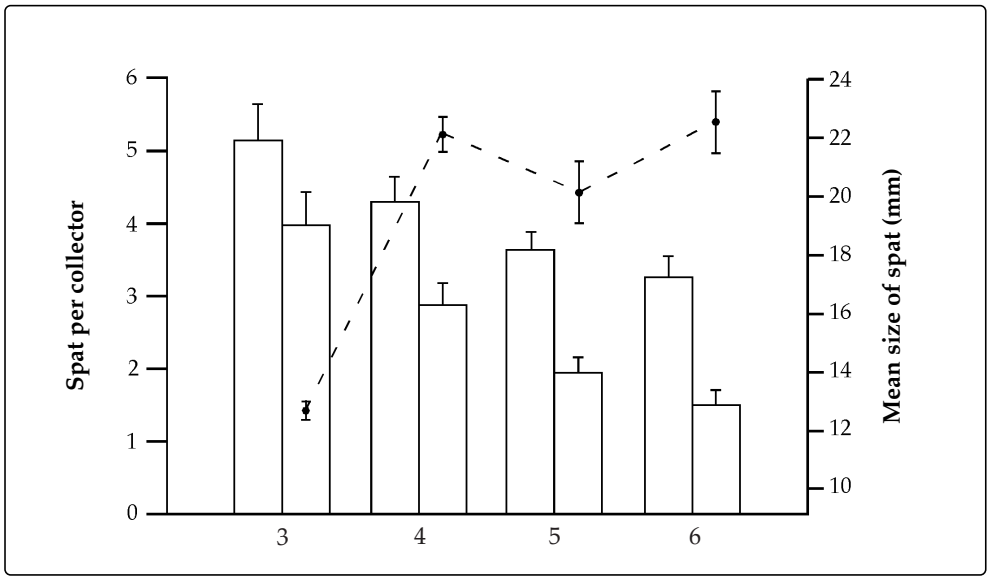


Figure 3: **Total (blank) and live (solid) abundance (±SE) of *P. margaritifera* spat harvested from collectors at 3, 4, 5 or 6 months from 9 sites in Solomon Islands. The dorso-ventral measurement (±SE) of live spat from each harvest is also given.**

tors; and (3) affect of removal of predators and algae from spat collectors during their period of immersion on the final number of spat.

The question of immersion time arose as collectors in early trials held large numbers of dead spat as well as recognised predators of juvenile bivalves. The mortality of spat and the presence of these predators—e.g. *Cymatium* spp. gastropods and portunid crabs—suggested that much spat mortality was due to predation. Consequently, we investigated whether spat survival was jeopardised by leaving them on collectors for six months, as practised in initial trials, or whether removing the spat earlier—after three, four, or five months—and rearing them in intermediate growout systems, could result in larger harvests.

We found that significantly greater numbers of live spat were retrieved from collectors immersed for three and four months than from collectors immersed for five and six months (Fig. 3). In addition, spat removed from collectors after three to four months had a good survival rate (> 82%) in intermediate growout systems.

It was proposed that shorter immersion times ensured larger harvests of live spat, as predators settling onto collectors did not have sufficient time to develop into a significant threat. However, if farmers were to harvest collectors after three to four months, they were obligated to ensure spat were robust enough for handling at harvest. (Spat must have a mean dorso-ventral measurement (DVM) of > 6–7mm.)

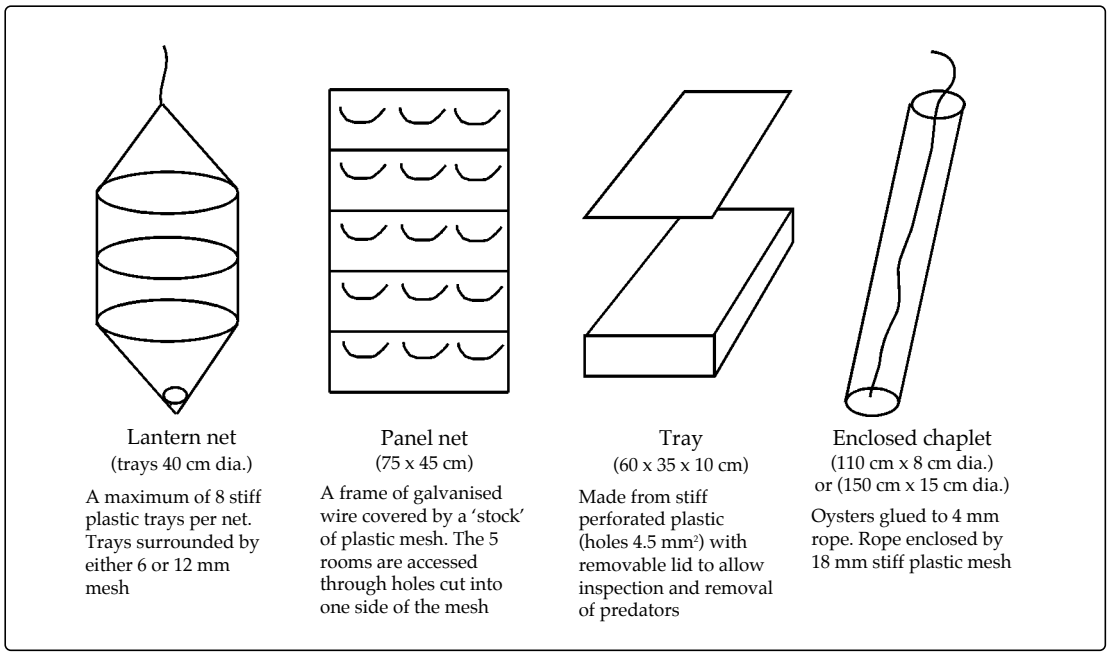


Figure 4: The intermediate culture systems used to grow out spat removed from collectors

In the second trial we examined whether catches from collectors harvested after three months, and re-deployed immediately, differed from those obtained from new—cleaned and dried—collectors. The rationale for this experiment was that re-deploying the same set of collectors, after removing spat, excess fouling, and predators, would reduce the number of collectors needed by the farmer and save the labour required to dry and restring collectors.

When the two types of collector were harvested, we found no significant differences in the number of spat on re-deployed and new collectors. However, when spat on the two types of collector were analysed for variation in spat size, the mean size of spat on re-deployed collectors was significantly larger than that of spat on new collectors. We also found that there were significantly greater numbers of predators (*Cymatium* spp. and crabs) on re-deployed collectors than on new collectors.

In addition to saving time and money, the advantage of deploying used collectors is that they might attract earlier settlement onto the dirty/conditioned surfaced of the collector, or that newly settled spat might remain on collectors after the first check, as they were too small to see. However, when using re-deployed collectors it must be noted that predators are equally advantaged.

In the third set of trials, two experiments were conducted to assess the effects of removing predators and filamentous algae from collectors *in situ* on the abundance of spat. Results from these trials showed that cleaning of collectors by divers failed to remove all predators. Not surprisingly, the abundance of live spat was not significantly different between the two types of collectors.

The growth of filamentous algae (mainly *Cladophora* sp.) varied greatly among collectors. Although collectors that were not cleaned had a greater mean biomass of algae than collectors in other cleaning treatments, this trend was not consistent across all sites. Overall, the cleaning regime did not have a significant effect on the abundance of spat.

From these results it seems best not to tinker with collectors during their immersion period. Spat of pearl oysters are cryptic settlers, and destroying the structure of a collector while looking for predators or removing algae may be more disruptive than beneficial.

Growout trials

Culture of spat removed from collectors

Growth and survival of spat removed from collectors were monitored in various growout units (lantern nets, sandwich nets, and prawn trays, see Fig. 4). In the 3.5 years of trials, growth and survival of oysters were affected by spat size and the type of growout system used. Throughout the trials, spat were very susceptible to predation especially by reef fish (Balistidae) and *Cymatium* gas-

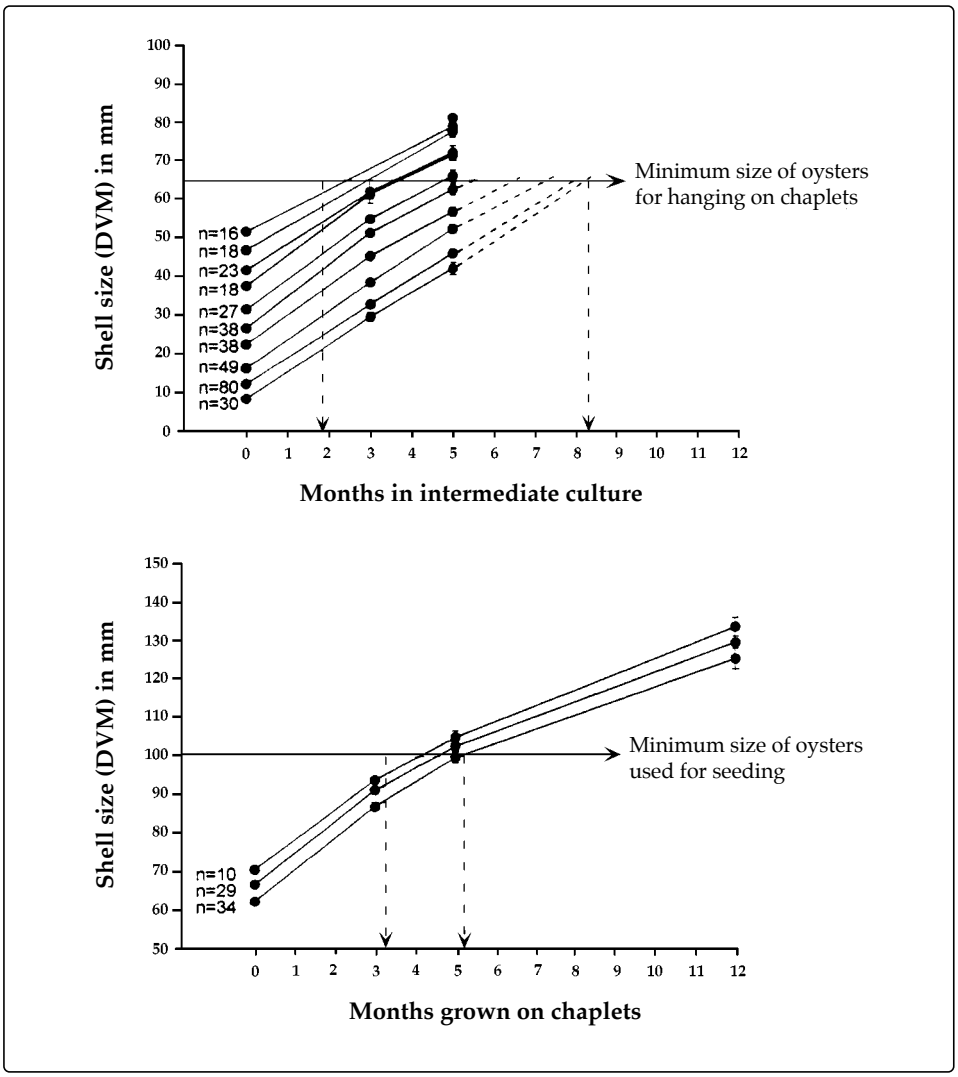


Figure 5: **Growth trajectories for oysters of different sizes a) entering intermediate culture, and b) placed on chaplets for grow-out**

tropods. Problems with fish were mostly eradicated when growout longlines were set in deeper water of at least 30 m (also > 40 m from reef). To overcome problems with other predators, checks to clean nets and remove predators were required every 10–15 days.

Initially, lantern nets were used to hold spat removed from collectors. The hard-to-get-to spaces and overall design of the unit made it difficult to remove *Cymatium* gastropods that settled into the nets and to clean algae fouling from meshes. Panel nets, which sandwich oysters between two layers of mesh pulled stiffly on a frame, greatly improved survival of oysters. These nets could be brushed more easily to remove algae fouling, and had fewer spaces that *Cymatium* could settle into. However, growth rates in panel nets were lower than in lantern nets, especially for spat in the smallest size groups (7–15 mm DVM), which required finer mesh coverings (6 mm mesh size). In addition, the wire sides and dividers of the panels often interfered with normal shell growth.

To overcome these problems we assessed growth and survival of spat held in prawn trays. The trays were made of stiff plastic mesh and had flip-up lips that allowed easy access for predator checks. These units gave the best compromise for growth and survival, and allowed easy handling of growing juveniles. However, we still found problems, as oysters placed individually into trays tended to form clumps. Growth of individuals caught inside clumps of oysters tended to be stunted, possibly because there was increased competition among individuals for food.

To combat this, cyano-acrylate glues were used to attach individual spat within trays. Growth and survival of oysters glued in trays or directly onto

ropes were compared with spat placed loosely in trays. We found that the use of glue to attach oysters to trays and ropes maximised growth and survival of juveniles held in intermediate culture. By stopping the oysters from clumping, there was no chance of oysters becoming trapped within clumps of other oysters and also fewer places for *Cymatium* to hide. Gluing spat directly onto growth units also allowed them to be held behind larger mesh sizes that would protect spat from fish but would be too large to retain the oysters if they were loose within the unit.

The growth of oysters removed from spat collectors and placed in intermediate culture is shown in Figure 5.

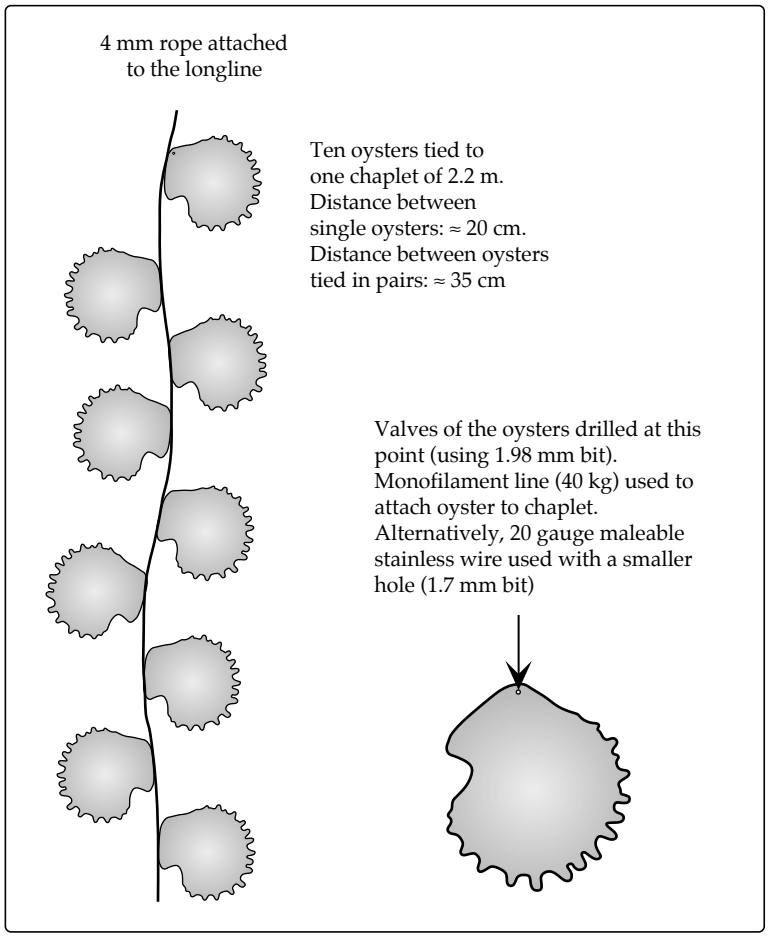


Figure 6: Chaplet system for growing out oysters and holding seeded stock

Growth and survival of oysters on chaplets before seeding

Oysters drilled and hung on chaplets (Fig. 6) had satisfactory survival rates and grew relatively quickly in the open-reef systems of Solomon Islands. From a monitored batch of 2000 oysters, 5.8 per cent were lost after a culture period of more than seven months. Most of the losses were due to shells breaking off the chaplets. Less than one per cent of oysters died on the chaplets.

The growth of oysters attached to chaplets at different sizes is shown in Fig. 5. Oysters attached at a size of 60–65 mm DVM attained the minimum size of 100 mm DVM required for pearl seeding within five months. When oysters were attached to chaplets at a size of 70 mm DVM, they were large enough to seed four months later. Most oysters caught as spat and reared in these trials reached 100 mm DVM within 14–16 months. By contrast, blacklip oysters take 20–22 months to reach this size in the Cook Islands (J. Lyons, pers. comm).

Oysters in the relatively nutrient-rich habitats of Solomon Islands had more fouling than those in the atoll lagoons of Polynesia. To identify a cleaning regime that provided satisfactory growth and survival but minimised labour for oysters held on chaplets, we trialed a number of cleaning frequencies (two, three, four, and six weeks). Cleaning involved brushing the oysters to remove algae. The oysters were measured before and after the seven-month growout period of the experiment to assess any differences in growth and survival of oysters among the different cleaning frequencies.

Despite the fact that algae grew heavily on the oysters, covering some of them completely, survival under all cleaning regimes exceeded 96 per cent. When the growth rate of oysters being cleaned after two, four, or six weeks was analysed, oysters cleaned every three weeks had a significantly higher mean growth rate than oysters cleaned on a two-week or six-week schedule. There was no significant difference between growth rates of oysters cleaned at three-week and four-week intervals.

As already indicated, some adult oysters fell from chaplets during growout because the holes drilled in their shells broke open. However, we observed that oysters that made byssal attachments remained fastened to the chaplets even when the drill hole failed. In most cases, this was because the oyster attached to another oyster on the same chaplet. The risk of losing oysters should therefore be reduced by attaching them to chaplets in pairs, rather than staggering them along the chaplet, as is commonly practised elsewhere. When byssal

attachment was assessed and oysters were re-measured after a four-month trial, it was found that oysters tied in pairs made attachments to each other in 95 per cent of cases, whereas only five per cent of oysters hung individually along the chaplet attached firmly to the rope. Another advantage of attaching oysters in pairs was that one valve of each oyster remained relatively free of fouling, so average cleaning times for paired chaplets were significantly shorter than for chaplets holding oysters attached singularly. A disadvantage of attaching oysters in pairs was that growth was reduced by an average of 1.8 mm over the trial period of four months.

Seeding of oysters to culture pearls

Oysters collected as spat between December 1995 and April 1996 and which had attained a size of at least 100 mm DVM, were conditioned for seeding in August 1997. Conditioning involved ceasing cleaning six weeks before seeding and alternately lowering and raising the longline holding the oysters between 5 m and 10 m once every week for three weeks before the seeding operation. The latter procedure was designed to induce the oysters to spawn without stressing them unduly. Conditioning the oysters by this and similar procedures is thought to prepare them for the seeding operation and reduce the number that reject the nucleus.

In September 1997, approximately 2,000 oysters were prepared for seeding by John Lyons, a pearl farmer from Cook Islands. Once each oyster was implanted with a nucleus and mantle tissue from a donor oyster, it was surrounded in a fine mesh catch-bag and returned to the growout longlines. The bags were checked after 30 days, so that oysters that had rejected the nucleus ('vomits') could be removed from the longline.

The seeding trial was used to test some obvious sources of variation seen in the oysters. First, we investigated differences between the performance of oysters derived from spat and those collected from the wild as adults. The proportion of oysters in each group surviving, and the proportion that retained the nucleus, was recorded after 30 days.

Second, we examined differences in the performance of the black and orange colour morphs of the species. This was an important experiment for prospective pearl farmers in Solomon Islands because the ratio of the two colour morphs of oysters is approximately 1:1. In Cook Islands, the orange morph is rare (1:2000) and there are anecdotal reports that it is less suitable for seeding than oysters with black mantles (R. Newnham, pers. comm.). To determine whether orange-coloured individuals have acceptable nucleus retention and survival, we recorded the colour of each oyster seeded. We also set up a reciprocal transplant experiment in which mantle tissue from black oysters was used to seed black and orange morphs and mantle tissue from orange oysters was used in both morphs. The aim of this experiment was to determine if any particular combination of mantle colour and oyster colour resulted in greater mortality or numbers of vomits.

After 30 days, 64 per cent of oysters grown out from spat had retained the nucleus. The retention rate for wild adult oysters was 46.9 per cent. The lower rate of retention by wild oysters was due to the fact that more of them died after the operation.

The retention rate for black morph oysters was only marginally greater (65.6 per cent) than for the orange colour morph (62.9 per cent). Mortality was eight per cent for the black and ten per cent for the orange colour morph. When we tested for differences in retention rates due to the colour of donor, mantle orange donated to orange oysters resulted in the lowest rate (53 per cent) and the greatest mortality (18 per cent). There were few differences in retention and mortality among the other three combinations of mantle and oyster.

These were the first blacklip oysters to be seeded in Solomon Islands. It will not be until early 1999 that oysters seeded in this trial will be harvested and any assessment can be made on the effects of oyster origin (wild/spat collected) or mantle colour on pearl quality. Once the pearls are harvested and the culture cycle has been completed, a full comparison of the relative advantages and disadvantages of pearl farming in the open reef systems of Solomon Islands can be made.

For further information please contact:

Kim Friedman,
Aquaculture Department,
James Cook University,
Townsville, QLD 4812
Australia.

Tel.: +61 747 81 5546
Fax: +61 747 81 4585
E-mail: Kim.Friedman@jcu.edu.au

Pearl industry takes off in the Marshalls

by Alice Keesing

Source: *SEAGRANT* publication

Strung out across the Pacific, the turquoise lagoons of the Marshall Islands are poised to host a thriving black pearl industry. Black pearl culture is a US$ 150 million per year industry in French Polynesia, and industry experts estimate it could more than double in the next decade.

Sea Grant Pacific Regional Aquaculture Specialist Simon Ellis is busy atoll-hopping between the new farms providing technical assistance. He said pearl farming is an ideal way to diversify the Marshallese economy.

'The beauty of pearl farming is that a lot of money goes back to the community,' Ellis said. Tending the oysters is also labour intensive, providing much-needed employment.

Sea Grant Pacific Region Sustainable Business Development Agent Anne Orcutt-Bailey said the Marshall Islands will see its first small harvest this year. One of the first hurdles to developing pearl farms in the Marshall Islands was finding enough oysters to work with. For farms in French Polynesia and the Cook Islands, it's simply a matter of collecting spat (young oysters) from the wild population.

Another answer, according to the Hawaii-based Black Pearls Inc., is hatcheries. BPI directors Neil Sims and Dale Sarver have developed a technique to hatch and grow out the Marshallese black pearl oyster.

Working with the Marshall Islands Marine Resources Authority on Majuro, BPI produced more than 600 000 spat last year in a single hatchery run. Many of these oysters are now growing out in Majuro Lagoon.

BPI envisions forming joint ventures with local farmers to start up two new farms in Majuro and the outer islands. Sims said under this arrangement, the Majuro farm could serve as the nucleus, providing spat and other support services for the satellite farms.

Sea Grant is working with the College of the Marshall Islands to develop training programmes. A pearl oyster culture manual and video are also in the works.

Co-operating in the ventures are: Black Pearls Inc.; Black Pearls of Micronesia; Robert Reimers Enterprises; College of The Marshall Islands Land Grant; Marshall Islands Marine Resources Authority; UH Sea Grant Extension Service, Department of Agriculture SBIR and Center for Tropical and Subtropical Aquaculture, Department of the Interior, Office of Insular Affairs.

Sea Grant's Pacific Program is funded in part by the U.S. Department of the Interior, Office of Insular Affairs. Visit the Pacific Program online at **www.soest.hawaii.edu/SEAGRANT**.

Hatcheries reduce stock concerns for Australian industry

by Dos O'Sullivan

Source: *Austasia Aquaculture*: 12(2) April–May 1998

Hatchery production of pearl oysters has been operating commercially for more than five years in Australia. Concerns about over-exploitation of wild stocks, or decreased access to them due to land/water claims by indigenous populations, are now being overcome through the increased availability of good quality hatchery-reared shell stock. One farm in the Northern Territory is moving along quickly.

Australian pearl farmers are leading the world in the production of high quality pearls from the silver or golden-lipped pearl oyster, *Pinctada maxima*. In the past all the shell stocked on farms has been collected from the wild by divers under a quota system. But not any more.

Adam Miocevich, one of the previous owners of Bynoe Harbour Pearls, believes that hatcheries are an important way to guarantee supplies of shell to pearl farms. 'There are a number of pearl hatcheries operating in Australia at present,' he told *Austasia Aquaculture*, 'and they're able to supply many of the farms. Currently, the hatchery at Stokes Hill Power Station provides our hatchery-reared stock. With time we'll probably build our own hatchery so we can be totally independent of any other operations.'

'We prefer to buy our spat—3.5 to 4 mm, about 60 days old—at the beginning of the wet season in December, although stock is available past April. The wet means good temperatures of around 29°–30°C and plenty of phytoplankton for food. However, strong tides can be a problem, stirring mud and depositing it on the shell. Thus we have to keep washing the shell.'

Concerns not justified

According to Adam, quite a few Australian growers are worried about overproduction due to increased stock holdings of hatchery-reared shell. 'Certainly Indonesia, Vietnam, and other places are setting up lots of farms,' he said, 'but the best technology and most skilled people are in Australia. Our water is a more constant temperature and we are not affected by too much rain, two important factors in producing the best pearls. Australia will continue to produce the highest-quality pearls.'

'Look at the Japanese akoa (freshwater pearl) industry. At an annual value of $US 300–400 million, the industry is worth more than twice the Australian South Seas Pearl industry. However, their small product is not as valuable as a South Seas Pearl, and it's the same with black pearls: lower quality and lower prices. We can concentrate on producing bigger and rounder and more luxurious pearls. We don't worry about producing large number of pearls, so we can take better care of them. The result is an overall bigger and better-looking product.'

Nursery phase important

To date, Bynoe has stocked over 4000 hatchery shells, mostly 60 to 80 mm across. They are usually shipped from the hatchery dry, in polystyrene boxes in lots of 50–60 000. High mortalities in the early stages have shown that during the nursery phase it is very important to keep the small shell (juveniles) clean of mud or fouling organisms. 'The shell can still move around by themselves, so they're great escape artists', Adam said. 'Thus you need a good system to hold them'.

To date he and his partners have tried five different nursery systems. Some systems are located in floating cages, others on the bottom.

Site selection is also critical. A constant water temperature and salinity are also important for the good survival and growth of the young shell,' he said. 'Big tides can be a problem, but our nursery areas are pretty well sheltered.

'Prices for hatchery-reared spat are determined by market forces, but I have been averaging around AU$ 0.11, usually on the smallest size. A seven-day period is used to see how many survive the initial transition.

'At present there is no fishing for shell in the Northern Territory—the beds are too deep—so all our stock comes from Western Australia. The Queensland stock situation is really on a site-by-site basis, but there are no really viable beds there', Adam said. 'The quota system has been introduced to protect wild stocks. Now, with hatchery-reared stock, the industry's long-term status is more assured. For example, more than 84 per cent of the coastline in the Northern Territory is either owned by Aborigines or under a claim, which means that new sites will be hard to access.

'Our site is one hour from Darwin, so it's much cheaper to run than those in remote areas. We don't need to use a floatplane or large ship to bring in workers and supplies. We also have pretty clean water, with low mud content and smaller tides.

'While we can buy shell from hatcheries in WA, we prefer to utilise local genetic stock. There is up to a 2°C difference in hatchery water temperatures between the two areas, which can cause mortalities in your shell if you're not careful.

For more information contact: Adam Miocevich, Bynoe Harbour Pearls, P.O. Box 106, Darwin, NT 0801, Australia; Tel.: +61 8 8978 2428; Fax: +61 8 8978 2527

Northern Territory – Pearl culture farm to be established in native title waters

Source: *The Age* (18 October 1997)

The first native title agreement over Australian seas has been signed by traditional Aboriginal owners and a Japanese–Australian pearling company. The agreement will see a pearl culture farm established in waters adjacent to Croker Island, about 200 km north-east of Darwin. Employment, training and infrastructure opportunities will be provided by the farm to the traditional owners, as well as AU$ 2 million in royalties during the 20 years of the agreement.

Stock assessment funded by Australia's FRDC

Mother of Pearl (MOP) stock evaluation in Western Australia will determine stock status in Zone 1 and nuclei production quality in Zones 2 and 3, so that sustainable harvest levels can be maintained in each of these fishing zones. WA pearling, the nation's most valuable aquaculture industry with annual earnings of up to AU$ 200 million, is also the world's last significant source of the wild mother of pearl used for culture. As well as seeking new sustainable harvest levels for production of conventional pearls, the industry also has an eye on the potential to use MOP as a source of large nuclei, which can produce special high-value pearls up to 20 mm in diameter. To date, such pearls have been cultured almost exclusively using nuclei made from a US freshwater mussel, which is now listed as threatened.

Project 98/153. Principal Investigator: Anthony Hart, Fisheries WA, phone +61 8 946 8444.

Note: FRDC is the acronym for the Fisheries Research and Development Council

Black pearl nucleus implantation techniques

by Dos O'Sullivan

Source: *Austasia Aquaculture*: 12(3) June–July 1998

According to Dr Maria Haws, 'Pearl production is one of the few highly lucrative and sustainable development opportunities for many island nations'.

However, the main hurdle is the availability of skilled technicians to seed, or graft, the nuclei, which is the first stage of cultured pearl production. 'The skills of the technicians affect the retention rate of the nuclei and also the quality, size and uniformity of colour of the pearls', she said. 'The majority of these technicians are highly-trained Japanese nationals who function as a professional guild, closely guarding the technology. Within the last 15 years, however, more non-Japanese have learnt to perform the procedures, but generally with a lower rate of success. Technology transfer occurs through limited opportunities for observation and extensive trial and error, resulting in high mortality rates, poor quality pearls, and financial loss'.

Dr Haws found that even the finest technicians have highly variable success rates, even low success rates. 'This further impedes the probability of establishing and operating a profitable pearl farm,' she pointed out. 'During the first 45 days of the post-implantation period, the best technicians can expect a 60–80 per cent retention rate. Of the remaining pearls, more than 50 per cent may be of such poor quality that they cannot be sold'.

She said that a variety of critical factors in the implantation procedure and farm management were responsible for host pearl-oyster mortality, implant rejection, and poor nacre quality.

Dr Haws said that spat were collected in many areas of the Pacific Islands and grown to about 8 cm (12 months old) by specialist nursery operators. The prices for spat can fluctuate widely according to supply and demand; in French Polynesia they are sold to farmers at US$ 0.60 to US$ 1.00 each. They are then held in wire or plastic mesh panels hanging from longlines or rafts.

At about 15 cm (18 months) the oysters are ready for nucleus implantation. According to Dr Haws, an empty gonad is known to elicit better results so the pearls are induced to spawn by pressure and temperature changes. This can be done simply by releasing the anchor lines on the longlines to allow the lines to come near the surface.

After the gonads are spawned out, the technician will select donors for the graft. They are usually healthy young oysters with good shell lustre and smooth nacre deposition. Generally, only one in every seven potential donor oysters examined is selected to be used for tissue grafting. The entire mantle is not used: usually only 15–20 grafts are taken from each oyster. Preparation involves sizing with scissors, using a sponge to remove mucus, and holding the graft on wet hardwood blocks. A 2 mm-wide, 15 mm-long strip is selected. This is cut into 2–3 mm-wide sections that cover one-quarter to one-third of the nucleus.

Also healthy and young, the host is usually at least 15 cm long. It should have gonadal tissues that are strong enough to retain the nucleus. However, they should preferably be empty of gametic material.

An incision is made in the gonad at a constriction. The shape and size of the gonad determine the size of nucleus to be utilised. The nucleus is inserted into the gonad next to the mantle graft: it is important that the epithelial cells of the mantle are facing the nucleus. This graft grows around the nucleus to form the pearl sac.

After about 45 days, the pearl oysters are retrieved from the farm and inspected, either by an X-ray machine or visually, for nucleus retention. Dr Haws noted that pearl oyster mortality could range from 5 per cent to 90 per cent. Those oysters retaining the nuclei are returned to the water.

'Over the next 12 to 24 months, as long as environmental conditions are suitable, some 2–3 mm of nacre will be deposited on the nucleus', Dr Haws said. 'The pearls are usually harvested by the same technician who implanted them. If the quality of the pearl is high, a similar-size nucleus may be inserted into the opened pearl sac.'

'About 18 000 pearl oysters would be needed to produce 6000 pearls. You would need to present 14 000 oysters to be seeded plus at least 666 donors. After on-farm mortalities, you will have approximately 10 000 pearl oysters. With a 60 per cent retention rate, some 6000 will be harvested.

'A good harvest would give five per cent grade-A pearls, 1200 grade-B, 1200 grade-C, and 3300 grade-D, and would give a gross return of US$ 30 000, and an 80 per cent rate would provide some US$ 60 000.

'The Japanese technicians give very good results. They also offer technical advice on farming methods and are able to assist in marketing. However, they are expensive and have a few other disadvantages. An increase in locally-trained technicians could assist the further development of the industry.'

Dr Haws went on to say that the number of seeding technicians available fore hire (≈500) is insufficient to service the number of existing and potential farms throughout the Pacific Islands. She recommended research to improve the existing technology, then disseminating the results and providing increased technical assistance to allow further development to occur.

To assist in training, Dr Haws has been working with Anne Bailey and Michael Ogden in the production of a pearl culture manual and a videotape entitled *Producing Black Pearls*. According to Ms Bailey, it is a general introductory tape on what it takes to set up a farm and it should be released mid-year. In addition, a video and a manual, set for release in October-November, are being produced on black pearl grafting. All these materials will be available through Sea Grant, University of Hawaii (contact Anne Bailey on fax: +1 808 956 2858, e-mail: **aorcutt@soest.hawaii.edu**) at a nominal price. 'The videotape series is evolving as a means to encourage more pearl farming in Micronesia and elsewhere,' Ms Bailey explained. 'It will feature results of our Micronesian research projects that focus on improving black pearl culture technologies'.

For more information contact Dr Maria Haws, Coastal Resources Centre, University of Rhode Island, 220 South Ferry Rd, Narragansett, RI 02882, USA, e-mail: **mhaws@gsosun1.uri.edu**

Aquaculture going swimmingly in the Pacific Islands

Source: CTSA Regional Notes

The new MERIP marine laboratory is just one of a number of exciting aquaculture developments in the US-Affiliated Pacific Islands. After a slow start, aquaculture has established a small but solid and growing presence in American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, the Republic of Palau and the Republic of the Marshall Islands.

In the Marshall Islands, three farms, one of which is privately owned, are culturing the black pearl oyster, *Pinctada margaritifera*. One pearl oyster culture facility is also operating in the Federated States of Micronesia, according to Simon Ellis, the CTSA-funded aquaculture extension specialist serving the US-Affiliated Pacific Islands. In addition, two new farms are being built.

A major constraint to development of the industry in the Marshall Islands is the lack of young oysters, known as spat, in the wild. A private Marshallese company, Robert Reimers enterprises, recently obtained a grant from the Department of the Interior to establish a system to collect spat from an area where they seem abundant. Ellis and Dr Maria Haws will coordinate the grant. Haws is an expert in pearl oyster culture who served as the CTSA extension specialist during the summer of 1996.

Mysterious virus plagues Japanese Akoya industry

by Dana Canedy

Source: *The New York Times NATIONAL*, Sunday, 24 May, 1998

In simpler times, only nature could make a pearl. Then mankind came up with the cultured variety, and pearls were transformed from nuggets of magic to predictable commodities. In recent years, though, nature has struck back: A mysterious virus has teamed up with disruptive weather patterns to kill more than half the oysters in the world's busiest undersea factory.

At first, shoppers at jewellery counters were blissfully unaware of all this because dealers, alerted to the blight, kept plenty of pearls on hand. But those supplies are running short, and suddenly just in time for prom and wedding season pearl prices are shooting up.

Luxury chains like Tiffany & Company as well as small, family-owned jewellers like Wilson & Son in Scarsdale, N.Y., have been forced to raise prices, in some cases by as much as 25 per cent, for top-quality strands. And prices are till rising. A necklace that cost US$ 800 to US$ 1200 a year ago might bring US$ 1500 today. A set of single-stud earrings now costs US$ 200, up from US$ 170 this time last year, according to the Cultured Pearl Information Center.

'This could not have come at a worse time, because pearl demand is way up,' said Devin Macnow, executive director of a trade group, which is financed by the Japan Pearl Exporters Association.

But the surge in consumer demand for luxury items, born of the powerful economy, pales next to the death of millions of Akoya oysters in Japan's coastal waters in the last few years.

In 1996, the last year for which full figures are available, 150 million Akoya molluscs died, according to the exporters' group. Cultured pearls dominate the American market, and half of them come from Japanese Akoya oysters.

The problem has been building for a decade, but became acute in 1996 and 1997, said Ichiro Nomura, a director of resources and environmental research at the Japanese Ministry of Agriculture, Forestry and Fisheries in Tokyo. 'The cause of increased death is yet to be known fully, and scientists of our agency are making their best efforts to identify it,' he said.

So, to meet demand in the United States, the largest pearl market after Japan, exporters have been reducing shipments to other countries, like Switzerland and Singapore, and also reserving more of the finest quality pearls for sale here. In addition, exporters have been shipping more pearls to the United States from China, but their ability to shift distribution is too limited to offset the shortfall.

So American jewellers must simply wait for nature and science to strike a balance.

When they first received word of the dying oysters, retailers increased their pearl orders and, for a time, had a surplus. But as the death rate accelerated, and inventories fell, retailers say they had no choice but to pass higher costs on to customers. The biggest price increase is for top-quality pearls, which even in a good year account for less than 5 per cent of a total harvest.

'It has become more difficult to procure fine-quality pearls,' said Linda Hanson, senior vice president for merchandising at Tiffany. 'We have adjusted some pearl pricing over the past several months and probably will be adjusting some others prices in the next few months as well.'

The supply problem will last until at least 2001, the minimum amount of time needed for young, healthy oysters to mature and produce pearls. But it could drag on even longer because it is too soon to tell whether the young oysters will remain healthy.

'All we can do is stay away from these areas considered the problem,' said Koichi Takahashi, senior vice president of the Mikimoto (America) Company, the largest distributor of cultured pearls in the United States, which operates its own oyster farm in Japan.

So jewellers like Matthew Wilson are left to wonder just how long they can keep from, once again, raising prices. Because he doubled his wholesale pearl order this year, Mr Wilson, an owner of Wilson & Son in Scarsdale, said his supply should hold up for a while. But he cannot afford to buy nearly as many pearls as he would like, and says he will have an even tougher time buying enough next year.

Gold dealers and the costume jewellery trade may be counting on finding a competitive edge. But with consumer confidence so high, jewellery

experts predicted, shoppers will still plonk down gold cards for pearls.

'Price is not an object in this market,' said Lynn Ramsey, president of the Jewellery Information Center in New York. 'In fact,' she added, 'the shortage may make pearls even more appealing.' 'People are willing to go to great lengths to get something of rarity and value,' she said.

Still, even in this market, not everyone can afford to pay top dollar, so bargain-hunters may opt for a single-pearl pendant instead of a strand or may choose lower-quality cultured pearls, whose prices are also rising but not as rapidly.

Farmers were first alerted to the problem when scientists noticed that an increasing number of oyster muscles were turning red or brown, which signalled that they were likely to die. Farmers then began to isolate healthy oysters, but even that did not make a difference.

Three factors are generally accepted as the most serious causes: climate changes, red tide—a severe rise in plankton, microscopic organisms found naturally in the water that cause the colour to turn red and kill the oysters—and an unrelated mystery virus. Speculation about other possibilities range from the use of chemicals in fish farming to poor oxygen levels in water because of overcrowding of oysters in cages.

Red tide and unpredictable weather have sent the pearl industry into turmoil at various times over the years, but the virus that has scientists perplexed is a relatively new nemesis. Scientists are not sure of its origin, but they think that once it took hold, unseasonable warm weather increased water temperatures and enabled it to thrive.

'Everybody is blaming everything, and it is really hard to determine what is the main cause,' Mr Takahashi of Mikimoto said. What is not in dispute is that if the industry is unable to find a solution, brides may soon have as hard a time affording high-quality cultured pearls as that perfect wedding gown.

Virus losses create strong demand for pearls

Source: Georges Boylen, in The West Australian (12 June 1998)

The Japanese pearl culture industry is suffering from ecological factors, including a mystery virus and red tide caused by warmer than usual oceans, that have killed more than half the word's pearl-producing oysters. As a result, prices are rising sharply and demand has strengthened, and the Western Australia pearl industry is benefiting.

Cultured pearls revealed to be an Australian invention

by Dos O'Sullivan

Source: *Austasia Aquaculture*: 12(4) August–September 1998

The famous Mikimoto was not the first person to discover how to produce a cultured pearl from a pearl oyster. It was an Australian fisheries officer named William Saville Kent in 1890. John Saltmarsh, who has been involved in the pearl industry in Queensland for more than 15 years, sets history straight.

One of the best-known pearl farmers in Queensland is John Saltmarsh, whose family-run Roko Pearls has been operating in Torres Strait for more than 15 years. At a recent conference, John surprised a lot of people by pointing out that Mikimoto was not the first person to produce cultured pearls—it was an Australian fisheries officer in 1890.

Long history of exploitation in Australia

For more than 100 years, pearl oysters in northern Australian waters have been fished for mother-of-pearl (MOP) shell. Any natural pearls that were found were considered a bonus to the shell-collection operations. As a result, pearl oysters are often referred to as 'shell'. During World War II, the MOP industry survived severe disruption, but has never fully recovered, due to the introduction of plastic for manufacturing buttons.

As early as the turn of the century, efforts were being made to cultivate pearl oysters. In the 1890s,

G.S. Streeter of Broome was reputed to have grown half pearls in Roebuck Bay by drilling minute holes in live oyster shells and inserting small studs of mother-of-pearl to form the nucleus.

The pearl culture industry began in earnest in 1956, when a farm belonging to Pearls Proprietary Ltd was established as a joint Australian–Japanese venture at Kuri Bay, 420 km north of Broome, Western Australia. By 1973, Kuri Bay was reported to be producing around 60 per cent of the world's finest round pearls, as well as the half pearls and baroque pearls. The pearl culture industry is now Australia's most valuable aquaculture industry, worth AU$ 200–250 million annually.

The main culture species is the golden-lipped *Pinctada maxima* farmed in the north-west of Western Australia (mostly around Broome), the Coburg Peninsula and Darwin/Bynoe Harbour regions of the Northern Territory, and north Queensland, especially in the Torres Strait region. Divers harvest wild-stock pearl oysters from the seabed under a quota system to prevent overfishing the stocks.

Traditional raft culture is still used in some parts of Queensland; however, most farmers use surface or sub-surface longlines. Bottom culture still exists in a few areas. Plastic mesh net panels hold the pearl oysters in individual pockets and this assists regular cleaning using high-pressure water jets on board small tender boats.

How Mikimoto got the pearl-making secret

'Everyone considers the famous Mikimoto to be the discoverer of the secret that had eluded man throughout history—a method of making a pearl oyster produce a pearl', John Saltmarsh told *Austasia Aquaculture*. 'The story of the young Japanese noodle-dealer's son with his dream of making pearls available to ordinary women of the world has been told many times, most recently in a documentary, 'The Mystique of the Pearls', shown on national TV. Mikimoto was indeed one of the truly great entrepreneurs of our time—but he didn't invent the cultured pearl'.

John said that while Mikimoto probably did more than any other man to build the pearling industry he did not discover the secret of the pearl.

'In 1907, two other Japanese independently applied for a patent over a technique for producing a spherical pearl in a pearl oyster. One, Mr T. Mise was a village carpenter; the other, Dr Nishikawa was a science graduate. One lived on the north island of Japan, the other on the south island.'

The story is certainly strange as the two men did not know each other and had never met. Yet within a week of each other they both submitted patent applications for a method of producing cultured spherical pearls. And the technique in both applications was identical.

John said that Mikimoto then took the process to glory, but the patent for the technique and principles was granted to Dr Nishikawa, to be jointly owned by Mr Mise.

But how did Dr Nishikawa and Mr Mise discover the secret of pearl making? To answer this we need to go to Australia.

An Australian was first

In Northern Australia, the late 1800s were the era of the great Japanese pearling fleet, the Arafura pearling fleet. According to John Saltmarsh, at times more than 400 Japanese vessels were working Torres Strait and as many as 2000 Japanese nationals were based at Thursday Island.

Pearl shell was a valuable commodity on the world market, which was dominated by the Japanese.

'The Commissioner of Fisheries in Queensland at that time was William Saville Kent', John told us, 'He was fascinated by pearls. He studied the technique for culturing half pearls used by the Chinese, who for many years had been producing MOP images of Buddha. They would drill a hole through the shell of a freshwater pearl oyster, place a tiny brass Buddha against the inside of the shell under the mantle, then secure it in place with a piece of thread pulled through the hole that they'd drilled in the shell. This was also the technique used by G.S. Streeter.

'Saville Kent improved on this by securing the nucleus to the inside of the shell with hot resin glue. He started Australia's first cultured pearl farm in Albany Passage, near Thursday Island. His half pearls fetched high prices and he spent years experimenting with round pearls. In 1890 he was successful and produced a genuine spherical cultured pearl.'

John said it was doubtful that Saville Kent fully appreciated the worth of what he had done, as he was willing to discuss his technique with anyone who showed an interest.

He promised to publish an account of his method, perhaps with an eye to the commercial possibilities, but he never got around to it. When he died in 1906, his farm at Albany was sold, together with his techniques and methods.

Dr Alvin Seale in the *Journal of Science* in July 1910 reported that the Australian who had purchased Saville Kent's experimental pearl farm had succeeded in growing spherical pearls using techniques bought with the farm. 'The gentleman must have lost interest, however, as there are no further records of the Albany farm until recent times', John said.

To get back to Dr Nishikawa and Mr Mise—they did have one small point of contact. Both Mr Mise's stepfather, whom he lived with, and Dr Nishikawa were fisheries officers with the Arafura Pearling Fleet at Thursday Island at the time that William Saville Kent just couldn't help talking about his technique for culturing round pearls.

In 1968, author Joan Young Dickinson was the first to make public this amazing coincidence. In her *The Book of Pearls*, she wrote, 'It seems that some time around the turn of the century an unsung Australian oysterman hit upon the method . . . and passed accidentally his secret unwittingly to these two brilliant young Japanese.'

Australian cultured South Sea pearls are recognised as the premium product in a very specialised and valuable market, so it's nice to know that an Australian was responsible for discovering the process.

For more information, contact: John C. Saltmarsh, Roko Pearls, Roko Island, Torres Strait, QLD (Postal address: P.O. Box 343, Thursday Island, QLD 4875), Tel : +61 7 4069 1769; Fax : +61 7 4069 1924.

References

The section on pearl production and the early history of the Australian industry was taken from a paper by David (Dos) O'Sullivan, Rick Scoones, Derek Cropp and Owen Bunter entitled 'The Old and the New of Australian Pearl Production', which was presented at World Aquaculture '98 Las Vegas, USA 15–19 February 1998.

First Paspaley 'Special Strand Tender'

Source: Australian Jeweller, March 1998

Paspaley Pearls, the largest producer of the world's finest pearls, together with its associates Nippo Pearl Co. Ltd of Japan, Hamaguchi Pearling Co. Ltd and Kyokko Ind. Co. will for the first time sell its pearls in strands (pearls are normally sold loose). The 'First Paspaley Special Strand Tender' will be comprised of Paspaley's finest completed strands from the 1997 harvest. These perfect pearls take years to create.

After carefully matching the natural colour, shape, size, skin and, most importantly, lustre, of the world's rarest pearls, only 43 strands have been created from this year's harvest. Conservatively valued at over US$ 10 million, each strand consists of 29 large (15 mm to 19 mm) round, silvery white, South Sea Pearls—some of the strands worth over US$ 1 million. Among the strands is a single outstanding golden strand. The increasing popularity of this rare colour saw a strand's worth of last year's finest golden loose pearls more than triple their reserve price at the 1996 harvest auction.

'These gem quality South Sea Pearls are the creme de la creme of our 1997 harvest and the strands are the world's finest, attracting many rich and famous buyers. Every year I become increasingly curious to see who will wear these beautiful strands,' says Nicholas Paspaley, managing director of Paspaley Pearling and Chairman of the South Sea Pearl Consortium. Attending the 'First Paspaley Special Strand Tender' will be the world's most important pearl dealers—including luminaries of the South Sea pearl industry responsible for 'bejewelling' royalty such as Queen Elizabeth II and leading ladies like Hilary Clinton and Elizabeth Taylor.

Chinese cultured freshwater pearls: the choice of a new generation?

Source: *Australian Jeweller*, March 1998

Making in-roads

At Miller Freeman's September 1997 Hong Kong Jewellery and Watch Fair, *Australian Jeweller* had the pleasure of attending a special update by the Gemmological Institute of America (GIA) covering the pearl industry. At that presentation, the GIA spoke highly of developments in the Chinese cultured freshwater pearl sector, saying that the quality of these pearls was improving rapidly and that they could now be seen as an attractive, competitive and legitimate product for jewellers to consider.

The lower price point of these pearls allows retailers to tempt customers into buying a number of different coloured strands for the price of one quality Akoya strand, which may have been the traditional purchase.

Traditionally, Chinese cultured freshwater pearls were tissue-nucleated (with a piece of mantle tissue cut from a donor mollusc implanted into the host animal). Akoya oysters, on the other hand, are implanted with a sphere cut from the shell of an American freshwater clam that's then implanted in the host oyster.

In recent times the Japanese sphere nucleation process has been successfully used in freshwater pearls by Chinese producers. Pearl traders travelling to trade fairs around the world will be well aware of the abundant amounts of strung white round Chinese pearls now available. A distinct white-rose tint is evident in these pearls—a characteristic historically more connected to Japanese Akoya pearls than any Chinese product.

One concern that has been expressed in the industry is that of bleaching. Whilst the idea of bleaching pearls is as old as Adam himself, there have been concerns expressed in the international press over the last couple of years that the bleaching process being used with the Chinese product could be damaging to the pearl's surface. Because of this, jewellers were warned to take a careful look at any of these pearls under the loupe before buying.

Today, however, conversations with pearl industry players seem to confirm that fine quality Chinese cultured freshwater pearls are finding a niche for themselves, just at a time when Japanese farmers are struggling to produce adequate quantities—especially in the area of Japan's famous Biwa pearls where pollution has forced producers to abandon the lake, therefore ceasing production of what many considered the best of freshwater pearls.

For retailers selling any freshwater pearls, the challenge is to convince consumers that the best pearl for them is not necessarily a perfect round white. The Chinese product produces a thick semi-translucent nacre coating and the baroques offer a vibrant individual look for the wearer, especially the younger clientele who would traditionally have been forced to choose a shell-based product for 'economic' reasons.

Why Chinese cultured freshwater pearls are here to stay

Interview with Bill Reed, principal owner, Linneys (Broome):

With 40 years experience in the pearls industry, Mr Reed has no objection to some synthetic pearls. 'Chinese cultured freshwater pearls have improved in quality recently. Although they are not as prestigious as their counterparts, the Australian South Sea or Tahitian, freshwater pearls still have a place in the market,' he says. 'For instance, they are suitable for young people buying their first string of pearls.'

Most buyers include family-run retail jewellers, chain store jewellers and buying groups. 'There will always be a market for them, catering for people who enjoy wearing pearls but cannot always afford the top-of-the-range,' he adds.

The lack of strict controls on the production of Chinese freshwater pearls has resulted in an enormous number being produced. 'Although there are no accurate statistics, some merchants have estimated 800 tonnes are being produced each year', explains Mr Reed. 'As a result, prices have come down 80 per cent in the last five years. Sales are stable but there shouldn't be an increase in the near future as the market is currently saturated.'

Imitation pearls – so-called 'I pearls' from Japan

Source: *Gems and Gemology*, Winter 1997

Professor Akira Chikayama of Tokyo discussed the modern production of imitation 'I pearls' in Japan. Although best known for its cultured pearl industry, Japan is also an important manufacturer of imitation pearls. During the production of most imitation pearls, spherical beads are given their pearly-luster coating through the application of the fish-scale extract known as *Essence d'Orient*. More recently, a lead-carbonate-based pearlescent coating material has also been used.

The least expensive manufacturing process for imitation pearls uses plastic bead centres formed by injection molding. Because of their low cast, such imitations are responsible for as much as 80 per cent of the imitation pearl market. Their low specific gravity, however, makes them less desirable than those imitations with heavier centres. This is particularly obvious when plastic imitations are used in strands, since these bead strands do not lay evenly or move 'naturally'.

The most expensive imitation pearls manufactured in Japan use central beads formed from shell. They can be quite convincing in both appearance and heft, and have been variously called 'shell pearls', 'imitation cultured pearls', and 'man-made pearls.'

The third form of imitation is produced from bead centres of white alabaster glass. In the past, these beads centres were hand blown. More recently, a modern automatic bead-forming machine was invented by Mr Satake of Izumi City. Machine manufacturing of the alabaster glass beads is much more efficient than the previous hand-blowing methods, so these glass-based imitation pearls are much more economical.

Because of the confusion created by numerous commercial names, the Japan Imitation Pearl and Glass Articles Association has suggested a new nomenclature to describe imitation pearls manufactured in Japan: the use of 'I Pearl' together with an indication of the base material, such as shell, glass, or plastic. The letter I stands for 'imitation' and also for the place of production, Izumi City. 'I' (Ai) also means 'Love' in Japanese.

Gemologists describe cultured pearls from Indonesia

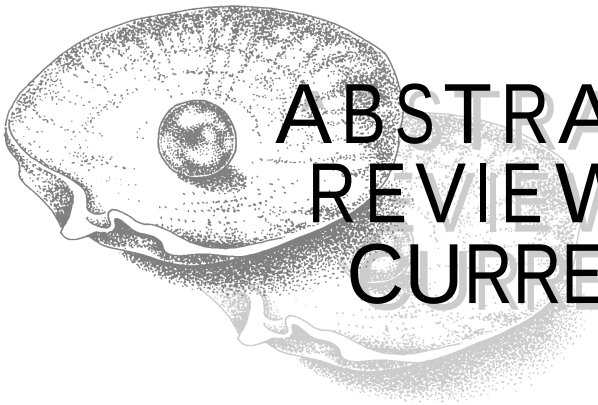
Source: *Gems and Gemology*, Winter 1997

In this report, prepared with H.C. Zwann, Dr Pieter C. Zwann of the Netherlands Gemmological Laboratory in Leiden noted that while conditions in Indonesia are generally good for the cultivation of saltwater pearls, actual production is restricted to a limited number of localities.

Earlier operations, between 1950 and 1960, produced a significant quantity of large cultured pearls, up to about 15 mm in diameter, from the Aru Islands in the Arafura Sea. Named after the most important trade centre in that area, these pearls are commercially known as Dobo pearls.

Examination of a collection of these pearls, ranging from 9.2 to 15.3 mm in diameter, gave a density between 2.691 and 2.755. The nacre thickness varied from 1.0 to 2.0 mm, which by European laboratory standards is considered very good. Dobo pearls are produced by the silver-lipped mollusc *Pinctada maxima*. Recent information indicates that important pearl trade activities are now going on in that area.

Cultivation of blister pearls on *Pinctada maxima* shells started several years ago near the coast of Lombok island, in particular in Street Lombok, around the very small island Gili Air. Three shells from this area with a total of nine mabe 'pearls' were examined and found to have hemispherical bead nuclei composed of artificial resin instead of mother-of-pearl or soapstone. These cultured blister pearls are sold on Lombok and Bali islands as natural pearls. At first glance, however, they resemble imitation pearls, because the relatively thin, translucent nacreous layer causes a deceiving sheen, which is produced by light reflection from the artificial nucleus. The specific gravity of these blister pearls is also extremely low, ranging from 1.815 to 1.905.



ABSTRACTS, REVIEWS AND CURRENT CONTENTS

The Lure of the Pearl

Reviewed by Rand Dybdahl, Palawan, Philippines, 14 September 1998

Berni Aquilina and William Reed's recent soft cover book, *Lure of the Pearl* has an important self-delineating subtitle: *Pearl culture in Australia*. Forty years of combined first hand experience in nearly every aspect of the Australian pearling industry have been amassed between the two authors. Their insiders' knowledge is evident from the comprehensive topics outlined in the table of contents. **Section 1: Origin**, has an introduction and two other chapters entitled 'The humble mollusc' and 'How pearls grow'. **Section 2: Journey**, has chapters on fishing shell; hatching oysters; seeding the pearl; the pearl farm, the harvest, grading, and marketing. **Section 3: Journey's End**, has practical information for buyers on choosing a pearl to cherish and a glossary of pearling terms.

The authors briefly describe the historic fishing of mother-of-pearl shell and then elaborate on the present day cultured pearl industry: from how wild pearl oysters are collected and seeded to grow pearls; then to how the oysters are cared for on the farm while the pearls are growing; to how the resultant pearls are harvested and marketed. While the hatchery protocol is similar to that used by other countries producing silver or gold-lip pearl oysters, the husbandry systems have evolved to suit Australian conditions. The text is remarkably free of inaccuracies and there is a restrained soft-sell marketing in the promotion of Australian South Sea pearls. Most pages have well chosen colour photographs that supplement the story line. The photos range from microscopic shots of hatchery-produced larvae; to pearl divers underwater and aerial views of the pearling grounds; to all varieties of pearls/jewellery. This concise book is recommended as a fitting portrayal of the modern Australian pearl culture industry.

About the authors

Berni Aquilina is a trained marine biologist, specialising in pearl oysters. She is one of the few pioneering women in the Australian pearling industry. Over the past fourteen years she has amassed experience in almost all aspects of the industry as a diver, seeding technician, pearl grader and biologist. Berni now operates her own business as a contract seeding technician and works seasonally on a number of Australian pearl farms.

William (Bill) Reed describes himself as a shopkeeper. He is part-owner and Director of Linneys of Broome, a high-class and innovative jewellery store, specialising in Australian pearls and diamonds. Bill has been involved in many aspects of the pearling industry around the world for about forty years. For some years he worked with FAO of the United Nations rearing pearl oysters in the Sudanese Red Sea. He later worked in the Persian Gulf and then spent seven years in Tahiti in applied research and development of the black pearl industry. He has been involved in pearl farming in Australia for the past 25 years and still is consulted about pearl farming and marketing in a number of countries.

Lure of the Pearl is 144 pages long. The text was only 20 pages, until the book's designer, Yaga Hadrys, added some alluring photos and graphics.

Copies are available from:

Kimbooks, Pty Ltd
P.O. Box 1870, Broome, WA 6725, Australia
Fax: +62 8 9192 1944
E-mail: kimbooks@bigpond.com

Pearls of Pearl Harbor and the Islands of Hawaii

*Reviewed by Beatrice L. Burch**

When the Western world suddenly became aware of Pearl Harbor a half-century ago, its pearl oysters were still present, but currently they are almost extinct. They need the protection given by both state and federal governments. The two Hawaiian pearl oyster species are now very scarce, occurring sparsely in two areas of the Hawaiian archipelago, namely off the major Hawaiian Islands and in the northern Pearl and Hermes reef where once they were common.

The original Pearl Harbor oysters, the small *Pinctata radiata* (Leach, 1814) were effectively dredged out of existence during King Kamehameha's time and by the middle 1800s, they were almost gone. Only two valves were found during a recent government-sponsored harbour survey. The other species, the blacklip *Pinctata margaritifera* (Linnaeus, 1758) is uncommon in near-shore waters of the main Hawaiian Islands. It also has been protected from collection for the last 60 years.

So, enjoy this account of Hawaii's pearls in this brief story of how Hawaii's protective pearling laws came to be. In addition to the early usage by Hawaiians and Westerners of the black pearl oyster shell, this book includes Hawaiian myths and history. The history culminated in the Waikiki Lucoral Museum sponsoring the author's 'Great Hawaiian Pearl Hunt of 1997' with the satisfying sought-for conclusion (a genuine Hawaiian pearl was rediscovered).

This enjoyable book of Hawaiian myths and usage of the beautiful nacreous pearl shell also briefly touches on the current attempts to cultivate pearl oysters. This is a great little paperback book for visitors, would-be visitors and 'lucky-you-live-in-Hawaii' residents. My only objection is to the cover, which shows Tahitian black pearls. This photo was suggested, I understand, by the editor of the book who, with all of us, hopes that some day the current attempts to culture the black pearl oyster in Hawaii will be successful.

Modified from the Internet Hawaiian Shell News, February 1998: <http://www/hits.net/~hsn>

Pearls of Pearl Harbor and the Islands of Hawaii
by Michael Walther
Natural Images of Hawaii, paper,
(US$ 7.95 + US$ 3.00 postage & handling)
P.O. Box 8059, Honolulu, HI 96830.
Fax: +1 800 861 6018
Edited by C. Richard Fassler, Hawaii State Aquaculture Development Program

* Beatrice L. Burch
Research Associate, Bernice P. Bishop Museum, Honolulu, Hawaii

Thomas A. Burch and Beatrice L. Burch
P.O. Box 309, Kailua, Hawaii, USA 96734
Phone: +1 808 261 7465; Fax: +1 808 263 6408
E-mail: tab@hits.net

Assorted abstracts

Effect of tetracycline hydrochloride (TC-HCl) coating to nucleus on pearl oyster (*Pinctada fucata martensi*) survival after nucleus insertion

by Nobuhiko Akiyama, Aya Itoh, Hiroshi Morohoshi, Kiyoshi Asahina, Hitomi Hirose, Nobuhiro Mano, Nobuaki Fukushima, Jirou Taniyma & Hiroshi Itoh

In order to improve the survival rate of pearl oyster after nucleus insertion, pearl nuclei were immersed in a coating solution containing 0.2% tetracycline hydrochloride (TC-HCl) and 0.4% succinated atherocollagen, followed by coating with polyethylene glycol 6000 to keep the surface dry. Each nucleus was coated with 200–220 μg of TC-HCl. The TC-HCl-coated nucleus formed an anti-bacterial circle against the following bacteria strains: *Edwardsiella tarda* NuF84, *Enterococcus seriolicida* NG8206, *Vibrio* sp. KP-01, *V. anguillarum* and *Pseudomomas fluorescens*. After the insertion, hydrochloride TC-HCl was gradually absorbed into the shellfish tissues. Their TC-HCl content reached the highest level of 133 μg/individual 6 hours after the insertion, and then started to decrease, reaching 10 μg/individual on the 7th day. Tissue concentration of TC-HCl was high in the visceral mass compared to that in the mantle, gill, and adductor muscle.

To ascertain the safety of TC-HCl to the shellfish itself, nuclei coated with four times higher concentration of the antibiotic were inserted into pearl oysters and the oysters were kept for 45 days. The survival rate of the antibiotic treated group (86.7%) was higher than that of the control group (63.3%; inserted with untreated nuclei). It was almost the same as that of the untreated group (83.3%). The effect of TC-HCl coating was also examined with large scale field experiments in Kochi and Ehime Prefectures. In the field conditions, the survival rates of the treated groups were higher than those of the control groups. The nuclei retaining rates were also higher in the treated group.

Evaluation of histological cassettes as holding containers for individual spat, and a weekly handling protocol to assess growth of the silver-lip pearl oyster, *Pinctada maxima* (Jameson)

by David Mills*

Source: *Journal of Shellfish Research*, Vol. 16, No. 2, 555–559, 1997.

The effects of holding *Pinctada maxima* spat within individual histological cassettes and of weekly handling on their growth, survival, and feeding were assessed by use of a flow-through culture method. Neither growth or survival was compromised by the use of the cassettes or by weekly handling. Initial spat size was not related to the subsequent specific growth rate; thus, rigorous grading is not essential in nursery experiments using *P. maxima*. Spat between 8.7 and 824 mg live weight had similar proportions of dry and ash-free dry weights of 63.5 and 5.5% of live weight, respectively. Daily algal consumption (dry weight of algae/live weight) ranged from 0.3 to 0.7%. Conversion efficiency for spat held in cassettes was higher (46.8%) than that for free spat (30.3%). The low algal consumption and high conversion efficiencies may reflect the oligotrophic environment in which *P. maxima* is naturally found.

* Aquaculture Co-operative Research Centre, Northern Territory University, Darwin Aquaculture Centre, Department of Primary Industry and Fisheries, P.O. Box 990, Darwin 0810, Northern Territory, Australia

Recent abstracts from a literature search, courtesy of PRAIS, in Hawaii:

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

by M.S. Doroudi

Source: *Indian Journal of Marine Sciences*. New Delhi, vol. 25, No. 2, 1996, 168–169

Infestation of the pearl oysters *Pinctada margaritifera* and *P. radiata* by boring and fouling organisms at pearl culture farms, as well as in the wild, was studied on the northern coast of the Persian Gulf. Barnacles, spat of edible oysters and tubiculous polychaetes were major fouling organisms in the pearl culture farms. In natural beds, however, fouling sponges, algae and ascidians were considered to be the main fouling organisms. The sponge *Cliona* and mussel *Lithophaga* were the most destructive boring organisms encountered, causing considerable damage to the shells.

Occurrence of mineralisation disturbances in nacreous layers of cultivated pearls produced by *Pinctada margaritifera* var. *cumingii* from French Polynesia – Comparison with reported shell alterations

By J.P. Cuif, & Y. Dauphin

Source: *Aquatic living resources/Ressources vivantes aquatiques*. Nantes, vol. 9, no. 2, 1996, 187–193

The authors deal with the microstructural and biochemical features of nacreous layer formation in *Pinctada margaritifera* in healthy and diseased conditions. They also present the mineralisation disturbances in nacreous layers of pearls: similarly with diseased nacreous layers shells.

The potential for growth of pearl culture in the Pacific Islands

by N.A. Sims & D.J. Sarver

Source: Proceedings of the PACON Conference on Sustainable Aquaculture '95, 1996, 318–326

No other aquaculture industry offers the tremendous potential for growth in Pacific atoll islands as pearl culture. There is a lucrative, established market, with a total retail sales volume of between US$ 3–5 billion per year. Black pearl culture is already well established in French Polynesia, where it is the second-biggest foreign revenue-earner at over US$ 77 million (1993). The black-lip pearl oyster, *Pinctada margaritifera*, is endemic throughout most of the South Pacific. In most areas, however, wild stocks of oysters are generally insufficient to support commercial pearl farming. This constraint has been overcome with the development of hatchery technology for this species. The remote hatchery methods allow spat to be shipped to potential pearl farmers virtually anywhere in the Pacific. The impending expansion of this industry raises concerns for its ecological and economic sustainability. This paper discusses these issues, and asserts that such concerns are often given too much emphasis. Certainly, outbreaks of pearl oyster diseases have severely affected most farming areas at some time or another, but little is known about the causative organisms. Farm quotas are often suggested as a means for preventing diseases, but there is little rationale for their use. Improved farm management methods appear more effective. In marketing, concerns for price-stability often overshadow the need for greater promotional efforts. International quality standards and co-ordinated market strategies imply some fixing of production levels, disadvantaging new farming areas. Increased promotional activities and alternative marketing strategies could instead provide more room for long-term market expansion.

Assessment of the nutritional value of three species of tropical microalgae, dried *Tetraselmis* and a yeast-based diet for larvae of the blacklip pearl oyster, *Pinctada margaritifera* (L.)

By P.C. Southgate, A.C. Beer, P.F. Duncan & R. Tamburri

Source: *Aquaculture*, vol. 162, no. 3–4, 15 March 1998, 249–259

This paper reports on two experiments in which three species of tropical microalgae, *Isochrysis* (T-ISO), *Pavlova salina* and *Chaetoceros simplex*, dried *Tetraselmis suecica* and a commercial yeast-based diet ('L-10', Microfeast registered) were assessed for their nutritional value for larvae of the blacklip pearl oyster, *Pinctada margaritifera* . In the first experiment, T-ISO supported significantly greater growth of D-stage larvae than either *Pav. salina, C. simplex* or a ternary algal diet (TAD) composed of an equal mixture of the three species. Fifty per cent of the mixed algal diet could be replaced with dried *Tetraselmis* without significantly affecting larval growth rate or survival. Indeed, growth of larvae fed a 1:1 mixture of TAD and dried *Tetraselmis* was significantly greater than that of larvae fed the three species of microalgae alone or the TAD. In the second experiment, umbo larvae were fed either the TAD, dried *Tetraselmis* , 'L-10' or 1:1 combinations of these diets. Survival of unfed larvae was significantly lower than that of fed larvae and larvae receiving food had significantly greater antero-posterior shell length than unfed controls. Larvae fed dried *Tetraselmis* were significantly larger than those fed 'L-10' but did not differ significantly in size from those fed the TAD. Larvae fed the 1:1 mixture of dried *Tetraselmis* and 'L-10' were significantly larger than those fed 'L-10' alone but significantly smaller than those fed dried *Tetraselmis* alone. The largest larvae at the end of Experiment 2 were those fed a 1:1 mixture of TAD and 'L-10', which were significantly larger than larvae fed the TAD.

Biodegradation of shells of the black pearl oyster, *Pinctada margaritifera* var. *cumingii*, by microborers and sponges of French Polynesia

By L. Mao Che, T. Le Campion-Alsumard, N. Boury-Esnault, C. Payri, S. Golubic & C. Bezac

Source: *Marine Biology*. Berlin, Heidelberg, vol. 126, no. 3, 1996, 509–519

The composition, distribution and infestation sequence of organisms that destroy the commercially valuable shells of the black oyster *Pinctada margaritifera* var. *cumingii* were studied. Three ecologically different groups of boring (euendolithic) organisms were identified: (1) phototrophic boring microorganisms

(cyanobacteria, *Hyella caespitosa, Hyella* sp., *Mastigocoleus testarum, Plectonema terebrans*, and green algae, *Phaeophila dendroides, Ostreobium quekettii*); (2) heterotrophic boring microorganisms (fungi, *Ostracoblabe implexa*); (3) filter-feeding boring organisms (sponges, *Cliona margaritiferae, C. vastifica*). The phototrophic endoliths dominate the external prismatic region of the shell, whereas the valuable interior nacreous region is attacked mainly by heterotrophs. Boring patterns reflect in part the shape and behaviour of the organisms and in part the structural properties of the shell, and inflict different types of damage. Infestation starts with microbial borers, which prepare the conditions for later invasion by more damaging clionid sponges. The infestation begins always at the apex, the oldest part of the shells, from which the periostracum is often removed by natural attrition or by cleaning procedure. The rate of bioerosion in one-year-old hatchery shells is 36 times higher than in natural populations.

An evaluation of some relaxants for use with pearl oysters

by J.H. Norton, M. Dashorst, T.M. Lansky & R.J. Mayer

Source: *Aquaculture*, vol. 144, no. 1–3, 1996, 39–52

As part of a research programme to improve the efficiency of round pearl culture procedures, various potential relaxants were evaluated in groups of *Pinctada albina* (L). The chemicals tested included propylene phenoxetol, 2-phenoxyethanol, menthol crystals, menthol liquid, clove oil, benzocaine, MS222, chloral hydrate, sodium pentobarbitone, magnesium chloride, sodium bicarbonate, carbon dioxide gas, dry ice (solid carbon dioxide) and also hypothermia. Of these, the following appeared promising: propylene phenoxetol at 2.5 ml L^{-1}, 2-phenoxyethanol at 3.0 and 4.0 ml L^{-1}, menthol crystals at 0.25 and 1.0 g L^{-1}, menthol liquid at 0.25 and 0.4 ml L^{-1}, clove oil at 1.5 ml L^{-1} and benzocaine at 1200 mg L^{-1}. Propylene phenoxetol (1-phenoxy-propan-2-ol) was selected to determine the effect of changes in relaxant concentration, water temperature, duration of exposure and shell size on the time to relaxation and to recovery and on survival after 7 days, in both *P. albina* and *P. margaritifera*. Oysters unexposed to relaxants were maintained as controls. Significant responses were found in both *P. albina* and *P. margaritifera* as follows: As propylene phenoxetol concentration increased, the time to relaxation decreased while the time to recovery tended to increase. Increased duration of exposure to the relaxants increased the time to recovery. Increases in temperature decreased both the time to relaxation and the time to recovery especially in the 21–25°C range. No association was found with oyster size within each species. No mortalities occurred within 7 days of having used propylene phenoxetol. It would appear that propylene phenoxetol is a suitable relaxant for *Pinctada* pearl oysters within the concentration range of a 2 to 3 ml L^{-1} and that *P. albina* might be a suitable experimental mollusc for evaluating relaxants in other species of *Pinctada*.

Particulate material as an indicator of pearl-oyster excess in the Takapoto Lagoon (Tuamotu, French Polynesia)

by E. Vacelet, A. Arnoux & B. Thomassin

Source: *Aquaculture*, vol. 144, no. 1–3, 1996, 133–148

The aquatic environment of black-lipped pearl oysters (*Pinctada margaritifera*) in the Takapoto Lagoon was studied to determine the cause of their recent diseases. Both N and P limitations were observed, and the oligotrophy was known from previous reports. The low N concentration appeared to affect the volumes of the various picoplankton compartments more than their numbers, whereas the P concentration affected phytoplankton, estimated as chlorophyll a. The values for the resulting biomasses of phytoplankton (3.8 μg C L^{-1}) and bacteria (2.8 μg C L^{-1}) were amongst the lowest reported values, as were the respective production rates (2.2–3.5 μg C L^{-1} reported and 1.22 μg C L^{-1} current work). Although unexpectedly low, the values for biomass and production of bacteria are consistent with the close relationship observed between phytoplankton and bacteria. Waste products from the reared *P. margaritifera* stock enhanced the growth rates of phytoplankton and picoplankton as shown when incubating in unpoisoned sediment traps, even though the concentrations of both populations were lower than those achieved in the surrounding water. Oyster filtering affected not only phytoplankton, but also smaller-sized plankton, including flagellates and the viable heterotrophic bacteria, but had a significant impact on total counts of bacteria only in the 0–7 m layer. The density of the pearl oysters appeared to exceed the nutritional potential of the lagoon. Owing to the oligotrophic conditions, phytoplankton and even bacteria were unable to sustain their grazing. The 0–7 m depth appeared to be more favourable to oyster growth than the bottom, despite

the higher amount of pigments collected in bottom traps. The suspended material in the upper layer was less degraded and showed a higher potential for microbial multiplication. The lack of exchange between the intermediate layer of 18 m and the upper and lower levels suggested that during our study, the suspended material at the bottom did not originate directly from the 0–7 m level owing to the particular circulation of water in the lagoon.

Hatchery and early nursery culture of the blacklip pearl oyster (*Pinctada margaritifera* L.)

by P.C. Southgate & A.C. Beer

Source: *Journal of Shellfish Research*, vol. 16, no. 2, Dec. 1997, 561–567

This article reports on spawning induction and larval and early nursery culture of the blacklip pearl oyster *Pinctada margaritifera* (L.). Spawning was induced using thermal 'shock,' where water temperature was manipulated from an overnight low of 22°C to a high at spawning of 32–33°C. Larvae were cultured in 500-L tanks in which the water was replaced every 3–4 days (static system) or in 500-L flow-through tanks in which 100% of the tank water was changed every 24 h. There was no significant difference in survival or growth of the larvae in static or flow-through tanks. Mean (± SE) anteroposterior shell length (APM) on Day 20, when larvae were transferred to settlement tanks, was 214.38 (± 3.06) μm and 217.52 (± 2.93) μm for static culture and flow-through culture tanks, respectively. Spat held in settlement tanks had a mean (± SE) dorso-ventral shell height (DVH) of 1.38 (± 0.03) mm at 43 days post-fertilisation when they were placed in plastic mesh trays and transferred to the sea. At 106 days of age, spat were removed from collectors and graded. The mean (± SE) DVH of 106-day-old spat was 11.2 (± 2.7) mm; the largest individual had a DVH of 23 mm, whereas the smallest was less than 2 mm. At grading, 0.2, 8.9, and 67.3% of spat were retained on 15-, 10-, and 5-mm plastic mesh, respectively, and 23.6% fell through the 5-mm mesh. Growth of spat in plastic trays and pearl nets was assessed at densities of 10, 50, and 100 per tray and at densities of 20, 50, 100, 150, and 200 per net over a 19-week growth trial. DVH was significantly greater in pearl oysters held in plastic trays at a density of 100 per tray (40.48 ± 0.9 mm). Oysters held at this density also had the greatest APM (39.68 ± 0.9 mm) and wet weight (7.44 ± 0.4 g). Pearl oysters held in pearl nets showed the greatest DVH (39.22 ± 0.6 mm), APM (38.36 ± 0.6 mm), hinge length (34.47 ± 0.5 mm), and wet weight (6.84 ± 0.8 g) at the lowest density of 20 per net. These values did not differ significantly from those of juveniles held at a density of 50 per net. Growth of juveniles held at densities of 20 and 50 per net was significantly greater than that of juveniles held at densities of 100, 150, and 200 per net. The presence of leatherjackets (*Paramonacanthus japonicus*) in trays and nets significantly affected growth rates of the spat.

PIMRIS is a joint project of 5 international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the 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.

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