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INFORMATION BULLETIN

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From the Editor

Whither goest Pacific pearl culture? Nacri-businesses, nucleus estates, margins and market forces.

In the past, much has been made of the broad socio-economic benefits that have accompanied pearl culture developments in the Pacific Islands. We have all admired the French Polynesian and Cook Islands models of myriad small-scale farmers, scattered across strings of atolls. We have pointed to the extended family cooperative basis by which many of these farms operate, and have cited it as further proof that pearl culture is an ideal development for rural areas. We have waxed lyrical in papers and presentations, praising the almost egalitarian apportionment of farming rights in Polynesian lagoons, and the wide and deep secondary spin-offs from this lucrative industry. We have looked at other potential pearl farming areas, and tried to imagine how to emulate this model.

But is this breathless admiration based on any reality? Is it perhaps merely an illusion, based on outdated information, romantic sentiments or egalitarian ideals? Some recent announcements suggest that we might need to re-evaluate our perceptions as to how pearl culture happens, and who benefits most. Bernard Poirine's comments in the last POIB, on the pattern of development in French Polynesia brought such concerns sharply to our attention. Bernard pointed out that the expansion in pearl production in the Tuamotus over the last ten years was not accompanied by a corresponding increase in levels of employment, because of the dramatic increases in productivity (pearls produced per man-hour). This was primarily because the existing Tahitian farms have become larger, more reliant on mechanisation, and more efficiently managed. Increasing vertical-integration, with independent auctions and direct marketing, also affords greater market clout and better profit margins to bigger farms.

Inside this issue

The large farms in French Polynesia will seemingly just keep on expanding, despite some prominent pronouncements of production stabilising at 6 tonnes, then revised to 8 tonnes. New farm projects being set up on previously unfarmed lagoons are mainly concessions (leases) to larger farmers, who have the capital and capabilities to support operations in more remote areas. Larger farmers are also reportedly busy buying up the concessions of smaller farmers. Tisdell and Poirine (in this issue) note that Robert Wan now controls over 50 per cent of the Tahitian industry; Pearl World also recently reported that the largest five pearl producers in French Polynesia are now responsible for over 75 per cent of total output.

We are witnessing the ascendancy of the pearl agribusiness: the nacri-business. Larger farms, with their better economies of scale, and their greater market leverage, are certainly more efficient. But is greater efficiency the optimum end product of the pearl industry? Should governments care about development goals for an industry, or just get out of the way and allow market forces to move at will? Does the history of pearl development offer any suggestions as to what works best? Would it serve us well to compare existing industry management strategies and their impacts?

More than mere rhetoric, this POIB aims to address, if not answer such questions. In this issue, we present extensive excerpts from an article by Drs Bernard Poirine and Clem Tisdell, comparing the patterns of development, management and socio-economic impacts in the French Polynesian and Australian pearl industries. There are more similarities than differences between the two, and there is an interesting inversion under way. While there may be a trend away from small-scale farm growth towards centralisation in French Polynesia, the formerly monolithic monopoly of Western Australian pearl culture is proving fertile ground for grass-roots growth of a different variety.

In this issue, Dan Machin, of Western Australia (WA) Fisheries, provides an overview of last year's Amwing Pearl Producers Association Industry Workshop in Perth, which highlighted the growing profusion of small-scale black pearl farms along the WA coast. We also have several other articles on the boom in WA blacks gleaned from various sources. These "non-*maxima*" farmers are all reliant on hatchery-produced stocks, yet the hatcheries and the farms vary widely in scale and style. Some farms borrow, buy or barter spat from other hatcheries, to keep their deckhands busy during the lobster off-season. Other farms have built their own hatcheries, and laid plans for expansion to rival Tahiti. The established Australian *maxima* pearl industry has let these farms proliferate, despite the continuing tight controls over growth in the *maxima* farm quotas.

With French Polynesian black pearl production reported at over 11 tonnes last year, there seems to be little sentiment among Australian non-*maxima* farmers – or any other fledgling farmers elsewhere in the Pacific – for imposing any form of restraint on expansion. With the increasing concentration of production capacity in French Polynesia under fewer larger companies, some limits on growth might have been imaginable. But Pacific pearl farmers are notoriously independent. Even in a lagoon where everyone knows everyone else's business, you still can't tell a Polynesian what he can or can't do with his birthright.

Are limits on growth even realistic? Should a government begin to involve itself in the business of establishing, managing and monitoring a pearl industry? Which development and management approaches work best, and which are most broadly beneficial: the vice-grip of the established Australian *maxima* industry? The profusion of farms in the Polynesian lagoons? *P. margaritifera* farms necklacing the northern half of Australia, or spreading endlessly across the Pacific and Indian Oceans?

Most would agree that governments should not be in the actual business of pearl farming. Socialism and pearl culture simply don't mix. Communally-owned and -operated pearl farms have pretty much all come to nought – either sundered by small island politics, left languishing for lack of motivated labour, or stripped of the oysters by folk who favour individual initiative over socialist ideals. Despite the overwhelming evidence, however, there is still a tendency in many isolated atolls, where the sense of community cohesion is high, for governments or development workers to try to suggest this approach. Yet can anyone point to a living, breathing government or community-owned pearl farm? If so, please let us know of it. If not, can we finally drive a wooden stake through the heart of the concept of communal pearl enterprises?

The small-scale, extended family cooperative model of pearl farming has always been the darling of development. It appears to offer a suitable profit-incentive, it is readily applied and reasonably manageable, and it seems to fit in well with the atolls' socio-cultural milieu. But most ideals do not withstand scrutiny well. Poirine and Tisdell point out in their article that over US$ 5 million of bank loans to small pearl farms in French Polynesia remain unpaid (one wonders what proportion of total loans this represents).

The trends towards nacri-business conglomerates in Australian and French Polynesian pearl culture suggest that the margins for small-scale operators will only further diminish. In the face of increasing production, some softening of prices, and trends towards vertical integration, the small-scale farm suffers serious disadvantages. Smaller-scale farmers can hardly establish their own retail outlets, or run their own auctions, but a plethora of Polynesians, with pockets full of pearls, can lead to further market instability.

In French Polynesia, cooperatives of small-scale farmers have played a crucial role in the broader development and cooperative marketing. To our small understanding, the Japanese pearl culture industry was similarly based on small-scale family-owned farms supported by larger cooperatively-run hatcheries and cooperative or tightly centralised marketing arrangements. Looking beyond the debilitating pollution and disease problems the Japanese industry has suffered of late, this economic model appears to have operated very successfully. Our curiosity is piqued, and we would be pleased to hear more from any of our readers who may be able to offer a comparable analysis of how the Japanese pearl culture industry worked – or how well it worked.

In the Marshall Islands, an attempt is being made at applying an innovative model for pearl culture development, and at evaluating its success – or otherwise. Black Pearls of Micronesia (partly owned by BPI – your Editor), is attempting to apply the old nucleus estate model, formerly used in plantation agriculture and more recently in shrimp production, to expand pearl farming beyond the one large, nucleus farm. The nucleus farm provides those services and support which best befit a large, capitalised operation: the hatchery, training and extension, bulk purchase of materials and supplies, provision of seeding technician services and greater marketing clout. The smaller satellite farms are independently operated, and provide those attributes best befitting locally-owned operations: lagoon and land access, boats, labour, local knowledge. We'll let you know how it goes.

In the past, the availability of seeding technicians has provided some limit to growth of the industry – both in volume and geographically. An article in this issue by our compadres from ITESM Perlas de Guayamas, however, suggests that – at least for the *Pteria sterna* of Mexico – pearl technician training may be a lot easier than conventional wisdom holds. Virtually untrained technicians with fewer than 7000 oysters under their belt were achieving 60–70 per cent retention in the best seeding months. This paper is one of the first serious scientific attempts to open the veil that has shrouded the process of seeding and technician training, and Snrs Nava, *et alia*, are to be heartily commended for their efforts.

(ASIDE: Just in case you don't want to learn to seed your own oysters, we continue to develop the SPC'S Pacific Pearl Seeding Technician Registry. A number of experienced technicians are already registered, and we hope to continue to build on this start. If you are a seeding technician, and would like to be registered, please fill out the form at the end of this Bulletin. If you are a farmer in need of a technician, please send your request for information to me here in Hawaii, or to the SPC Fisheries Information Section in Noumea.)

Also germane to these questions of industry growth and management is the issue of how one physically tracks number and area of farms and oyster abundance. Ben Ponia and Co, in the Cook Islands, have made a useful start with a census and mapping survey of Manihiki farms, using databases linked to a GIS program. They share their methods and their findings with us in an article also in this issue. SMA (formerly EVAAM) in French Polynesia also have a sophisticated GIS mapping and monitoring model, but there has been little public dissemination of their methods. Such computerised census and mapping systems at least let the farmers – and the industry – know where they are growing.

We would like to see or hear of more efforts in these directions – towards assessing the effects of what we do, describing the path of how we do it on a macro-level, and attempting to monitor and manage industry growth. We want to think a bit beyond simply what we do in the water, the wharf, the hatchery and the auction-house. It's a sign of a maturing industry, and it's part of the responsibility that we bear as pioneers.

Aloha all

Neil Anthony Sims

The Pacific Islands Marine Resources Information System (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.

RESEARCH NOTES AND REPORTS

Manihiki Atoll black pearl farm census and mapping survey

Ben Ponia, Tangi Napara, Martin Ellis & Ravengakore Tuteru
Ministry of Marine Resources, Rarotonga, Cook Islands [1]

Abstract

Pearl farming in the Cook Islands is based on cultivating the black-lip pearl oyster and is presently centred at Manihiki Atoll. Cultured pearls are the nation's most valued export, officially worth NZ$ 5 million in 1998 and accounting for 84 per cent of total exports. In view of the importance of this industry there is a need to ensure its sustainability. Two limiting factors affecting the capacity of Manihiki Lagoon for farming are: 1) the number of pearl shell should not exceed the natural levels of food production, and 2) the space or depth strata available for farming.

This survey has calculated the number of cultivated adult pearl shell at 1.5 million oysters. One quarter (24%) of the pearl shell is in pre-seeded conditioning phases while most (65%) are seeded. The total number of cultured adults has increased from 520,000 oysters in 1991 to 880,000 oysters in 1996. Similarly, the number of pearl shell per farm has increased. For instance in 1996 only five per cent of the farms recorded 20,000 to 50,000 oysters, at present this range is attributed to 20 per cent of the farms. In addition the percentage of farms exceeding 50,000 oysters has doubled from three to six per cent.

Approximately 1.1 million spat (pearl oyster juveniles) are being cultivated on spat collectors. However there is a disproportionate distribution of spat among the farms, with the majority of farms (93%) possessing less then 13,000 spat or no spat. The peak in spat population was recorded in 1996 when 3.5 million spat were estimated. It is suggested that the pearl farming industry should develop a spat collection niche in order to moderate future spat supply and prices.

This survey recorded 111 farms with a total of 690 culture lines and 424 spat collection lines. The total length of these farm lines is 160 kilometers. The farms cover seven square kilometres compared to 9 square kilometres reported at 164 farms in 1996. The reduction in pearl farms is attributed to the impact of Cyclone Martin in 1997. Presently, farm areas account for 30 per cent of the depth strata where pearl farming is feasible, i.e. the 10 to 30 meter depths.

It is estimated that the annual production from Manihiki is on the order of NZ$ 12 million dollars or 250,000 pearls. Considering that the official statistics for export value in 1998 was only NZ$ 5 million, it is thought that exports may be underreported by a factor of 50 per cent. The growth trend suggests that by the year 2003 there will be 2 million cultured adult shell and annual production of NZ$ 18 million.

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The ecological sustainability of the pearl industry has good prospects provided the whole lagoon is managed as one unit. This is logical given that the degradation of one farm will eventually affect all other farms. The proper use of the space for pearl farming, if done correctly, should allow for the forecast expansion to two million oysters without having to degrade the lagoon environment. Presently there is some frustration among pearl farmers because the allocation of farm areas is not properly managed. For example, some farmers are being forced to overstock oysters in their areas because they cannot expand farm boundaries. This is due to encroachment from neighbouring farms that are not properly utilising the space already available to them. In addition, new farmers or farmers who wish to relocate to a new area are often unsure of which areas in the lagoon are actually available.

This study has developed a computer package that incorporates a pearl farm census database linked to a geographical information system (GIS) and a bathymetric lagoon map. Such a tool could prove useful to ensure that the stocking density of pearl oysters and the allocation of pearl farm areas are managed in accordance with the food and space capacity of the lagoon.

Introduction

Manihiki Atoll in the northern Cook Islands is renowned for its abundant stocks of black-lip pearl oysters. Historically the oysters were harvested for their mother-of-pearl shell but since the mid-1980s the pearl shell has been cultivated for its black pearl instead. Manihiki Atoll is the center of production for pearls produced in the Cook Islands accounting for about 90 per cent of the total output. The only other lagoon where significant pearl farming occurs is at Penrhyn (Tongareva) Atoll.

The stocking of mature oysters in close proximity at farms is thought to enhance the chances of breeding. This may explain the large cohorts of juvenile (spat) retrieved on artificial collectors in recent years. As a result, there has been a rise in farm production. For example, the annual value of exports in the three years from 1996 to 1998 has increased from NZ$ 1.5 million to NZ$ 3 million and NZ$ 5 million, respectively. Presently, pearls are the Cook Islands' most valuable export, accounting in 1998 for 84 per cent of total exports (MFEM 1999).

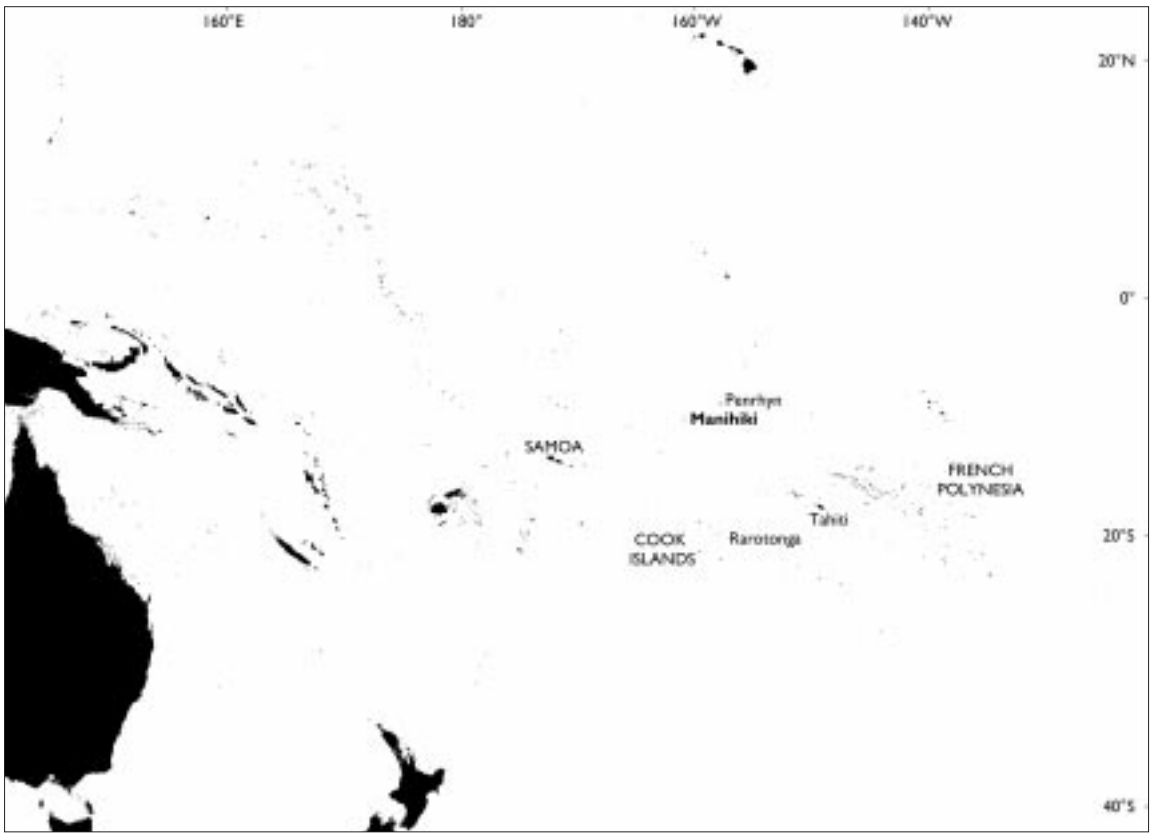

Figure 1. **Location of Manihiki Atoll.**

The black-lip pearl oyster (*Pteriidae*) retains many of its primitive strategies of survival. The surrounding seawater is constantly pumped through its gills in order to oxygenate the blood system. Simultaneously, suspended particulate matter in the water is filtered as food (or expelled as pseudofeces). Large volumes of water may be required for these purposes. Adult oysters have been shown to clear up to 20 liters per hour (Ponia 1996). The aggregation of oysters at a pearl farm can be likened to a large sieve that progressively removes oxygen and food from the water as it passes through the farm.

With a few exceptions, pearl farming on Manihiki is limited to the island's descendants. These farmers realise that the pearl industry has the potential to sustain economic opportunities for their future generations. There is also widespread awareness that virulent oyster diseases and poor pearl quality has resulted from poorly managed pearl farming industries in countries elsewhere. Therefore farmers accept that some management measures must be adopted to avoid these causal conditions.

Regulation of pearl farming is the responsibility of the local Government of Manihiki (known as the Island Council). In the past, farm licenses were issued periodically but since the disruption of Cyclone Martin in November 1997 this has not occurred. Nonetheless the Island Council has plans to re-introduce the license conditions. The responsibility of the national government agency, the Ministry of Marine Resources, is mostly for environmental monitoring. But it is believed that a more proactive approach may be to also utilise the Ministry's technical skills to support management initiatives where necessary.

The aim of this survey was to assess the number of pearl shells being cultured and the extent of pearl farm areas. Manihiki Atoll has a finite capacity to sustain the food requirements of cultured pearl shell and a limited amount of lagoon space for pearl farms. Information on the total number of pearl shells and areas occupied by farms is fundamental to managing the lagoon in a holistic manner.

A targeted output was a computer database to store and analyse the farm census data and a geographical information system (GIS) to map this information. Ultimately, this computer package could be routinely used by management authorities who possess basic computing skills.

Survey methodology

This survey essentially comprised two parts: 1) the census of pearl shells, and 2) the mapping of pearl farms. Field work occured in April–May 1999.

The information from the pearl shell census was provided during visits to individual farmers. Farmers were asked to detail the number and category of adult pearl shells (i.e. first or second seeded, reject or conditioned). This was verified by field checks during farm visits. Also recorded were the number and sizes (i.e. length) of juvenile oysters (spat). Often the farmer did not have estimates of total spat counts so a spat assessment survey was conducted at the farm.

Proceeding the census of oyster stocks, farmers were asked to draw a layout of the farm lines, describing the length and type (culture line, spat collector line, etc) of farm lines. Additional data about the farm (e.g. farmer title, company name, and landmarks) were also recorded. On the basis of the farm layout, points were selected to represent the boundaries of the farm areas. Accompanied by the farmer, field staffs were directed to the exact location of these points and the coordinates recorded using a hand-held global positioning system (GPS). These coordinates were used to define the farm boundaries.

Data analysis

The pearl shell census information was stored in a Microsoft Access database. The database design incorporated numerous "drop-down" lists to properly categorise the data. Some preliminary analysis such as total number of adult oysters or total spat was inherently performed. More advanced analysis of the census results could be achieved by performing queries of the database. The farm boundary coordinates were also stored in the database.

The farm coordinates and pearl shell census were converted into GIS maps using MapInfo software. A link between the Access database and MapInfo GIS was established by custom writing a Visual Basic application. This software directed MapInfo to retrieve from the Access database the appropriate tables (farm boundaries and census query) and then convert the farm boundaries into spatial areas and also assign the census information to the farm area. Additional software was written that enabled simple thematic maps, such as farm areas, to be sorted according to the range of total adult oysters. Simply loading the application files and clicking the appropriate menu bar would initiate these applications.

Finally, three-dimensional maps of farms overlaid on the lagoon bathymetry of the Atoll were produced using Vertical Mapper software, an add-on application to MapInfo. Depth contours were recorded from a previous survey conducted by the South Pacific Applied GeoScience Commission, SOPAC (Solomon 1996).

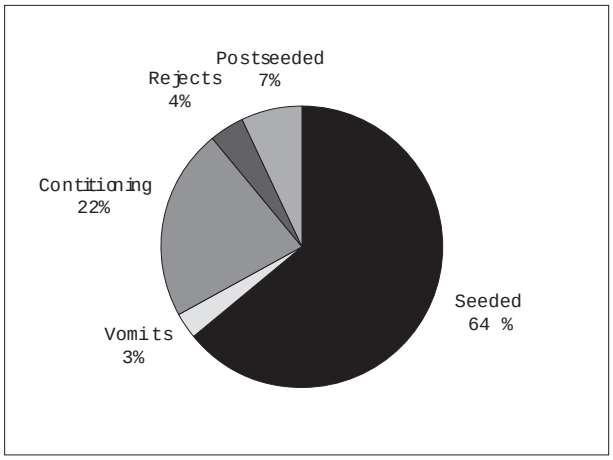

Figure 2. Categories of adult oysters cultured at pearl farms on Manihiki Atoll

Figure 3. Pearl farm areas on Manihiki Atoll. Heavy lines demarcate the farm boundaries of the present survey. Light boundaries are the farm areas reported in 1996.

Results

The total number of adult pearl shell[1] reported by the census was 1.5 million oysters. About a quarter of the oysters (22%) were in pre-seeding phases (such as conditioning). The majority of oysters (64%) were seeded. Some oysters (7%) were in early post-seeded stages (i.e. are still in seeding catch bags) whereas four per cent of the oysters were unsuitable for seeding at the time ("rejects"). The smallest percentage of oysters (3%) were those that had expelled the pearl nucleus ("vomits") and will either be harvested for their meat or seeded for blister pearls (Figure 2).

The number of cultured spat was 1.1 million. The average number (and standard error) of spat counts per collector was 17.9 (0.3). A total of 47 farms and 267 spat collectors were sampled. The number of spat less then two inches length (i.e. generally less then one year old) and spat between two and four inches (between one and two years age) was about the same.

The number of cultured adult pearl shell has increased from 520,000 in 1991 to 1.1 million in 1996, to the present figure of 1.5 million (Table 1). The total number of spat has declined from 3.5 million in 1996 to the present amount of 1.5 million spat. The peak number of farms was reported in 1996 when 164 areas were identified compared to the present number of 111 farm areas (Figure 3).

The total area claimed by the 111 pearl farm areas was 7.73 square kilometers. This was less then the area reported in 1996 (9.02 km^2). The total area of lagoon that can be utilised for farming (i.e. the depth between 10 to 30 meters), was estimated as 25.29 square kilometers.

Therefore, the farms presently account for about 30 per cent of the farmable lagoon area (refer to Figure 4 for a bathymetric map). The farms had a total of 690 individual farm lines and 424 spat lines. The total length of these cultured lines was 160 kilometers.

1. The term adult generally refers to oysters that are of "seedable age" (i.e. about two years) and to differentiate from the juvenile oysters that are still attached to spat collectors.

Table 1. **Total number of cultured pearl shells**

Year	Nos farm	Adults	Spats	Reference
1991	97	521,000	108,000	Tuara, 1991
1996*	164	880,000	3,500,000	LEMMP, 1997 (revised)
1999	111	1,525,000	1,078,000	This Report

* Note that subsequent analysis of the original 1996 figures by the author suggests these estimates may be overestimated. Shown are revised figures, the original estimate of adult oysters was 1,086,000 and spat was 8,000,000.

Table 2. **Distribution of pearl farms according to number of cultured adult pearl oysters.**

Year	1996		1999	
Nos of Oysters	Percentage of farms	Number of farms	Percentage of farms	Number of farms
No oyster count	50%	77	31%	34
<5,000	27%	41	23%	25
5,000–20,000	15%	23	22%	24
20,000–50,000	5%	8	19%	21
>50,000	3%	4	6%	7
Total	100%	153	100%	111

In comparison to the last survey conducted in 1996, the number of adult pearl shells per farm has increased. In 1996 about 80 per cent of the farms comprised less than 5,000 oysters or no none at all. Presently, farms in this range account for 54 per cent of the total number. In 1996, only five per cent of the farms had 20,000 to 50,000 oysters compared to about 20 per cent at present. Also there were four farms exceeding 50,000 oysters compared to seven farms recorded during the survey (Table 2).

There was a disproportionate distribution of spat among farms. Only two farms reported more than 150,000 spat. Eight farms had less than 150,000 spat but more than 36,000 spat. The remaining majority of farms (93%) had either less than 13,000 spat or no spat at all (Figure 5).

Discussion

This survey has demonstrated a desktop computer package that incorporates a pearl farm census database with links to a farm GIS and lagoon bathymetry (Figure 6). This could be a useful management tool, especially with regard to the carrying capacity of the lagoon in terms of allocating space and assessing the number or density of cultured pearl shell.

The pearl culture industry at Manihiki Atoll rates as one of the Cook Islands' most important economic sectors. On the basis of 1.5 million adult pearl shell (this census) the annual production is estimated on the order of NZ$ 12 million dollars, or 250,000 pearls. The present trend of growth suggests that by the year 2003 there will be two million cultured pearl shell and an annual production of NZ$ 18 million dollars.

There is some discrepancy between production figures of this report and official export statistics, even taking into account the small proportion of pearls sold on the domestic market. The export figure for 1998 of NZ$ 5 million suggests that there is gross underreporting of pearl exports on the order of 50 per cent or more.

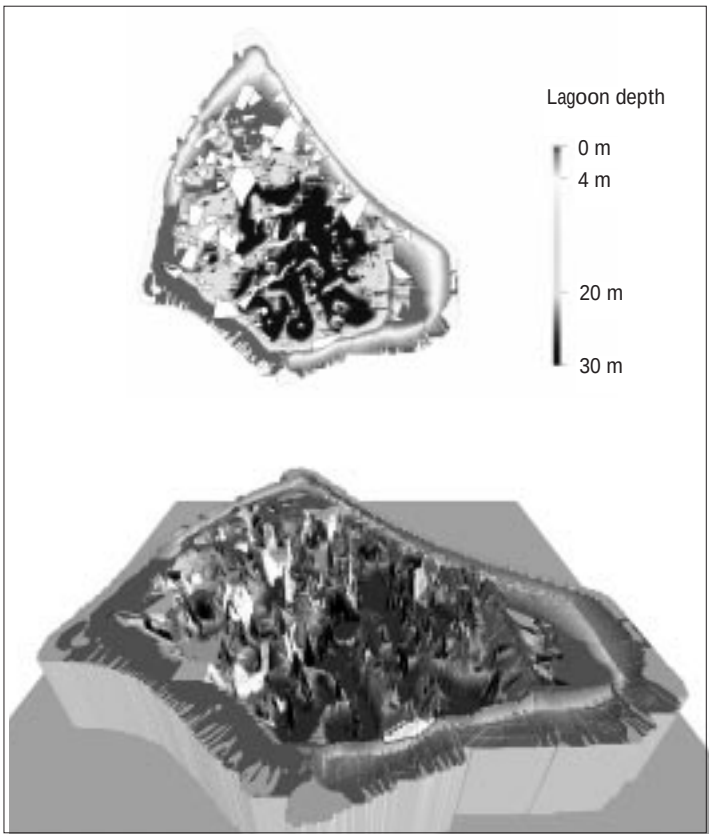

Figure 4. **(Top) Lagoon bathymetry of Manihiki Atoll overlaid with pearl farms (white areas) mapped during this survey. (Bottom) The same view shown with a three-dimensional perspective.**

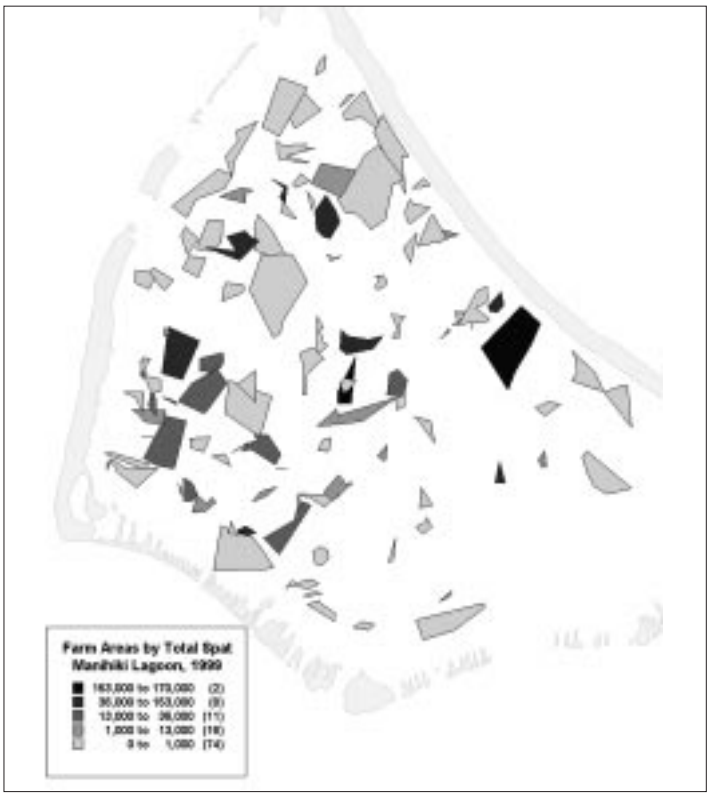

Figure 5. **Number of spat at pearl farms on Manihiki Atoll**

The ecological sustainability of the industry has good prospects provided lagoon-wide management measures are implemented within the immediate term. A priority is the tenure of farm leases to be allocated so that pearl shell are evenly distributed to ensure that overstocking, or "disease hotspots" do not occur. Many farmers expressed frustration at being forced to overstock their farm area because of neighboring farmers who have increased their boundaries without fully utilising the area already available. This raises the challenge of establishing a system of allocating farm boundaries that can be readily referenced and distributed on a fair basis. An unpublished report by one of us (BP) has detailed plans to realign pearl farms according to a grid reference system.

In fact, since the last survey in 1996 there has been a reduction in the number of areas claimed as farms (164 versus 111 farms) and the amount of lagoon space utilised (9 km^2 versus 7 km^2). This is probably a result of migration after Cyclone Martin. The current population of Manihiki Atoll is 468 persons (unpublished report, Ministry of Outer Islands Development, MOID) compared to 662 in the 1996. There may be a need to assess the implications of abandoned areas that are still claimed as pearl farms but are not actually being used.

Assuming space is properly managed in the lagoon then the portion of farmable strata occupied (30%) suggests that farming of two million pearl shells could be attained without density-dependent consequences on the health of the oyster. Many farms surveyed have culture lines placed about the spacing (>10 meters) suggested by modeling studies to allow adequate supply of food to the farm ecosystem (Ponia 1996). Also, a recent baseline survey of disease and pathogens in Manihiki concluded that, the present intensity of farming harbors low levels of pathogens amongst pearl oysters or other bivalve reservoirs of disease (Hine 1998). A responsible approach would be to establish checkpoints to assess pearl oyster and lagoon ecosystem health as the cultivated stock increases.

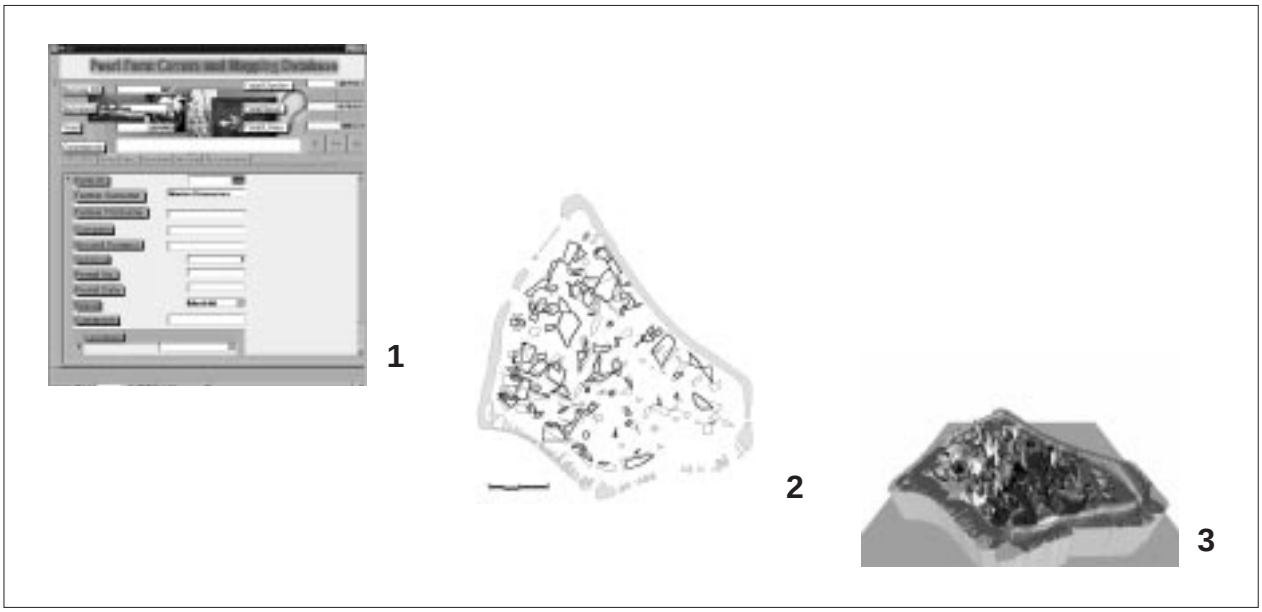

Figure 6. Computing management package developed from this survey. Elements include (1) a database, linked to (2) a GIS and (3) mapping software.

Oyster health and lagoon ecology aside, it is more difficult to predict density-dependent effects on the quality of the pearls produced. The growth trials conducted throughout the lagoon have reported reduced shell growth rates at highly stocked pearl farms compared to controls (MMR, unpublished data). It is possible that there may be some correlative impact of poor growth rates on pearl quality as farming levels intensify to the two million oysters mark.

Perhaps a concern to the development of the industry is the decline in the numbers of spat population. Projected growth figures of the industry assume availability of spat. Yet while many pearl farms have increased their number of cultivated adults this appears to have caused efforts to be diverted from spat collection. Several farmers whom have concentrated mostly on culturing adult oysters commented on the difficulty in securing adequate spat from other sources for ongoing operations. There is a need to develop a niche for farmers to concentrate on supplying spat. This may be important for the pearl farm industry in order to moderate future spat supply and spat prices.

Acknowledgements

We are grateful to Franck Martin and Les Allison of SOPAC, Fiji Islands, who assisted with the computing outputs of this survey. We would also like to acknowledge the support of the Manihiki Island Council, particularly the Mayor Hurricane Woonton and councilor responsible for marine affairs, Kora Kora. Finally the support of pearl farmers who freely provided information and assistance when requested.

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Amwing Pearl Producers Association Industry Workshop, Perth, 1999

Dan Machin
Aquaculture Development Officer, Western Australian Fisheries

In recent years the development of the Amwing[1] pearl oyster industry in Western Australia (WA) has been impressive, with 19 licences issued by Fisheries WA since 1995. This rapid expansion has seen a genuine desire by industry to understanding and discuss research findings, market information and government policy to aid the growth of the industry.

Over 50 delegates, representing all industry sectors, attended the annual Amwing workshop held on 30 and 31 October 1999 at the Underwater World Function Centre, Perth. The workshop hosted key international and interstate speakers, with the assistance of the Aquaculture Development Council, Aquaculture Council of WA, Fisheries WA and industry sponsors[2] and addressed the theme of "From Farm To Market Place."

The participants enjoyed Neil Sims' erudite and humorous keynote address "Boot-strapping beyond Tahiti" where he likened the global pearl industry to ocean-going vessels. He took the participants on a nautical journey of the waters charted by the brilliant ship SS *Tahiti*, with her inherent natural benefits and allure. Contrasting her to the work in progress in the seas being chartered by the frigates *Hawaii, Central Pacific, Western Pacific* and *Western Australia,* and highlighting the vagaries of uncharted waters, with their pirates of biological and cultural constraints.

Symantha Suprain, of Percy and Marks, a 100 year Sydney-based jewel retailer specialising in Australian diamonds and pearls, encouraged participants with her great enthusiasm for the unique colours she saw in a selection of Western Australian Amwing pearl shell. She commented on increasing consumer awareness of pearls and pearl quality stating that a "distinct 'point of difference' will be critical to creating demand and sales at the shop front".

Prior to lunch the participants revelled in Rocky de Nys' presentation on the potential cost savings by using anti-biofoulants paints developed by the Centre for Marine Biofouling & Bio-Innovation Tasmanian Aquaculture and Fisheries Institute. Amwing members eagerly await the results of trials currently being conducted in the *Pinctada maxima* industry, particularly with respect to pearl quality.

In the remainder of day one, other speakers addressed pearl oyster shell management research and practices. Kim Friedman outlined the results of seeding trials of black pearl oyster in the Solomon Islands by the International Centre for Living Aquatic Resources Management (ICLARM) and Australian Centre for International Agriculture Research (ACIAR), highlighting critical factors to optimise resultant pearl quality. This presentation was complemented, in part, by Dan Machin's video presentation on optimal pearl oyster condition. Paul Southgate, ACIAR project leader, provided an excellent update on ACIAR funded research into hatchery techniques for black and wingshell pearl oysters. Prof John Lucas, covered research he and Dr John Norton had undertaken to improve culture pearl formation by the utilisation of standard veterinary practices. This highlighted Rick Scoones' point (on day two) that only scientific experiments can determine improvement in pearl oyster management practices – as common sense does not always prevail.

In the afternoon session, Damien Bell provided an excellent account of key farm management practices on South Sea pearl oysters, *P. maxima*, and Alan Pearce outlined CSIRO's research on the Leeuwin current and the Southern Oscillation Index and its effects on weather, oceanographic and fisheries events off the WA coast.

Day two commenced with business management sessions. Bob Galloway, Small Business Develop-

1. "Amwing" is an amalgam of the three key pearl oyster species *Pinctada albina, P. margaritifera* and wing shell (*Pteria penguin*) cultivated by the association members.

2. Architectural Heritage, Australian Commercial Marine, Australian Netmakers Pty Ltd, Aquafarm Management Systems, Environmental Moorings Australia Pty Ltd, Fish Unlimited Pty Ltd, Jeyco (1992) Co., Kingswood Marine Pty Ltd, Netcraft Pty Ltd, Orca Marine Supplies Pty Ltd, Paragon Pearling Pty Ltd, Pearl Wholesalers Australia Pty Ltd, Perth Scientific Equipment, QE Marine & Rural Supplies Pty Ltd.

ment Corporation, highlighted the importance of "knowing thy business" by thorough business planning. Bob stating that "Only then will proper business decisions be made, based on maximising profit and reducing loss." This was also a point highlighted by the economic model (version 1) presented by Bill Johnston and Peter Rawlinson who identified the three key cost centres of technicians, labour and capital depreciation, accounting for greater 65 per cent of the production costs (based on a 50 000 shell farm).

Overall, the two-day workshop was regarded as a success, aided by the conducive atmosphere of the Underwater World Function Centre and the sponsor's trade show. Day two's open session derived many key outcomes for the Amwing Association to pursue in 2000, particularly in the area of strategic branding and marketing.

Copies of workshop abstracts are available from: Simon Bennison, Executive Officer, Amwing Pearl Producers Association Inc., tel. 9244 2933 fax. 9244 2934 or Dan Machin, Fisheries WA, tel: 08 9482 7201 fax: 9482 7390.

Evaluation of success in the seeding of round nuclei in *Pteria sterna* (Gould 1851), a new species in pearl culture

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Introduction

The Mexican pearl fisheries of the rainbow-lipped pearl oyster (*Pteria sterna*) have existed since before the arrival of the Spaniards to the American continent. Evidence of the use of ornaments made from these shells was found deposited in an ancient burial site – probably belonging to the indigenous Seri Indian nation – in the coastal part of the State of Sonora. It is very common to find pieces of this shell in ancient shell hills (*concheros*) related to the presence of semi-nomadic groups that roamed most of the central coast of Sonora, before the arrival of Western civilisation. After this incipient use of pearl beds, much larger efforts were given to the pearl fisheries of the Sea of Cortez (*aka* Gulf of California), from the start of the Colonial period until 1940. These fisheries gave abundant supplies of naturally coloured pearls, from light-grey to dark-purple, with many intermediate tones of pink, gold and green.

The rainbow-lipped pearl oyster populations, as has been the case of all commercial species of pearl oyster, suffered severely from over-exhaustion. The Mexican Government was forced to decree in 1940 a permanent ban on its fishery that still holds to this day.

Historical background

Over the past few decades, several Asian-Pacific rim countries have used a species of the same genus (*Pteria penguin*) for the culture of half-pearls. The general belief of Japanese specialists is that round pearl production in pearl oysters of the genus *Pteria* is technically difficult. Shirai (1981a) mentions "most of the genus *Pteria* are too small. Also they have a wing-shaped shell, which makes the entire operation rather difficult". The same author states, referring to *Pteria penguin*: "the extraordinary luster of the shell's interior has invited many to try and produce round pearls but, at the moment, not any effort has been rewarded with success" (Shirai 1981b). Monteforte (1997) reports on the results of seeding both species of pearl oysters (*Pinctada mazatlanica* and *Pteria sterna*) and mentions that – when compared with *Pinctada mazatlanica* – "*Pteria sterna*, on the contrary, presents anatomical difficulties for round pearl production, because the pearl sac is very wide at its base and the graft moves freely…"

There is one commercial pearl farm in Mexico that utilises *Pteria sterna* as its main production species. The farm has been able to produce cultured half-pearls and loose pearls on a regular basis (McLaurin et al. 1997; McLaurin et al. 1999; http://www.perlas.com.mx).

The present article analyses the "seeding operation" costs and the number of pearl oysters needed for the implementation of the round pearl seeding technique on *Pteria sterna* at the commercial first modern Mexican pearl farm, ITESM/Perlas de Guaymas.

Materials and methodology

The implementation of the round pearl production technique was performed under the following circumstances:

a) The use of a species reported unsuitable for the production of cultured loose pearls, *Pteria sterna*.
b) No outside training or help was given to the seeding technicians.
c) An adaptation of the "Mise-Nishikawa" technique was developed locally.

Obtaining organisms

Pearl oysters 18 to 36 months old were used for this study. All of them were grown from wild spat at the pearl farm facilities of the Instituto Tecnológico y de Estudios Superiores de Monterrey, Guaymas Campus (ITESM-Guaymas), found at the central zone of the Gulf of California on the continental side (Figure 1). For details on the pearl oyster culture techniques used at the farm, please consult the information found at our website: http://www.perlas.com.mx.

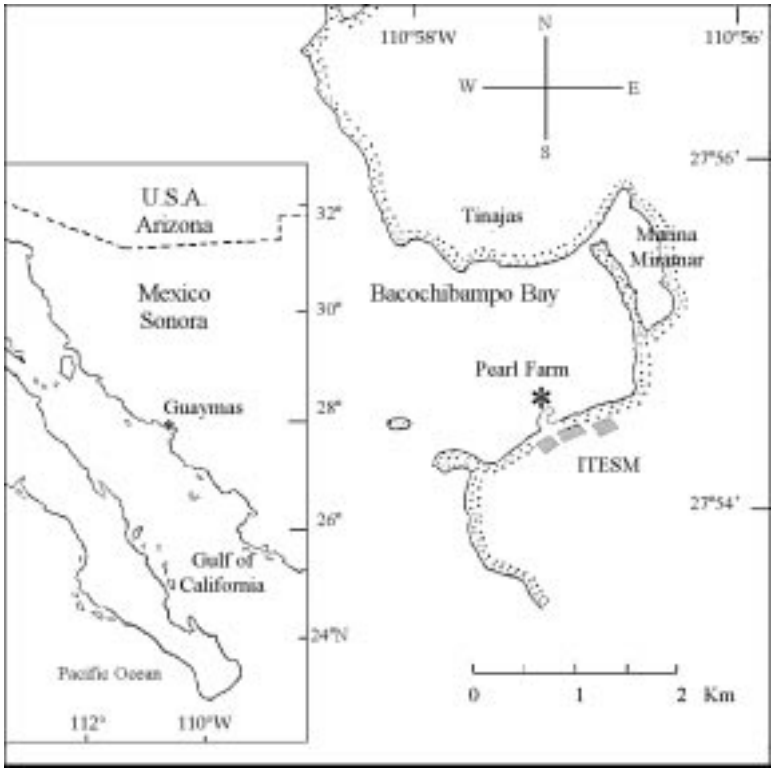

Figure 1. Location of the ITESM/Perlas de Guaymas pearl cultivation facilities in the Gulf of California, Mexico

Seeding operations took place during two seasons (between November 1997 and May 1999) and were performed by four different researchers/technicians. Commercial shell nuclei, in sizes between 5.5 to 10.0 mm, were employed. Nuclei size selection was decided on operation based on the overall condition and size of the organisms.

Each grafter's lots were kept separate and examined under X-ray after eight weeks, to identify those oysters that retained their nuclei, and reject those that had not. Mortality was also registered.

For comparison with available literature, data was analysed eight weeks after the operation took place.

Results and discussion

Figure 2 represents the accumulated nucleus retention percentage, based on the total number of operated organisms by each grafting technician. In the case of grafters 3 and 4, a significant descent, from modest to high, in the retention percentage was followed by a rapid increase up to a maximum level for each person.

Grafters 1 and 2 only show the second phase of grafters 3 and 4 curve, that is, from a slow to rapid increase up to a maximum retention.

This can be attributed to:

1) Individual differences in the "seeding skill" of each person.
2) Selection of pearl oysters. Initially, organisms for seeding were strictly selected and thus had the ideal condition for seeding. Later, as animals became more scarce, all available oysters were subject to operation, many of which did not have the best condition (physiological or size) for operation. This was due to negative influences of *El Niño* on the growth of oysters.

In the case of grafters 1 and 2 this is different because the majority of selected organisms did not belong to the lots that followed a strict selection process. In this case, the initial behaviour of the retention curve is more related to the second part of the curve from the other two grafters, where a steep increase can be observed. This can be attributed to the experience they were acquiring over time, as well as an improvement in the overall physiological and size condition of the organisms.

Another point to emphasise in Figure 2 is the fact that the tendency to improve the retention percent-

age is different for each grafter. In the case of grafters 2 and 3, the period of a slower increase in the retention percentage begins at about 4000 seeded organisms, while for grafters 1 and 4 this number can be found at around 6000–7000 seeded organisms. Grafter 1 has yet to reach this decrement after more than 7500 seeded oysters. According to many authors, some 10 to 15,000 pearl oysters are needed in order to produce a single trained seeding technician (Salomon and Roudnitska 1986; Lintilhac and Durand 1987).

This differs significantly from our results: each grafter arrived at a different time at its maximum retention value. Undoubtedly, as a grafter acquires more experience he can increase his retention rate. However, for three out of four of the grafters in the present study it can be seen that after 7000 seeded oysters this strong tendency to improve is lessened. This is highly significant because none of the grafters received any kind of training, and so it can be considered that when some form of technical training takes place, the number of organisms required to develop the maximum potential of a grafting technician can be lessened.

Haws et al. (1999) mention that the "success rates of trained technicians range from 60 to 80 per cent nucleus retention at 30–40 days post-implantation". This retention rate is for the *Pinctada margaritifera*, a species used for at least three decades now for the production of cultured pearls. In Figure 3, with the elimination of the two last months of operation (January and February, 1999) which had anomalous temperature conditions that made the retention rate of all four grafters go down (Figure 3), three of the four grafters had already attained a retention rate higher than 60 per cent, eight weeks after operation started (post-op). Thus, according to Haws et al. (1999) our group of grafters fall in the category of "trained technicians", if these results are applied to *Pinctada margaritifera*.

If we take into consideration the period prior to December 1998, three of the four grafters had attained values higher than 60 per cent of retention rate, and only one of them had operated over 7000 organisms. So, we can most certainly state that 7000 seeded organisms give the necessary training to consider a person as a "trained technician".

Figure 3 shows a similar behaviour for all four curves, representing the retention percentage of all four grafters, but slightly out of phase. This can be directly related to the individual skills of each person. On the other hand, the general behaviour of the curves – being very similar in all four cases – demonstrates the influence of external factors that directly affect the retention rate.

Total retention percentage of all four grafters shows marked variations on the short-term. This could be attributed to a series of external factors, some of which have been identified as influential: the variation in the proportion of seeded organisms in each lot by each grafter (remember that the retention rate is different for each person); the daily variation in the physiological condition of the organisms in each lot; the variation in the size of used nuclei; and, most importantly, the mean sea temperature variation.

Both our results (from unpublished grafting log book) and those published by Tamura (1966) show that the bigger the nucleus, the lesser the retention. In the two different seeding seasons, nuclei size increased. In the first season, nuclei size range was 5.6 to 6.5 mm with a mode of 5.6 mm. In the second year, the nucleus size range was 5.6 to 10.0 mm with a mode of 7.5 mm. Also, the overall condition and size of the organisms differed. This also resulted in erratic changes in the retention rate.

When examining temperature behaviour in Figure 4, the main tendency in the variation of the total retention rate has approximately the same curve variations as that of the temperature. Some parts of both curves show values that seem unrelated, but examining data on the daily log we found that for points "a", "b" and "d" of the curve, the operated organisms belonged to small lots of strictly selected organisms with very good size and gonadal development; on the contrary, in part "c" of the curve, the operated organisms had a prior operation (resulting in no retention), and posed some seeding difficulties. Another point of importance is related to water temperature. Bacochibampo Bay (where the farm is located) presents a minimum temperature of 16° C under normal environmental conditions, but due to the anomalous environmental conditions created by *La Niña*, the winter months of 1998 and those at the beginning of 1999 registered temperatures lower than 16° C (down to 15° C). This lower water temperature present for such a long period, could have been in part responsible for a lower retention rate, as seen on Figure 4, at points "e" and "f" of the curves.

Conclusions

The results of this study were obtained in the real operation conditions of a commercial pearl farm.

In the case of seeding round nuclei in *Pteria sterna*, a grafting technician can be considered as "technically trained" (having developed the best part of his potential) after seeding 7000 pearl oysters. This number could be reduced if there is a previous training effort.

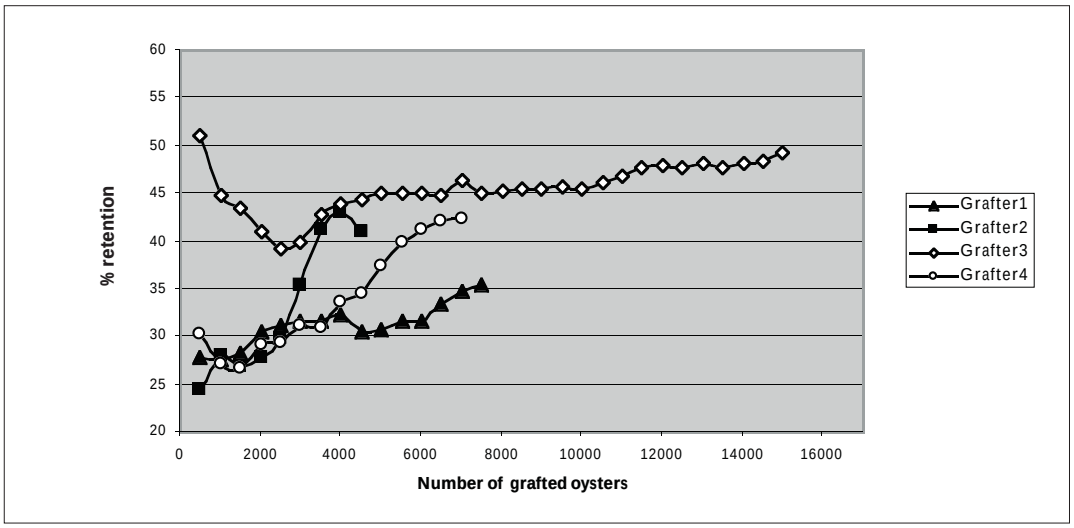

Figure 2. **Accumulated retention percentage, based on the total number of operated pearl oysters (*Pteria sterna*, Gould 1851), for four different grafters/technicians.**

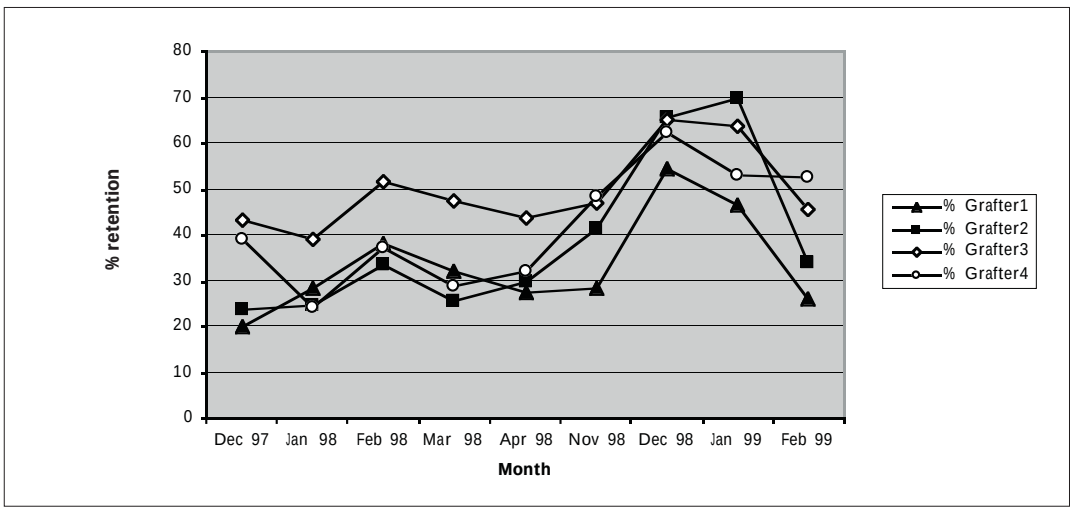

Figure 3. **Percentage of monthly retention for four different *Pteria sterna* grafters.**

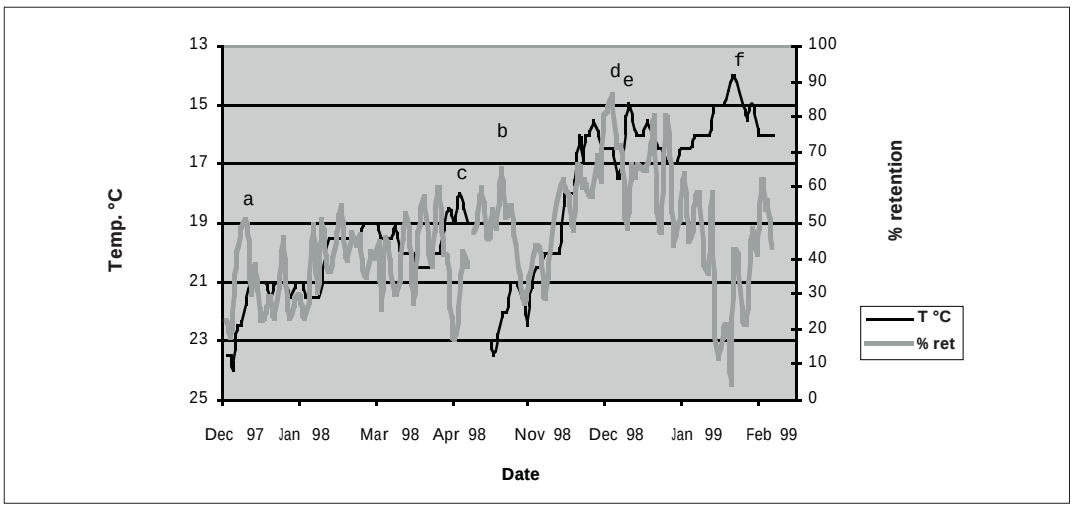

Figure 4. **Monthly retention rate in *Pteria sterna* (Gould 1851) for all four grafters, compared against seawater temperature at the time of operation. The letters in the graph are discussed within this article context.**

The most important factors influencing the retention rate of pearl oysters (*Pteria sterna*) are water temperature, nuclei size and the overall condition of the organisms.

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Pearl oyster training course at James Cook University

A five-week training course in pearl oyster propagation was recently held (4th to 5th November 1999) at James Cook University's Orpheus Island Research Station as part of the ACIAR project "Pearl Oyster Resource Development in the Pacific Islands." The trainees included three Fisheries Officers from Kiribati (Mr Beero Tioti, Mr Iannang Tealoro and Mr Iobi Arabua); two from the Solomon Islands (Mr Celtus Oengpepa, ICLARM and Mr Gideon Tiroba, Solomon Islands Fisheries); Mr Mataarora Masters (Marine Resources, Cook Islands); Mr Tevia Taumaipeau (Fiji Fisheries) and Mr Rajesh Prasad, a PhD student from University of South Pacific.

The Course covered aspects of the biology of the blacklip pearl oyster longline establishment, broodstock maintenance, spawning induction, larval rearing, microalgae culture, settlement, nursery and grow-out culture systems. While culture techniques developed at James Cook University formed the basis of the training course, trainees brought considerable and varied experiences to the course from their respective countries and sharing these experiences complemented to training course considerably.

During the course, trainees conducted a number of spawnings and reared 1.2 million *P. margaritifera* larvae through to settlement. These larvae were used in an experiment to assess different types of spat collectors and resulting spat will be used for subsequent nursery culture experiments.

To complement the course, trainees received a training manual outlining biology and general culture methods for blacklip pearl oysters. This will form the basis of a more comprehensive culture manual to be published by ACIAR in 2000. A second shorter training course should be conducted in Kiribati in the second half of 2000.

Source: Paul Southgate, Project Coordinator, ACIAR/JCU Blacklip Pearl Oyster Project, James Cook University

A review of mass mortalities in pearl oysters

Tint Tun[1]
Pearl Culture Technician & Pearl Oyster Biologist

This paper was presented to the Myanmar Pearl Enterprise in July 2000

Introduction

Pearl cultivation is a form of aquaculture. The cooperative effort between humans and aquatic bivalve molluscs, results in precious gems, pearls. There is always the possibility of mass mortality of pearl oysters and these can be a serious problem, bringing the industry to the brink of collapse.

Myanmar's pearl cultivation had also been affected by abnormal mortalities of pearl oysters since about 1983. As a result of study, a bacterium, *Vibrio*, was identified as a causative agent of the mass mortality.

The purpose of this paper is to present information on mass mortalities of pearl oysters, and causes and symptoms are compiled and described. Based on the available literature and my experience, I also present some suggestions.

Mass mortalities

From 1969–1970 a mass mortality of pearl oysters occurred in pearl farms from Port Moresby (Papua New Guinea) to Kuri Bay and Smith's Harbour (Australia). It was observed that death rate on many occasions reached 100 per cent and many times, out of one cage containing ten oysters, only one had survived (George 1992).

Mortality of pearl oyster, *Pinctada maxima* was about 80 per cent, although 30 to 60 per cent was more common in the Australian pearl culture industry since 1974. It continued for more than one decade, and a three-year investigation (1980–1983) into the causes of mortality was conducted. The investigation found that mortality was related to transporting oysters from fishing grounds to lease sites, which took a ship about 37 hours. During the longer fishing periods, collected oysters were held on board for a maximum of four or five days. The oysters were kept and transported in high densities on fishing vessels with inadequate water circulation, which caused a build-up of bacteria in oyster carrier tanks. A bacterium, *Vibrio harveyi*, was found to be responsible for high mortality rates in the tanks (Dybdahl and Pass 1985).

High pearl oyster mortality rates, ranging from 30 per cent to as much as 85 per cent (depending upon the farm and its location), occurred in most, but not all, areas throughout Indonesia in 1992–94. It was likely the result of erratic weather pattern that influenced the flow of air and water currents and affected elements such as temperature and plankton (Anonymous I 1994).

In 1985–86, abnormally high mortality rates of both cultured and natural pearl oysters were observed in the Takapoto pearl farms in French Polynesia. Farms raising spat and grafted oysters suffered losses of 50 to 80 per cent of stocks during the worst disease outbreak (Intes 1995b).

The Chinese Akoya pearl industry also experienced a problem of mass mortality, with very high mortality rates. Many farmers discovered that even after four or five months of cultivation, their nuclei were still not coated at all. The major reason for this incredible turn of events was that coloured or bleached Chinese or Vietnamese made nuclei were either totally rejected or received no nacre coating at all. Furthermore, in most cases the oysters themselves eventually died (Anonymous II 1994).

In Japan, a decade-long chain of mortality problems became acute in 1996 and 1997, resulting in the death of 150 million Akoya pearl oysters in Japan (Canedy 1998). Average mortality rates, depending on locality, ranged from 25 to 60 per cent (Anonymous 1998).

Causes

Table 1 lists twelve causes (in alphabetical order) of mass mortalities of pearl oysters described in the literature.

Symptoms

The decline in physiological condition of infected or moribund pearl oysters is indicated by many symptoms. One or more of the 16 symptoms described in the following table indicate an oyster in bad condition.

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

Table 1: Causes of mass mortalities of pearl oysters.

	Causes
1	Bacteria
2	Climate change
3	Farm management
4	Fouling organisms
5	Natural disasters ("tsunami" (huge wave), earthquake, etc.)
6	Nucleus
7	Parasites
8	Pollution
9	Predators
10	Red tide
11	Rough handling
12	Viruses

Table 2: Symptoms indicating a decline in the physiological condition of pearl oysters.

	Symptoms
1	Colour of adductor muscle turning red or brown
2	Slow response of adductor muscle when mantle edge is touched
3	Visceral mass becoming soft, glassy and watery
4	Abundant mucous secretions
5	Malformed mantle lobe
6	Necrosis of outer mantle
7	Heavy amorphous organic matter secreted mainly in the nacreous periphery of the valves
8	Deposition of brownish material on the inside of the shell valves
9	Twisted or irregular growth process
10	Growth processes disappear or discontinue
11	Ventricule is swollen and filled with blood
12	Rectum is swollen
13	Oyster ceases to grow altogether and finally dies in most cases
14	Reproductive function is discontinued or greatly reduced
15	Crystalline-style feeding mechanism and amount of feces are reduced
16	The function of the pearl formation mechanism is changed and effect deposition of calcium carbonate in the form of calcite instead of aragonite

Occasionally, after the disease outbreaks, a recovery follows. A strong demarcation zone on the valves indicates the oyster was infected but has recovered from illness.

Discussions

Infectious diseases have been recognised as one of the factors limiting the development of marine invertebrate farming. Normally, oysters can handle natural stress and moderate handling, but they are particularly vulnerable to diseases. However, the etiology of pearl oyster diseases and available literature are still limited. The good news for researchers is that gross and histopathological studies could provide baseline data on the occurrence and prevalence of potential pathogens and provide a basis for the diagnosis of infectious and non-infectious diseases of *Pinctada maxima* (Humphrey et al. 1999).

Besides biological factors, physical and chemical conditions can also cause serious problems for pearl cultivation. Among these factors are: decreased salinity, high water temperature, cold tides, red tides, hydrogen sulphide and pollution by domestic and industrial effluents (Mizumoto 1979; Anonymous I 1994).

Natural disasters such as hurricanes, earthquakes and tidal waves (“tsunamis”) must also be taken into account (McCormick 1966). During late 1982 and early 1983, six hurricanes struck the Tuamotu Archipelago, destroying most of the shallower bottoms and pearl farms (Intes 1995a). Indonesian pearl farms were severely affected by earthquakes and “tsunamis” in 1992, and oysters became ill and too weak to stand seeding operation (Anonymous I 1994). Nowadays, in order to improve the survival rate of pearl oysters after nucleus insertion, antibiotic coated nuclei are being produced in Japan and USA and positive results have been observed (Akiyama et al. 1998; Anonymous 1999).

George (1992) pointed out the pattern of spreading mortalities. He said that pearl shell mortalities were permanent in the Japanese home industry since 1960 and in all the pearl farms of the South Seas established with their cooperation. According to George (*ibid*), Japanese technicians moving around various culture farms may have been the carrier of causative agent(s). Increased attention is now being given to risks posed by the frequent movement of technicians and their instruments between and within countries (Aquilina 1999).

Cleaning and sterilising every instrument used in seeding has become an essential precaution and should be done before and after a technician

moves from one place to another. While there is no substantive evidence to support George's claims, it is still a good practice to sterilise the instruments used in delicate surgery on oysters of various levels of health.

Heavy mortalities due to confinement during transshipment could be controlled through improved handling and holding practices: better water circulation, decreased densities and improved hygiene on farms and during transshipment, and avoiding transshipments during colder months (Pass et al. 1987).

Transportation of pearls oysters to areas where they did not occur naturally in abundance may have resulted in the spread of diseases, parasites and predators associated with these shells. It would be unwise to introduce oysters from known infected areas to other areas and even from an area that was struck by a kind of natural disaster such as cyclone because pearl oysters may be weak.

Braley et al. (1993) warn that oysters contracting an unknown "disease" could look healthy but within two or three days only a gaping shell with dead soft tissue remains. It is therefore rather hard to say that individual stocks are "disease-free".

Except for obvious causes (e.g. "tsunami"), causative agents are usually not identifiable. Mr Koichi Takahashi, senior vice president of the Mikimo (America) company, commented on a mass mortality of pearl oysters that occurred in 1996–97 in Japan. He said, "Everybody is blaming everything, and it is really hard to determine what is the main cause"(Canedy 1998).

A better understanding of pearl culture area's ecosystem is essential for noting any abnormal changes. Managing oyster numbers on farms, spacing, maintenance operations, restrictions on stock transfers, and monitoring the hydrological environment can enhance the health of a culture farm. Closed and semi-closed lagoons, opens lagoons, bays and estuaries, sheltered coasts and open coasts progressively experience more water exchange and, thus, the risk of detrimental impact to water quality resulting from any perturbation is lessened (Anderson 1998).

Suggestions

Based on my experience, and literature studies, I offer some suggestions in Table 3 (see next page).

Acknowledgements

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Table 3: Suggestions for managing pearl oyster farms.

	Suggestions	Purposes
Pearl Oyster		
1	Attention should be paid to any abnormal mortalities of oysters	To know the first occurence of mass mortality as early as possible
2	Detect any abnormal condition of shells and visceral mass	To know the occurence of potential problems leading to mass mortality
3	Infected oysters should not be moved from one station to another	To prevent spreading of disease
Culture area		
1	Oyster lines laid on the sea bed should be in the same direction of water current	To enhance flowing of water current among oyster lines on the sea-bed and between the two valves (shells) of every individual
2	Wide space between culture lines	To provide good hygiene and food availability
3	Discarded fouling organisms should not be shelved close to the oyster-lines area	To prevent accumulation of fouling organisms, and unnecessary dead matter heaped up on culture grounds
4	Detect any abnormal quantity of predators (e.g. gasteropods)	To know the probable predation on cultured pearl oysters
Seeding operations		
1	Intruments (including gloves) used in seeding operation should be sterilised regularly	To prevent infection by instruments
2	Instruments used by a technician who moves to another station must be sterilised before and after he / she moves from one place to another	To prevent spreading of causative agents by technicians
3	Infected oyster meat should not be thrown in the sea. It should be buried on land	To prevent infection to other oysters
Other		
1	Partitions in an oyster cage should be reduced to five, to house ten oysters in a cage	To reduce substrates for fouling organisms and, as a consequence, to reduce their competition
2	Rough handling should be avoided	To reduce stress on pearl oysters, especially infected oysters
3	Record the hydrological condition of culture area regularly	To detect any environmental changes
4	Study and analyse past experiences	To identify significant facts that can help early detection

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Socio-economics of pearl culture: Industry changes and comparisons focussing on Australia and French Polynesia

Clem A. Tisdell[1] and Bernard Poirine[2]

Adapted, with kind permission, from World Aquaculture Magazine, *June 2000. 30–60.*

World production of cultured saltwater pearls has expanded greatly during the last two decades, mainly due to an increase in the supply of black pearls. Australia, French Polynesia, Indonesia and Japan are the principal producers of marine pearls in the world. French Polynesia and Indonesia have been the main sources of the increased supply of black pearls and South Sea pearls, respectively. While this increase in supply expanded the market for pearls globally, it has also led to a decrease in price per pearl. Numerous causative factors are involved in this price decrease and various social and economic impacts are apparent. Australia and French Polynesia are major pearl producing countries that have different regulatory systems, production approaches, industry structures, and marketing. Therefore, exploring how each country has influenced the worldwide market and the possible consequences captures interest.

History of pearl culture

Western Australia is by far the major producer of pearls in Australia, producing over US$ 200m dollars of mostly South Sea pearls annually. A brief history of the existing industry there is worthwhile. Pearling in Northern Queensland and the Northern Territory showed similar trends.

The economics of the early pearl industry relied on mother-of-pearl shell, mainly used for buttons and inlay work. Actual pearls, if found, were just a bonus. The Western Australian industry developed in the late 1800s relying first on Aboriginal and Malay divers and then Japanese divers. The industry, however, declined dramatically in the 1920s and 1930s with the introduction of plastics. Nevertheless, a useful side benefit of this decline was the opportunity for over-harvested populations of wild oysters to recover.

The Western Australian pearling industry owes its recovery to the introduction of pearl culture in the 1950s. Most of the production is based on the culture of *Pinctada maxima*, although some is derived from the black-lipped pearl oyster, *Pinctada margaritifera*. The industry is based, primarily, on the collection of wild oysters. These oysters are collected, seeded, and placed in seabed panels, turned regularly for the next 2–3 months, and then taken to farms and held on panels suspended from long lines. They are cleaned regularly to eliminate bar-

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nacles and other marine growth. Oysters are about 3 years old when they are captured and seeded; two years later they are available for harvesting. *Pinctada maxima* is a very large oyster yielding white, rose, blue, or golden pearls between 10 and 18 mm in diameter.

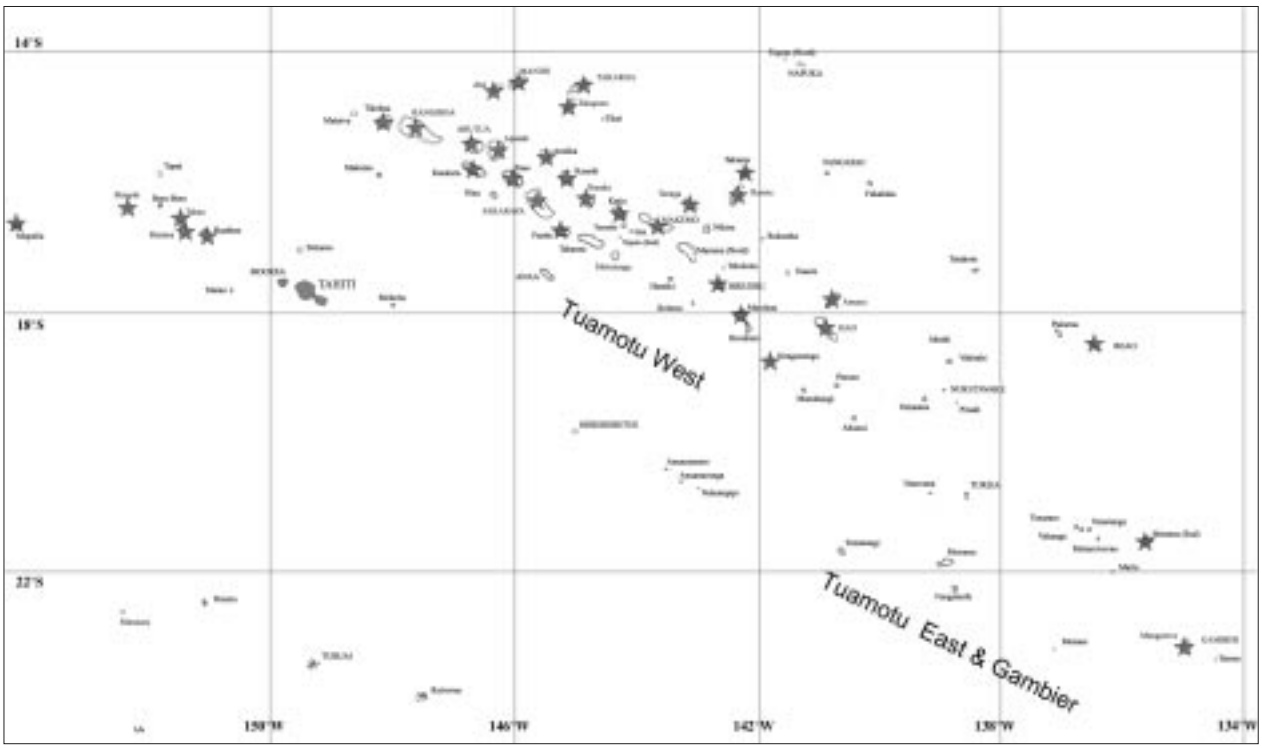
To reserve parent stocks, and to control supply to some extent, state governments regulate the industry. Producers must be licensed and are allocated annual quotas and catch areas for collecting wild oysters for implanting. Currently, there are 16 licensed companies in Western Australia with individual catch quotas ranging between 15,000 and 100,000 shells. The total allowable annual catch is about 572,000 shells. The cost of landing oysters for implantation is about US$ 20 / shell.

Hatchery production of pearl shells has recently developed. In 1992, the Western Australia Fisheries Department issued licenses with a right to use 20,000 shells from hatchery stock. If all 16 licensees were to exercise this option, there would be an additional 320,000 shells (oyster) for implantation; in fact, it seems that licenses for about 350,000 shells have been issued. This amount represents just over 61 percent of the total allowable catch of 572,000 shells (oysters) in Western Australia. Most licensees are in the process of taking advantage of these quotas, which have a potential to increase Australia's supply of South Sea pearls substantially.

Development of the pearling industry in French Polynesia was originally associated with collection of mother-of-pearl shell. Presumably, the French Polynesian industry suffered a fate similar to that of the Australian pearl industry due to the introduction of plastics. The resurrection of the pearl industry in French Polynesia is quite recent and began in the 1970s with the emergence of a black pearl industry.

Polynesians have been diving in the Tuamotu islands to collect mother-of-pearl from *Pinctada margaritifera* oysters since 1820–1830. Mother-of-pearl was exported to make buttons and inlay works. Occasionally, a rare natural black pearl was found. Approximately one in 15,000 black-lipped oysters gave a natural south sea black pearl.

In 1963, the head of the Tahitian Fisheries department, Jean Domard, with the help of an Australian company, Pearls Pty Ltd, based at Kury Bay in Western Australia, experimented with black pearl grafting on *Pinctada margaritifera*. Pearls Pty Ltd sent grafters to Hikueru and Bora Bora. Two years later, pearls of excellent quality were obtained. In 1967, Mr Jacques Rosenthal, a reputed gem wholesaler, who had seen the pearls harvested by the Fisheries Department, hired Mr William Reed, an Australian biologist, to study the feasibility of a pearl farm on Manihi Atoll (Tuamotu Archipelago). Reed recommended spat collection because natural



Map of French Polynesia with areas of black pearl production highlighted by stars.
Source: Service des Ressources Marines, Ministère de la Mer , Tahiti, French Polynesia

oysters were in short supply due to over-harvest to sell the oyster shells. Later, Mr Reed was hired by the Fisheries Department to study spat collection, a project financed by a French Government grant. The project was a success, showing that spat collection was indeed possible on a large scale on Manihi, Takapoto, Hikueru, and in the atolls of the Gambier Archipelago.

In 1973, William Reed founded his own pearl company Tahiti Perles, on Mangareva Island, Gambier Archipelago. Robert Wan, today's foremost producer of Tahitian pearls, bought the company in 1975. Around this time, two other persons began pearl companies: Koko Chaze, on Manihi (Tuamotu), and Jean Claude Brouillet, on Marutea (Tuamotu). The latter bought from the local government the stock of black pearls obtained by Jean Domard in 1965 following the 1963 grafting experiment. Brouillet had been told the cultured black pearls were valueless because there was no market for them.

Brouillet traveled around the world to show his sample of Tahitian black pearls to famous jewelers in Paris, London, Tokyo, New York and according to his own account, the result was a pitiful fiasco (un fiasco pitoyable). In his book he recalls a humiliating meeting with the president of Cartier in Paris: "He began to smile and to play with the pearls on his desk, like a kid. Obviously, he was very much amused. Not me." Brouillet nevertheless decided to pursue his project and founded Polynesie Perles, a company now owned by Robert Wan who currently controls 50% of Tahitian black pearl exports. Later, Brouillet met Salvador Assael, a New York wholesale jeweler and pearl dealer, who decided to promote the South Sea black pearl among the most famous jewelers in the United States and France. As a result of their joint effort, the market for Tahitian black pearls began to emerge. After Brouillet sold his company to Robert Wan, he and Assael continued their joint effort to promote the South Sea black pearl on the American market. However, Japan soon became the main importer, and also the main exporter of black pearl necklaces and jewels to the rest of the world.

French Polynesia is now the main producer and exporter of loose South Sea black pearl, with a 95 per cent share of world exports, and a 28 per cent market share of total pearl exports (in 1998).

Starting with less than 2 kilos in 1972, French Polynesia exported close to 9 tonnes of black pearls in 1999, 70 per cent of those being bought by Japan. From 1980 to 1999, export growth (in grams) has been exponential (Figure 1). Between 1989 and 1999 exports increased more than fifteen fold, from 575 kilos in 1989 to 9 tonnes in 1999 (a 31.6% average annual increase). Pearls now account for more than 95 per cent of French Polynesia's total exports of goods (Figure 2).

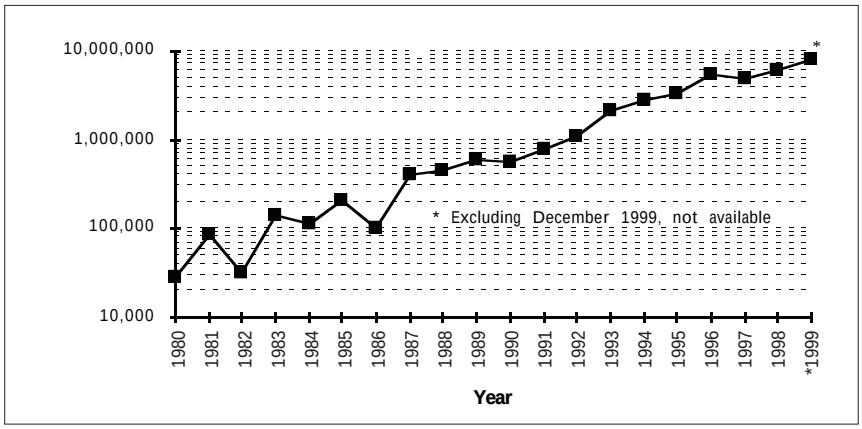


Figure 1. **Tahitian black pearl exports (weight in grams)**
(Semi-logarithmic scale)

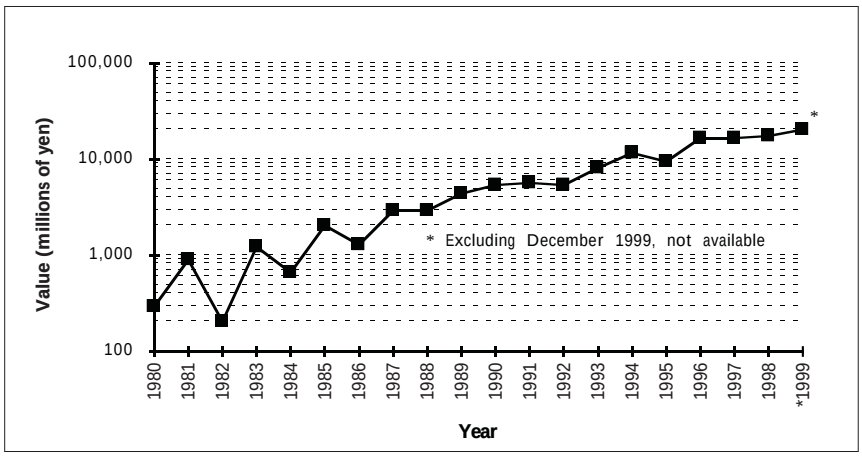


Figure 2. **Tahitian black pearl exports (value in millions of yen)**
(Semi-logarithmic scale)

Industry and technology

Being sheltered from open seas, atolls are ideal breeding grounds for oysters and the production of juveniles (spat). Spat collectors are made of plastic strips that hang about 2 metres below the surface, one every 1–2 metres, and are tied on 200-metre lines. This method of collecting juvenile oysters is easy and economical and they sell for approximately 1 US dollar each. This activity does not require much capital and is very profitable. The cost to construct a spat collection station, which does not require much maintenance, is about US$ 2000. After one year, the spat can be sold for US$ 6000 to 8000. As a result, many families of the Tuamotu islands have engaged in this activity.

A pearl farm, a grafting house and a grafter at work in French Polynesia

Pictures provided by the Service des Ressources Marines, Ministère de la Mer, Papeete, Tahiti.

By contrast, wild spat collection is not yet possible in the open sea fisheries of Western Australia. Juvenile wild oysters must be collected on the seabed by divers and, as a result, cost about 20 times more than those in French Polynesia. The Australian operators are now allowed a quota to breed spat in hatcheries, but this method of procurement is still much more costly and risky than natural spat collection in the lagoons of French Polynesia.

This cost difference explains why the industry structure and regulation in Australia and French Polynesia are so different. In Australia, the wild oyster resource is limited and overfishing would rapidly deplete the stock; therefore the imposing of quotas is necessary. In French Polynesia, some atolls have been overexploited and in others spat collection is not possible, but there are still dozens of atolls where spat collection is very easy and plentiful. One large-scale operator may have up to 1000 spat collection stations in one atoll. Where spat collection is not possible, it is easy to purchase oysters from another atoll and ship them in. For example, in 1997, one pearl farmer on Raiatea (leeward island in the Society Archipelago) received an air shipment consisting of a 4-ton supply of juvenile oysters from Takaroa (Tuamotu Archipelago).[3]

Spat collection also helps to increase the stock of breeding oysters, because many spats which otherwise would have been killed by predators survive on the collectors and some then fall to the bottom to grow and breed. As a result, natural stocks of oysters are in little danger of depletion as was the case when shells were being collected for mother-of-pearl and spat collection techniques had yet to be introduced. Therefore, this is one of the reasons why a quota system has not been established to preserve natural stocks.

In French Polynesia, a small-scale operation is easy to establish. There are no expensive open sea vessels to buy; everything can be done at the same place with small boats. A small family operation works well with family members and no salaried labor. The maritime concession is easy to obtain and, sometimes, not requested before setting up an operation. Also, the fee is relatively inexpensive and, often, never paid. In addition, no quota on grafted oysters exists, even though the size of the operations on the lagoon surface is specified by the maritime concession. Moreover, the government of French Polynesia has been following a policy to promote activities to repopulate the outlying islands. As a result of atomic testing, people have emigrated from these islands to the main island of Tahiti and its capital city of Papeete since 1962 in search of well-paid salaried jobs. Local, small-scale family and co-operative operations have been promoted through a co-operative organization called GIE Poe Rava Nui, which has been helping with technical advice, marketing (an annual auction held in Papeete), and financing through loans secured from the SOCREDO development bank. Technical help is also provided to small producers through an administrative body called Etablissement pour la valorisation des activities aquacoles et maritimes (EVAAM). In addition, the very high price obtained for Tahitian black pearls until the middle of the 1980s made this activity

3. Personal communication by J.P. Dihlan, pearl producer and wholesaler

very profitable and attractive to the locals, as well as Tahitian and Chinese entrepreneurs from Tahiti.

The structure of the pearl industry in the two countries is very different. In Australia, there are only 16 licensees and most of them are large-scale operators. In fact, the Paspaley Pearling Company produces more than 50 per cent of Australia's cultured pearls. In French Polynesia, the industry is bi-level in nature. A few important companies represent at least 70 per cent of the industry's output. They are affiliated with the Syndicat des Producteurs de Perles de Polynésie (SPPP). The four most important producers are Robert Wan, Jean-Pierre Fourcade, Anatila Bréaud and Patrick Rosenthal. Robert Wan alone claims to represent at least 50 per cent of total sales. The very small family or co-operative operations are federated by a groupement d'intérêt économique: GIE Poe Rava Nui. Their combined production represents only 3.5 per cent of total exports. The number of family operations affiliated to GIE Poe Rava Nui grew from 13 in 1981 to 446 in 1994, and then decreased to 321 in 1996. Only 160 of these farms sold lots at the 1996 auction, suggesting that some of them either ceased activity or sold their harvest through other channels. Some medium-scale operators have set up yet another association: le Syndicat des Producteurs de Perles de Tahiti et des Iles (SPTTI), which is associated with GIE Tahiti Pearl Producer, a marketing association. Many of the 200 independent small-scale operators have not joined any association. However, sharply declining prices since 1989 have caused bankruptcies among medium- and small-sized producers. Since 1970, 9459 maritime concessions were granted for operations on 47 islands and 1929 were for spat collection. In 1996, 330 new concessions were granted, and 60 were cancelled. In practice, many concessions are not exploited (more on this later).

Because supplies of oysters for Australian pearl farmers are limited by a quota, every effort is devoted to maximize the number of pearls obtained from each oyster, and to obtain the highest quality possible. Since oysters are so plentiful and so inexpensive to purchase in French Polynesia, and with no quota imposed on grafted oysters, a trade off between quality and volume exists. Generally, investment toward increased input and output is more profitable than an increase in the average quantity and quality of pearls from a fixed supply of oysters. Falling prices since 1986 have further encouraged this tendency to increase production at the expense of quality, because higher volumes are needed to maintain profits when profit margins tend to fall.

The readily available and abundant supply of spat and the lack of quota imposed on producers have made possible a spectacular growth of the supply of Tahitian black South Sea pearls: from 104 kilos in 1986, to 1069 kilos in 1992, to 9 tonnes in 1999. The share of Tahitian black pearls in the overall world loose pearl market increased from almost nothing to about 28 per cent in 1998. Whether market share will continue to expand at that rate is doubtful. Therefore, a slow down in the rate of growth of supply will be necessary to keep in phase with world demand and thereby preserve the present level of prices. Indeed, the world demand for pearls declined between 1994 and 1998.[4]

The big operators typically deplore the anarchic nature of the industry in French Polynesia, but at the same time they are reluctant to accept any form of regulation. Since most of them own private atolls, they do not feel concerned about tragedy of the commons type of problems. They believe they can manage their operations in their best interest, and do not see the need for government interference to prevent over-exploitation of the oyster resource.

Socio-economic impact

In Western Australia, about 1000 persons are employed in the primary aspects of pearl production. Taking into account the Northern Territory and Queensland, the total persons employed in Australia in primary production of pearls is less than 1500, considerably fewer than in French Polynesia. Furthermore, a considerable amount of the Australian employment is seasonal. Production is located in the warmer northern tropical waters of Australia, areas that are sparsely populated.

At least 4000 persons are now estimated to derive their living from pearl farming or spat collection in French Polynesia. In the islands of the Tuamotu and Gambier Archipelagos, where pearl farming takes place in about 35 islands, it is estimated that one family in four earns a living from this activity (the active population there numbers 6427 at the 1996 census). According to social security statistics, 1020 salaried persons are employed by 87 employers in large or medium scale pearl farms. Many small farms use only non-salaried family labour. More and more small family operations turn to spat collection, and big farms buy juveniles from the small-scale family operations.

The pearl boom has had both positive and negative impacts. Positively, it has reversed the former emigration trend from the outer islands of the

4. GIE Perles de Tahiti, Perles de Tahiti News, N° 21, July–August 1999, p. 9

Gambier and Tuamotu Archipelagos to Tahiti. The islands where black pearl farming occurs have experienced a strong return migration movement. For example, between 1988 and 1996, the population of the Gambier Archipelago has increased by 75 per cent. Individual islands in the Tuamotu Archipelago have had spectacular population growth over the same eight year period: Kauhei +191 %, Ahe +133%, Apataki +106%, Fakarava +88%, Arutua +81%, Manihi +79%, Rangiroa +46%, Takapoto +31%, Takaroa +23%. The economic impact is also positive. Census figures indicate that living standards have improved rapidly. Households are better equipped with modern amenities, including cars and even motorcycles (in Arutua, they replaced bicycles and scooters) (ITSTAT 1991, 1997; Pollock 1978). Clearly the positive side of the industry is that jobs are created on remote islands from where young people previously emigrated to find jobs. Additionally, most of the jobs created are well suited to the kind of outdoor work that Polynesians always liked to do in the remote archipelagos, such as fishing and diving for shells. This industry offers a working environment and a life style as close as possible to the traditional activities of the local population.

Socially, this rapid growth has also had some negative side effects. Many small family operations went into debt to invest in pearl farming. Due to the lack of knowledge about management and a tendency to confuse turnover and profits, they were never able to pay back their loan to the bank. In 1996, outstanding, unrecoverable loans to small pearl farmers represented at least 5 million US dollars.[5] The considerable amount of cash generated by pearl farming has increased inequalities between successful and unsuccessful families, and between islands where pearl farming is booming and where copra production is still the only cash resource. Moreover, there are often conflicts between locals (islanders) and outsiders from Tahiti or other islands moving in to establish pearl farms. In the recent past, big producers have tried to encourage government regulation to limit production of small scale operators, on the grounds that small producers tend to produce lower quality pearls and market them less satisfactorily than professional dealers. On the other hand, long time residents and landowners in the Tuamotu and Gambier islands have been complaining that the government was granting licenses to aliens[6], to occupy the maritime public domain for pearl farming. These aliens are mostly Chinese, Tahitians, half-Tahitians (Demis), and European businessmen from the main island of Tahiti and have neither relatives nor property on the island. In many instances, newly arrived outsiders were met by violent demonstrations from the locals, who believe that the riches of the lagoons are theirs by right and that no maritime licenses should be issued to aliens (Rapaport 1991, 1993, 1996).

Foreign pearl farming operations are not authorized although many local operations are believed to be covertly financed by Japanese interests acting through straw men. According to Rapaport (1993), almost all of the authorized pearl farming area on Takaroa had been allocated to alien entrepreneurs. Alien pearl farmers occupy half of the total nearshore lagoon farm area, blocking more than a third of the occupied shoreline. They also use a substantial proportion of the central lagoon area for spat collection. These activities violate previous agreements with the community as well as the authorized concession limits set by the administration.

A note of the Ministère de la Mer (1990) describes an anarchic occupation of the public maritime domain, without any real control and an obsolete regulation of maritime concessions whereby oyster density within the lagoon is not considered. Increasing delinquency (oyster and pearl stealing) is noted and protests linked to granting of maritime licenses to outsiders (people not originating from the island) are increasing, even though French laws do not allow discrimination on the basis of residence or place of birth (our translation).

Adverse economic side effects are also beginning to appear. The large-scale operators such as Robert Wan privately own islands and therefore are personally interested in preventing over-exploitation. This concern is not demonstrated by small and medium scale operations that share a common resource, the lagoon. Such a situation is a typical case of the tragedy of the commons (Hardin 1968; Gordon 1954); each private farm tries to maximize the scale of its operation, even if over time such a strategy may lead to overexploitation and, therefore, massive oyster mortality. Well before the occurrence of overexploitation, pearl quality and productivity deteriorate, causing a reduction in each operator's profit. Spat collection yields seem to provide a good advance indicator of whether or not a lagoon is overexploited. For example, in Takapoto, a once very rich pearl producing atoll, spat collection has been abandoned, and pearl farming is now much less productive than elsewhere. Massive oyster mortalities have occurred in

5. As of June 1996, unrecoverable debts owed to the SOCREDO bank by small pearl farmers amounted to at least 550 million Pacific Francs, that is, around US$ 5 million (Institut territorial de la Statistique, Points Forts, 1997).

6. In the following text, alien means not born on the island

Hikueru in 1977 and in Takapoto in 1985. The transfer of oysters from one lagoon to another can also spread diseases.

In the common interest of all operators sharing a lagoon, it seems necessary to limit the over-exploitation of the free common resource by creating the (missing) market for the access to the lagoon (this is similar to the enclosure of the commons in 17 century England). This could be done by designing a scheme of transferable quota rights that limit the number of oysters farmed and grafted each year. These quota rights would be sold periodically by auction and be based upon biological carrying capacity and economic yield. Such a scheme was used to manage oyster banks in Holland from 1870 on (Van Ginkel 1988), even though the optimum level of exploitation was not precisely known. To alleviate the previously described conflicts of interests that caused locals to oppose outsiders, some of the proceeds from the auctions could be transferred to the locals through either financing of communal projects or subsidising of local co-operative pearl farming operations. Another part of the proceeds could be used to finance promotional efforts worldwide. Some free quotas could also be reserved for islanders as long as they really exploit them and do not resell them on the market.

However, such a stated scheme is not likely to be enforced in the near future in French Polynesia. Government regulation is almost non-existent; the existing formal regulation is far from being strictly enforced; and the need for public management and regulation of a common natural resource is not widely recognized as valid by most producers.

Marketing aspects

Prices

Between 1990 and 1995 the average price of the Tahitian black pearl decreased almost fourfold (3.85), from 9486 yen per gram in 1990 to 2464 yen per gram in 1999, as production and exports expanded very rapidly (Table 1, Figure 3).[7] Figure 4 shows that the volume of exports, in grams, tends to be related inversely to the price per

Table 1. **Tahitian South Sea pearls exports and prices per gram, 1980–1999**

Year	Exports in grams	Value of exports million Fcfp	Value of exports million yen	Price/g in Fcfp	Price/g in yen	100 yens in Fcfp
1980	28,779	102	300	3,544	10,424	34.0
1981	86,527	404	898	4,669	10,376	45.0
1982	32,310	99	206	3,064	6,383	48.0
1983	139,888	712	1,228	5,090	8,775	58.0
1984	112,183	441	668	3,931	5,956	66.0
1985	206,463	1,392	2,017	6,742	9,771	69.0
1986	104,114	998	1,279	9,586	12,289	78.0
1987	407,620	2,252	2,963	5,525	7,269	76.0
1988	446,827	2,513	2,953	5,624	6,610	85.1
1989	608,861	3,764	4,428	6,182	7,273	85.0
1990	575,007	3,732	5,455	6,490	9,486	68.4
1991	786,521	4,404	5,761	5,599	7,324	76.5
1992	1,069,126	4,195	5,517	3,924	5,160	76.0
1993	2,113,728	7,749	8,319	3,666	3,936	93.2
1994	2,815,070	11,718	11,863	4,163	4,214	98.8
1995	3,239,745	9,394	9,685	2,900	2,989	97.0
1996	5,486,900	14,071	16,362	2,564	2,982	86.0
1997	4,988,940	14,658	16,657	2,938	3,339	88.0
1998	6,182,700	14,587	17,724	2,359	2,867	82.3
1999*	8,200,000	20,000	20,202	2,439	2,464	99.0

* Excluding December 1999.
Sources: Institut Territorial de la Statistique, French Polynesia, and GIE Tahiti Perles

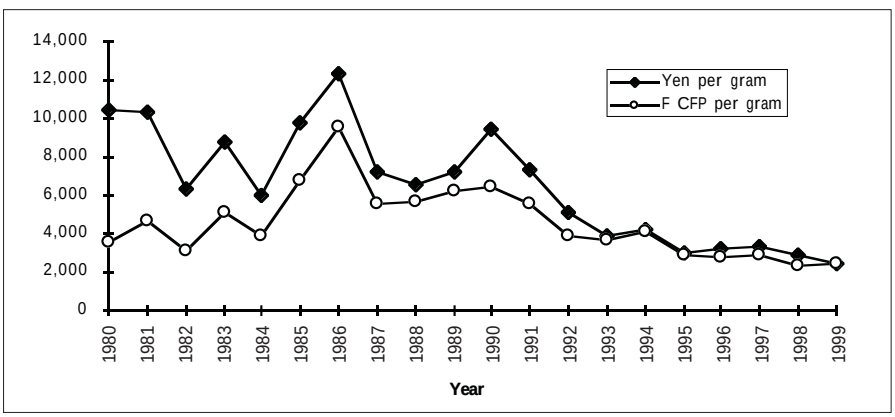


Figure 3. **Average price per gram of French Polynesia's black pearl exports.**

7. The average price per gram does not take into account the varying quality of production from one year to the next and the overall increase or decrease in average quality and size over time.

gram in yen. This trend is not surprising because the supply of Tahitian pearls is rather inelastic in the short term. Supply depends on the quantity of oysters grafted 18 months before, and producers do not stock their harvest from one year to the next. Therefore, prices tend to decrease if supply grows faster than world demand. The average price in yen per gram has decreased six fold between 1986 and 1999.

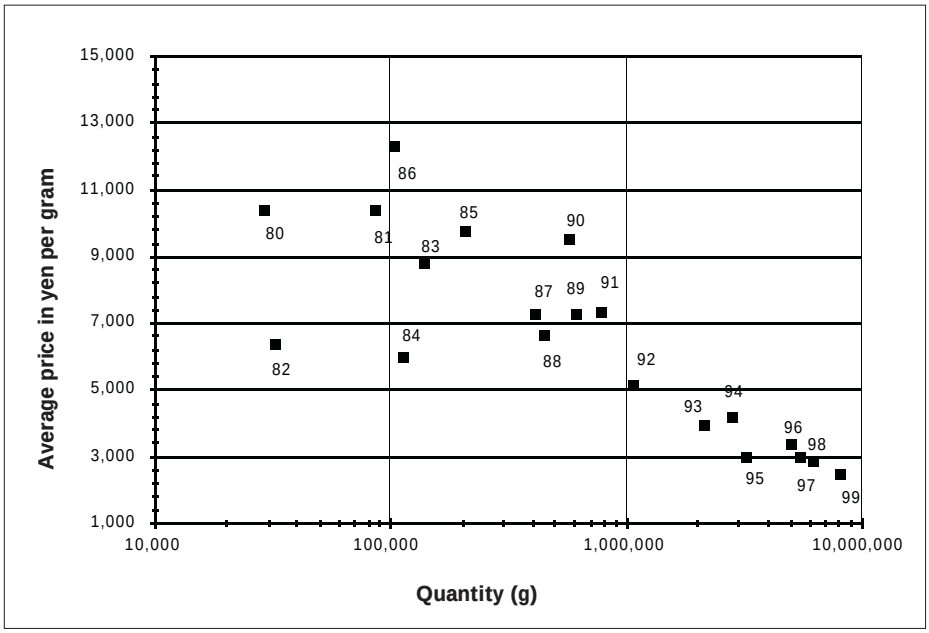


Figure 4. **Relationship between average price (yen/g) and quantity (g) of black pearl exports from Tahiti**

Market shares

Tahitian black pearls are no longer an extremely rare and expensive item reserved to a privileged elite. They now appeal to a wider clientele. The declining price of the Tahitian South Sea Pearl (TSSP) over the past few years has helped expand its demand in both volume and value, and therefore its share of the world market. In 1995 the market shares for TSSP and ASSP were almost identical, at 24.5 per cent (GIE Perles de Tahiti). From 1995 to 1996, their combined market share increased markedly, from 49 per cent to 57 per cent, at the expense of Indonesian, Japanese and Chinese competition. ASSP supply has been rising at a rate much less than that of TSSP, thereby helping to maintain high prices, but slowing the overall increase in value.

Hatchery production of oysters for seeding has the potential to raise the supply of pearls in Australia considerably. Given current quotas for aquacultured shells, aquaculture can increase the Australian supply of pearls by 60 percent, compared to the wild limit, which seems to be the product of biological constraints. Any constraints on aquacultured shells can be expected to be determined by market considerations. Australia relies heavily on the high quality of its pearls to obtain premium prices.

Distribution

Japan, still the principle importer of loose Tahitian black pearls, bought 70 per cent of the total value of Tahitian pearl exports in 1996, much more than the USA (10%), and Hong Kong (8.6%). In 1996, Japan's share of worked Tahitian black pearls exports was 96 per cent. Dealers in Kobe, Japan, work with high volumes that enable them to match pearls of similar size, color and quality perfectly, and then assemble them into strands. It is estimated that more than half of Japanese imports of loose Tahitian black pearls is re-exported, after processing, mainly to the USA.

However, a challenge to the Japanese *de facto* monopoly on the worldwide marketing of Tahitian black pearls appears to have been laid down. According to GIE Perles de Tahiti, the share of loose Tahitian black pearls bought by Japan was 68 per cent in 1998. More and more non-Japanese jewelers and wholesalers are buying from two cooperatives of small pearl farmers, GIE Poe Rava Nui and GIE Tahiti Pearl Producers, and from local wholesalers at the annual auctions held in Papeete. Local wholesalers are beginning to offer a better choice of paired pearls because they are working with volumes that are much larger than those of a few years ago. Following the successful example of Australian producer Nick Paspaley, who managed to bypass the Japanese monopoly by setting up his own international auction of Australian South Sea pearls, Robert Wan, Tahiti's leading producer, has held annual auctions in Hong Kong for the last three years, with much success. Hong Kong is now the second largest importer of Tahitian pearls.

As from January 1999, legislation required all pearl dealers in French Polynesia to be licensed in order to sell pearls abroad. The conditions for licensing pearl dealers in French Polynesia are rather stringent. However, small producers of pearls in French Polynesia are still allowed to sell

directly to whomever they want. In some cases, small producers who have a desperate need for cash have been known to sell directly to jewelers in the United States at vastly discounted prices. As a result, the profession's credibility has been adversely affected and a prejudice toward professional wholesalers exists.

Some producers of Tahitian pearls, wholesalers, and jewelers have proposed to establish a central marketing board to prevent small producers from selling directly at discounted prices. An overabundant supply, stemming from the lack of quota schemes regulating growth, is bound to lead to such anarchic behaviors, because each producer strives to sell directly to maximize diminishing profit margin. Only large producers working with high volumes can offer homogeneous lots by pairing pearls. Smaller producers are compelled to sell heterogeneous lots that command a lower average price. In theory, a central marketing board would select only the best quality pearls, classify and pair them, and sell only homogeneous lots. This production approach would return the important value now added by wholesalers (most of them Japanese), who are doing this work, to the producers. Also, producers would have the opportunity to regulate the market to prevent wildly erratic price changes from year to year.

Since 1992, the local producers in Australia have sold their annual harvest directly through annual auctions held in Hong Kong and Japan. These auctions, and the quota system, which limits supply and encourages producers to improve pearl quality, have helped to achieve prices much higher than those in French Polynesia. Ten years ago, average prices per gram between the Australian and the Tahitian pearls were very similar (about US$ 100 per gram). Due to its limited supply, the Australian pearl now commands a much higher price, about US$ 180 to 200 per gram, compared to US$ 25 to 30 per gram for the Tahitian pearl. Using these prices, the value of pearl exports was approximately the same in both countries in 1995. But by 1998, the value of pearl exports from French Polynesia exceeded that from Australia. However, about 10 million oysters must be grafted in Tahiti, while only 572,000 oysters are grafted in Australia.[8]

Promotion

Much more money has been spent on promotion of the Tahitian South Sea pearl in the last few years. An association for the promotion of the Tahitian black pearl, GIE Perles de Tahiti, was created in 1993 and receives half the proceeds of the export tax, 160 F CFP per gram, on Tahitian black pearls. Proceeds from the tax increased rapidly as the value of exports increased in recent years. Therefore, the promotion budget of GIE Perles de Tahiti has been steadily rising (+63% in 1996). Promotion was aimed at fine jewelers in 1995 and 1996 and, since 1997, all efforts are being directed toward establishing an association of Tahitian black pearls with the world of high fashion and show business. Promotion associations have been set up in Japan, the United States and Europe (France, Germany). Still, the overall promotion budget (379 million F CFP) represents only 2.7 per cent of total sales (14 billion F CFP in 1996), a relatively modest percentage in the world of luxury goods (GIE Perles de Tahiti 1997). In Japan, a similar association of black pearl import companies, the Japan Black Pearl Promotion Association, was also created in 1993.

Successful promotional efforts since 1995, as well as falling prices, are probably responsible for the growing interest for black pearls in the world of jewelry and the increasing market share of the Tahitian black pearl in total exports of loose cultured pearls in recent years.

Observations from recent statistics on Australian pearl exports

Australian statistics on pearl exports are incomplete. Figures for both volume and value of exports are only available from 1994 to 1995 and thereafter. In the initial years (1994–1995 and 1995–1996), the volume of exports is only available as number of pearls, and weight must therefore be estimated.

Table 2 presents estimates of average prices received for Australia's export of pearls. In 1995–96 the considerable expansion in volume of exports compared to that of 1994–95 was accompanied by a substantial reduction in the average price received for pearls. Price recovered in 1996–97 when the volume of pearl exports was reduced to about three-quarters of that in 1995–96. The pattern of price fluctuations is similar to that observed for Tahitian black pearls. However, the relative variation in price is greater for the Australian pearl, and, after the trough of 1995–96, a seemingly stronger recovery of price was achieved for Australian pearl exports. This occurrence possibly reflects a much sharper reduction in relative supplies by Australia following the 1995–96 collapse in prices. In turn, the greater market concentration in the Australian industry compared to that in French

8. This estimate is obtained by dividing the 5 tons harvest of 1996 by the average weight of pearl, which gives 3,700,000 oysters, and then applying a rate of one marketable pearl for every three grafted oysters.

Table 2. **Recent statistics on Australian pearl exports*: prices in AU$**

Reference period	Total Exports		Total Value (FOB)	Average price/pearl ($)
	Numbers	Weight (g)**		
1994-95	976,605	2,856,569.63	210,146,225	215.18
1995-96	1,218,106	3,562,960.05	79,870,844	65.57
1996-97	937,334	2,741,701.95	191,753,714	204.57

Source: The Australian Bureau of Statistics

* In 1994-95, Australia exported articles of natural or cultured pearls (71161000) and round cultured pearls, unworked, not mounted or set (71012110) worth $1,307,572 and $488,713 respectively. The corresponding figures for 1995-96 were $1,623.719 and $116,028,252 respectively. Data on export weight for these two categories were not available and have been estimated as in note **.

** Initially unit of quantity was given only as number. In order to determine the average per gram price of a pearl, number was converted into weight (grams) using the industry estimates: Average wight of each pearl = 0.78 momme; 1 momme = 3.75 grams (Paspaley Pearling Co. Pty Ltd, Darwin personal communication).

Table 3. **Major export markets for Australian pearls (cultured worked - 71012201), 1996–97**

Country of destination	Number	Value (FOB) (AU$,000)	Market share in value (%)
Japan	53,011	17,183.281	30.63
Hong Kong	22,662	8,934.125	15.93
United Kingdom	32,980	7,468.752	13.31
United States of America	38,081	4,547.850	8.11
Germany	18,323	3,401.825	6.06
Switzerland	10,644	2,869.397	5.12
Others	118,951	11,691.568	20.84
Total	294,652	56096.798	100.00

Source: The Australian Bureau of Statistics

Polynesia, and therefore superior capacity to regulate supply, are possible explanations.

Japan was the principle market destination for such pearls, followed by Hong Kong and the United Kingdom with the United States of America, Germany and Switzerland providing significant market outlets (Table 3).

Conclusion

In September 1998, Robert Wan, Tahiti's leading pearl producer, told Jewelry News Asia magazine that Tahitian pearl production would reach a maximum of 7 to 8 tons in 5 to 6 years. By November 1999 production had reached 8.2 tons for 11 months, a 35 per cent increase compared to the 1998 annual export figures. Thanks to a booming world demand, the 1999 value of exports increased by 39 per cent over 1998, (excluding the month of December 1999). Any industry increasing its supply at a rate of more than 40 per cent a year is indeed fortunate not to see the world price decline!

Obviously, the Tahitian pearl industry would benefit from the adoption of the Australian quota system or a similar one, such as the former Dutch regulation system for oyster banks (Van Ginkel 1988). Nonetheless, there is no immediate danger of over-exploitation of the oyster resource. It is estimated that present production could increase by a factor of four because many lagoons are still under exploited. More than forty lagoons are suitable for pearl culture in French Polynesia. However, limitation of the growth of supply is still necessary to avoid a further decline in prices as well as anarchic commercial practices. A quota system will be difficult to enforce because pearl farming occurs on 43 islands scattered on the oceanic zone of French Polynesia, encompassing an area as large as Europe. As most pearling activity occurs underwater, monitoring is more difficult, even with the help of satellite technology. Grafting activity is also difficult to enforce as more and more local grafters are trained and become proficient in their trade. Moreover, the difficulty of monitoring hundreds of small-scale operations, many of them already operating without official licenses, far exceeds that encountered with just 16 licensed large operators in Australia.

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Black pearl industry continues to expand

The Micronesian US-affiliated Pacific Islands have a small but rapidly expanding pearl farming industry based in the Republic of the Marshall Islands (RMI) and the Federated States of Micronesia (FSM). While only three farms are currently operational all show sings of expansion and growth, indicating the enormous potential for pearl farming in the region.

At the forefront of expansion is Black Pearls of Micronesia Inc (BPOM) based in Majuro, RMI. Started by Hawaii Residents Neil Sims and Dale Sarver some years ago, BPOM had their first pearl harvest last year and have undergone rapid expansion in the last year. Included in this expansion are new farm site and hatchery in Majuro. BPOM is also looking for joint venture partners in an effort to step up their expansion efforts. Dale Sarver said in a recent press release, "As well as expanding BPOM's own 'nucleus' farm, we would like to involve local Marshallese partners in developing 'satellite' farms in the surrounding lagoons." Sarver added, "We have now reached the stage where we would like to begin this expansion." BPOM currently employs 19 full-time staff.

Also based in the RMI is the Robert Reimers Enterprises (RRE) Pearl Farm at Nam Lagoon on Arno Atoll. Started five years ago, RRE also had its first pearl harvest in 1998 and currently has about 11,000 shell under cultivation. Hampered in this expansion efforts by a chronic shortage of pearl oyster spat, RRE's CEO, Ramsey Reimers recently collaborated with the Center for tropical and Subtropical Aquaculture (CTSA) and the University of Hawaii (UH) Sea Grant extension service in a spat collection trial on Jaluit Atoll. Mr Reimers is also exploring the possibility of hatchery production of spat and expansion of the RRE pearl farm through joint venture partnerships.

About 1000 miles southwest of Majuro is the tiny atoll of Nukuoro in Pohnpei State, FSM, which is home to the third operation pearl farm in the US-affiliated Pacific Islands. Started in 1995 with significant technical assistance from the CTSA regional aquaculture extension agent, this community-owned and -operated farm had its first pearl harvest in 1999 and is currently the only operating farm that sustains itself on wild spat fall. The Nukuoro pearl farm, which is managed by CTSA Industry Advisory Council member Toshiyuki Rudolph, has 14,000 shell under cultivation. A grafting technician has been scheduled for early in the year 2000 to "seed" 11,000 of the farm's oyster stocks. The Nukuoro community was also the recent beneficiary of a CTSA/UH Sea Grant sponsored workshop on making jewellery out of pearl oyster shell, an important aspect of maximising pearl farm profits.

CTSA, in conjunction with the UH Sea Grant Extension service and the College of Micronesia

Land Grant program continues to support the expansion of the pearl industry in the U.S. Affiliated Pacific Islands. By learning from the successful farming in other Pacific Island nations such as French Polynesia and the Cook Islands, it is hoped that pearl framing will eventually contribute significantly – and sustainably – to the economies of these developing island nations.

Source: *CTSA Regional Notes*, 11 (1) Fall, 1999, p. 1.

Abrolhos black magic

The evolution of an aquaculture industry from which the mystery, romanticism and beauty of the pearl is born, is unfolding in the sheltered, clear waters off the Abrolhos. Abrolhos Pearls, owned by Alf and Don Woodckock and Murray Davidson, are pioneering the development of the unique black coloured pearl in Western Australia.

Alf Woodcock started his affinity with the sea as a cray fisherman spending over 40 years fishing off and living on the Islands.

Mr Woodcock and his partners laid the foundation for the black pearls in Western Australia, seven years ago when they took the first step to survey the Islands. "To see what shell was out there, to see whether it was worthwhile starting an industry".

"We searched the whole Island group for pearl shell, discovering five species, the one thought the most promising was the black," Mr Woodcock said. "We knew they were there from the early days when we were cray fishing, they were around the lagoon where we had our camp, but we never had the time or the finances or expertise to do anything about it."

Using divers and looking on the shallow reefs the search took about three years, in between doing other work. Mr Woodcock said there were many challenges in getting started. "We didn't know what we were doing in the early years".

They invited visitors from around the world who had experience with black pearls and have been adapting world technology for the Abrolhos environment. After experimenting with producing black pearl from black lipped oyster shell caught from the wild, the Abrolhos pearling venture realised that to be economically viable and to increase control of the pearl quality, the oyster shell stock needed to be hatchery produced.

When the juveniles reach the size of a pea they are taken off the ropes and placed in pockets in the panels. The panels are attached to longlines in the clear ocean waters at the pearl farm, located off Pelsaert Island.

Only an oyster species which occurs naturally in an area can be farmed in that area. The shells need cleaning every month, using a cleaning machine to remove the barnacles and sea-grass.

"One feature about the black pearl oyster is you get about five different colours of pearls – bronze, black, silver, pink, you can even get the white ones," Mr Woodcock said.

Every part of the oyster is usable with the meat being sold as an aphrodisiac to Asia, the shell polished and even scrap shell is used to add shine to paint and in cosmetics.

Although still very much in the development stage, Mr Woodcock said it was a very exciting project.

"We have been out there for a long time and haven't produced anything. It has taken a long time to get the formula right to grow the spats from the hatchery and then to get the right time of the year to seed them, to find the right size nuclei – the formula has been everything."

Abrolhos Pearls has had their first pearls crafted into earnings and a necklace by Verity Jewellers. These are the first black pearls to be produced in Western Australia. They have only matured for seven months and were from experimental shell caught from the wild.

Verity Jewellers' owner Glenn Lake said they were very excited about these first black pearls from the Abrolhos.

"If the colour of these pearls are any indication of what's to come then the local pearling industry shows a lot of promise.

Soon, Abrolhos Pearls, one of two pearls farms at the Islands, will take an exciting leap forward, preparing to seed their first crop of 25,000 black lipped hatchery produced pearls.

Source: *The West Australian*

Pearler pins hopes on black beauties

Black pearl production at Shark Bay could be worth AU$ 200 million a year within a decade, according to pearl farmer Peter Morgan.

He said divers had collected the key to the industry, the coloured shell, which provided the vital genetic broodstock for thousands to be bred at a Carnarvon hatchery and then seeded at Shark Bay.

Mr Morgan claimed the local black pearls were the first produced in Australia. He said the area was ready to go into commercial production.

He had investors with up to AU$ 10 million ready to put into a project but they were holding off because potential producers such as himself needed long-term tenure.

"At present we have a licence to operate for only a year", he said. "That is laughable for banks and other money suppliers. We want 21-year leases like the established pearling industry gets".

Mr Morgan has a 900 ha water area at Monkey Mia and is seeking 700 ha more. Another potential black pearl producer is operating off Dirk Hartog Island.

Mr Morgan said his family's research and AU$ 2 million investment over the past six years had proved that the black and full *albina* (white, pink and golden) pearl could be produced at Shark Bay. A local industry could provide jobs for up to 60 people at his family's farm alone.

He denied claims that the longlines of growing shells in the water interfered with seagrasses and marine life such as dolphins.

Shark Bay shire president Les Moss said the development of pearling and aquaculture was crucial to the region's economy, which depended mainly on fishing tourism. This was too fragile for the long-term interests of the area.

Fisheries Western Australia (WA) programme manager pearling and aquaculture Greg Paust said claims of a AU$ 200 million industry for WA were optimistic. World production was about that level but WA production of AU$ 15 million to $ 20 million was possible.

He said Fisheries WA was working towards long-term tenure such as the 21 years sought by Mr Morgan.

Source: *The West Australian*, 31 August 1999

Austasia Aquaculture status report: Australian pearl production

The overall value of *Pinctada maxima* production increased significantly to AU$ 229.4 million due to improved market prices. While more than 30 operations were farming pearl oysters the bulk of the Australian production comes from Western Australia, valued around AU$ 189 million. Production from the Northern Territory remained steady at AU$ 40 million and for Queensland pearl farming was thought to be slightly down, worth approximately AU$ 0.5 million.

For a number of years pearl oysters have been Australia's most valuable aquaculture sector, upheld by the "south-seas" pearl's reputation as the finest quality in the world. In the past, the market outlook was uncertain due to increased competition from several overseas countries, especially Indonesia, and prices were expected to fluctuate. However, prices remained high for quality product, resulting in Australian farmers concentrating on pearl quality as well as production numbers.

Further sector development has been restricted by an annual quota system designed to protect the low stocks of wild caught shell available for seeding. However the investigations into improved hatchery production has meant increased stocks on the farms. Innovations in longline and bottom culture methods and an expansion in the number of farms will also allow further production increases.

In Western Australia (WA) some pearls farmers were adding tourism to increase income flow in their business. In early 1998 a pearl farm was established adjacent to Croker Island (200 km NE of Darwin) following agreement between traditional Aboriginal owners and Japanese-Australian pearling company.

Whilst several other by-products are sold, including dried oyster meat (prices over AU$ 50/kg were reported) and shells for mother-of-pearl, the quantity or value of these are not known.

In most of these states, some experimentation is underway with a number of non-*P. maxima* pearl oysters, including the black lip (*P. margaritifera*), and the penguin (*Pteria penguin*) pearl oysters. Commercial harvest of pearls, shell and meat is expected to begin in 1998/99.

Prospects

The value of the *maxima* production is dictated by market prices, which can vary considerably. The use of hatchery-reared stock will continue to allow more stock on the farms for experimentation, and as these animals seem to suffer less from handling then their wild caught cousins, they are likely to result in improved retention rates and increased quality of product. This will allow Australian producers to compete effectively with overseas pearl producers.

Source: *Austasia Aquaculture*, Trade Directory 1999/2000

Weather the storm: pearls will survive

Sarah Quick

The worldwide value of loose pearl exports fell by five per cent in 1998, with Australia bearing the brunt of this decline, with a 47.4 per cent decrease in the value of its exports.

But the Asian economic crisis is not the only change to effect the world pearl market, with oyster mortality problems in Japan and the rise of the Chinese freshwater pearl also having a significant impact. Within this context, competition between industries has increased and new producers in Asia are emerging as the ones to watch.

According to the French Overseas Trade Centre, based on information supplied by the United Nations Statistics Office, the value of loose pearl exports fell to $ 375 million in 1998, down from $ 395 million in 1997 (all prices expressed in US$).

The value of Australian exports fell to 19.6 per cent of world exports in 1998, after peaking at 30.4 per cent in 1997. Australian exports were worth $ 73 million last year, down from $ 120.4 million in 1997.

Consequently, Tahiti has overtaken Australia in the value of exported loose cultured pearls, exporting loose pearls valued at US$ 104 million. Australia had held the title of number one exporter since 1994.

The change in the world pearl market in 1998 nearly dried up the consumer market for very expensive, top-of-the-range cultured pearls like those from Australia, according to Matin Coeroli, GIE Perles de Tahiti general manager.

Shanthi Wimalaratna, director of Universal Gems, adds the world market is not buoyant for finer pearls, unlike several years ago when the Asian markets were strong.

"Everybody is price conscious. They're looking at a certain price range, a more commercial type of goods. I think this will continue."

While loose pearls are a crucial aspect of the world pearl market, the trade in strands is also significant. Over recent years, pearl farmers have become increasingly involved in the production and retailing of pearls strands. The long-term impact on wholesalers and retailers of farmers being involved in retailing is unknown.

The question of whether or not this is a move linked to the current economic climate will only be answered when the pearl market returns to its pre-Asian crisis level.

The rarest pearl

The Australian pearling industry has gained greater international recognition over recent years, as illustrated by the rise and rise of the Australian South Sea Pearl.

Chryss Carr, South Sea Pearl Consortium manager, says desire for South Sea pearls has grown in all markets, and that unless there is an economic or "cataclysmic" environmental crisis, the market will continue to expand. "The amount of South Sea pearls is quite low, so demand is always bigger than supply. So when the Asian crisis impacted, the demand from the US grew. Prices have remained solid or stable for a long time, unlike the black pearls market."

Australia produces one per cent by volume and up to 25 per cent by value of the world pearl crop.

Rudi Zingg, Devino president, says that Australian production of South Sea pearls is set to increase

substantially, which he says is the biggest challenge the industry here faces.

One strength of the pearl industry is that it is controlled, to a degree, by the quality and quantity of material produced by the oysters, adds Carr. "If man had his way, [the oysters] would be pumping [pearls] out … but he hasn't and he can't sit and write a five year promotional strategy based on what you think you're exactly going to get.

The Japanese akoya market is testament to this fact, with both production and demand suffering recent blows. Japanese akoya production dropped from 16,500 kan in 1996 to 7000 kan in 1999 due to high oyster mortality rates, with production expected to reach between 10,000 to 15,000 kan by 2002, accordingly to *Jewellery News Asia.*

Mike Muller of Bolton Gems says he has experienced a significant and abrupt drop in demand for akoya pearls since June. They had traded very well up until last Christmas. While he cannot put his finger on the reason behind the downturn, he does not believe the fall will be permanent. "People will come back to akoya, they always have. It's a temporary thing."

While Japan has long been the leader in the pearl industry, Vietnamese akoyas, mainly in small sizes from two to six millimetres, have been produced from native akoya oysters found along the coast of Vietnam. Larger pearls are expected when larger oysters are available from the Pearl Vietnam hatchery. The development of akoya farming in Vietnam began in 1992. Production is expected to reach 1000 kilograms by 2001, to be marketed through Japan, according to Orient Pearl and Pearl Vietnam.

The Japanese industry is also looking more directly to China to overcome its mortality problems, with a new breed of akoyas being created by cross breeding Chinese and Japanese akoyas. According to the September issue of *Jewellery News Asia*, while this move is in its trial stages, it is expected the effect of the project will be known within two years.

The Chinese and Vietnamese akoya industries may over time become competitive with Japanese akoyas on quality, but have a distinct disadvantage in that Japan has simply been in the industry for far longer.

Freshwater future?

Another pearl variety to keep the established industry on its toes is the Chinese freshwater pearl. The freshwater pearl is currently the subject of a massive public relations effort by the Ikecho Pearl Company. Karen Linley, managing director, describes the market for these pearls as "galloping ahead in leaps and bounds."

These Chinese pearls come in a range of natural colours from dark purple, to orange and pure white. The shapes vary from round to egg shaped and baroque. "It's very price effective, it's about a third of the price and look what you get," says Linley. The freshwater pearls are being marketed on the basis that they are "99.9 per cent pure pearl," as opposed to other cultured pearls that contain a bead nucleus.

The *International Pearling Journal* has reported that it is estimated that 600 tonnes are being harvested annually. Of this, large pearls (over eight millimetres) in a variety of shapes account for approximately three per cent, while top quality rounds account for 0.015 per cent of total production. Even this low percentage should reap a significant supply, given the size of the overall harvest.

While Mike Muller says the Japanese akoya industry has to be a little concerned about the surge in popularity of the freshwater pearl, he has always believed that akoyas and freshwaters have had different markets. "People will come back to akoya, they always have. Just at this point, the curve back to akoya might just be a little bit longer in coming," he says.

Competition and variety

The Japanese pearling industry is not the only one facing competition, with farms in the Philippines, Indonesia and Myanmar already producing South Sea Pearls.

The Philippines is expected to produce over 200 kan of South Sea Pearls toward the end of this year and launched its largest and most technologically advanced farm in April. Shanthi Wimalaratna, director of Universal Gems, adds that farms in Myanmar are producing "very nice" South Seas, with better quality expected very soon. "Some of the finest golden South Sea Pearls come from there. [Myanmar] is in co-operation with Japan so the prices should be steady for South Sea pearls," he says.

Indonesian South Sea pearls are now being cultivated in sizes greater than 12 millimetres, with 16 millimetre pearls also possible. But nucleus retention rates are still significantly lower that those in Australia.

Jonathan Jacobson, director of JW Jacobson, says the growth of South Sea production in Asia will help meet the global demand for smaller sizes.

"The markets are expanding. The US market is untapped and world demand for South Seas in not being met. If people at all levels keeps prices realistic, basically there's opportunity for all suppliers," he says.

But Rudi Zingg says that as production of South Sea pearls increases, it is only natural that the price of these pearls will decrease. "As soon as Indonesia [produces] a better ratio of white pearls it will have a great impact on South Sea pearl prices in general. With the worldwide production increase, prices will have to come down to meet market consumption demands."

Tahitian pearls a bright light

The popularity of Tahitian pearls was reinforced by the result of the Third Robert Wan Tahiti Perles Auction held in Hong Kong in later September, where the collective reserve price for loose pearls and pearl necklaces increased by 47 per cent.

The average price per sold pearl was US$ 103, while the average price per momme was $ 169. Over 90,000 Tahiti cultured pearls, divided up into 242 lots, sold for $ 9.3 million.

While Shanthi Wimalaratna, from Universal Gems, admits the Asian pearl market has been suffering, he says that there has been a slight improvement, and pearls are increasing in popularity here in Australia. "People think things are depressed, but once you go to the [Tahitian] auctions you see a different story. The bidding is very strong…"

He adds that prices for the better material are higher, and only prices for low-end goods have fallen. He believes that black pearls are more popular at the moment than white pearls.

Martin Coeroli, Perles de Tahiti general manager, describes the market for Tahitian pearls as "excellent". He is expecting 1999 to be a record year for export in volume and value.

Already the French Polynesian government has reported that pearl exports rose by 13 per cent in the first seven months of 1999, compared with 1998 figures.

Coeroli says the recent Asian economic crisis had a strong impact on the Tahitian pearl market, causing strong pressure on prices in 1998 as Japan, Hong Kong and other Asian countries represent 80 per cent of the export market.

Guy Wan of Tahiti Perles says the US market has been the driving force recently, generating demand for Tahitian pearls, but he is expecting sustained growth in demand in Asia.

Despite these rosy assessments of the Tahitian pearl market, Salvador Assael, president of the Tahitian Pearl Association, and chair of Assael International Inc, has expressed his concern about the quality of Tahitian exports.

He has labelled the Tahitian pearl market disorganised and says regulations implemented by the French Polynesian government in January to control low quality exports have not worked as had been hoped.

Jonathan Jacobson adds that Tahitian pearls are becoming increasingly available at a wider range of outlets, reflecting their slightly fallen status.

A new kind of natural

Semi-baroque, baroque and circled pearls are increasing in popularity, as many people believe they look more "natural" than perfectly round pearls, and they are also more price competitive.

Melvin Placks identifies another future trend as the combination of pearls of different colours, such as black, gold and white, in necklaces. The invisible or floater necklaces that are currently popular and the accessibility of freshwater pearls may set young women on a path of lifelong pearl purchases.

Source: *Australian Jeweller*, November 1999, 33–41.

Powerful family pearling network: The central figure of a new distribution network has pearling in his veins

Kelly Chandler

The relationship between farmers and their pearls is metaphysical and all-encompassing, according to David Norman, whose impeccable pearling lineage makes him the perfect person to act as exclusive agent for some of Australia's oldest pearling family businesses.

"As a kid, you can catch pearl fever from exposure to them though your family business. It represents a marriage of nature and mankind – we have to put a lot of effort into nurturing the pearl, but nature does most of the work. It's one of the only commodities that is made by this fusion," Norman says.

Norman came to establish the Australian Pearl Centre (APC), which is over a year old, by a sort of fusion that works in parallel with his pearling past. Through family friend Nick Paspaley Jr, he established APC as the exclusive agent for Paspaley and also Norwest Pearls.

Norman's grandfather came to Australia in 1910 in search of natural pearls, and ended up marrying the daughter of a natural pearl dealer before establishing his own company and producing a son, Boris Norman. In turn, Boris formed a close friendship with Nick Paspaley Sr. He is also renowned in the industry for having purchased, in 1959, the first South Sea pearl crop ever to be harvested in Australia.

"My mission is to create a truly global distribution network from farmers to wholesalers." Says Boris' son David Norman of APC. "The main difference between us and our competitors is the connection we have with the farmers. We arguably have the largest selection of loose pearls and ready-made pairs and necklaces. We're supplying them direct from farm to market," says Norman.

"We're in a position to go into competition with wholesalers in Australia and sell directly to retailers. The domestic mission is to increase my customers (retailers') awareness of the product and familiarity with the range, which will hopefully be passed on to the public. Also, we have full range of stock that a lot of retailers haven't had access to before.

Adapted from: *Australian Jeweller*, November 1999

Pearls add luster to risky abalone venture

Abalone farming isn't the quickest way to make a buck. Although the rock-clinging mollusk is in short supply and its meat fetches US$ 60 or more per pound, the seaweed-munching mollusks grow at a snail's pace. It takes at least three years of care and feeding to grow a modest 3-incher in captivity. To fetch a greater return, US Abalone of Santa Cruz County, also known as US Abs, is muscling into a new market with its abalone pearls.

The Davenport aquaculture company, which grows abalone in beachside tanks, has just printed a catalogue for its cultured abalone pearls fashioned by Carmel's Crossroads Jewellers and plans to sell them from its Web Site (www.usabalone.com).

Pearls produced by abalone are not the traditional spherical variety produced by oysters. Unlike the docile bivalve, abalone have a powerful foot that is adept at kicking out foreign objects. That would ordinarily make it hard to culture abalone pearls. However, US Abs says it has a proprietary way to permanently attach an inserted bead to the inside of the abalone's shell. The bead is then covered with layers of lustrous nacre. After 12 to 18 months, the critter can be harvested both for meat and a "blister" or half-dome "mabe" pearl, which might sell for US$ 200 or 300.

"We could make a living doing meat, but pearls make us interesting to Wall Street, "said US Abalone CEO James Webb, who has started talking to investment bankers about a possible IPO.

Abalone traditionally has been a pricey item on the menu, with restaurants charging US$ 40 to 80 for a single entrée. Webb said it is popular from sushi bars in Japan to San Francisco restaurants. Three-inch abalone that sell for US$ 4 or 5 each yield only about an ounce of meat, and the texture and mild flavor are similar to the much cheaper scallop or calamari steak.

Source: *San Francisco Chronicle*, 17 November 1999

Tahitian pearls constitute 28.8% of world market

Tahiti cultured pearls that grow inside the black-lipped oyster *Pinctada margaritifera*, represent 28.8% of the high stakes game of world pearl production in 1999, up from 14% in 1994, according to pearl authority Andy Müller of Golay Buchel in Japan. The leader is still the South Sea cultured pearl, produced primarily in Australia, Indonesia and the Philippines from *Pinctada maxima*, a white-lipped mollusc. Their production increased from 19.9% in 1994 to 44.4% in 1999. The akoya cultured pearl, produced from *Pinctada fucata martensii*, in Japan and China, has dropped from a N° 1 ranking in 1994 with 66.1% of world pearl production, to N° 3 in 1999 with 26.8% of production (*Professional Jeweler*, September 1999).

Cultured pearls retail growth was up 6% in 1998 according to a survey by Jewelers of America. That compares with the JA's other retail growth findings: 18% in platinum jewellery; 10% in diamond jewellery; 9.3% in sterling silver jewellery; 5.2% in watches; and 3.8% in karat gold sales. The JA survey also found that cultured pearls accounted for 1.9% of revenue from different retail items, compared with 42% for diamonds (loose and jewellery); 13% for karat gold jewellery; 9.4% for repairs; 9.2% for coloured stone jewellery; 5.9% for watches; 5.6% for other sales; 4.9% for other jewellery; 3.4% for silver, tabletops, gifts; 2.2% for estate jewellery; 2% for fashion jewellery; and 0.5% for appraisals. (*GemKey Magazine*, November–December 1999)

Pearl colour was again the big news at the June JCK International Jewelry Show in Las Vegas. Grey, golden and pistachio South Seas, Tahiti and very fine freshwater varieties were the high-end favourites. Pinks and peaches abounded as well. Pearls were increasingly mixed with gold and platinum chains. (*JCK Magazine*, August 1999).

Black cultured pearls from Baja California, Mexico

At last month's Tucson shows, Lab Notes contributing editor Karin Hurwit saw beautiful black cultured pearls that were harvested from Baja California in 1999. According to ITESM (the Monterrey Institute of Technology and Higher Education, in Mexico) these represent an unprecedented success in culturing pearls in the rainbow-lipped pearl oyster, *Pteria sterna*, native to the Gulf of California. The Gemological Institute of America (GIA) Gem Trade Laboratory subsequently had the opportunity to examine a few smaller pearls.

The off-round pearls ranged from approximately 7 mm to 9 mm in diameter. Their body colour mimicked the characteristic colours of the host oyster, primarily light and dark greys and browns, as well as blacks. In addition, some of the samples displayed strong purplish pink overtones, with green in some areas. The fine suture lines in the nacre, which cause the optical effects such as orient and overtone in pearls, were tightly spaced and very prominent in texture. All the cultured pearls showed a metallic luster.

X-radiography revealed the round bead nuclei used in the culturing process. The samples fluoresced a distinctive red to long-wave UV, with some variation in intensity. This fluorescence serves as an identifying characteristic of pearls from Baja California. (See Gem Trade Lab Notes in Spring 1991, p. 42, and Summer 1992, p. 126, for more background information).

Source: *Gems & Gemology*.
To learn more about *Gems & Gemology* or to subscribe contact the Subscriptions Manager, Debbie Ortiz (dortiz@gia.edu) or visit G&G online at http:// www.gia.edu/gandg/

Nucleation of Chinese freshwater cultured pearls

A joint study by GIA Gem Trade Laboratory's Tom Moses and American Gem Trade Association (AGTA) Gemological Testing Center's Ken Scarratt has concluded that the vast majority of Chinese freshwater cultured (CFC) pearls in the market today are indeed mantle-tissue nucleated. The study, which involved the X-radiography of more than 41,000 CFC pearls from dozens of different farms, was conducted in response to recent claims that most of the large (10+ mm) round CFC pearls

that have recently entered the marketplace contain mantle-tissue-nucleated CFC pearls that were polished into round nuclei.

These results confirm the experience of these two researchers since they began their studies of Chinese freshwater cultured pearls in the early 1980s. Very few of the hundreds of thousands of CFC pearls they have examined showed any evidence of bead nucleation. Given the distinctive nature of the growth structures in mantle-tissue-nucleated CFC pearls, Moses and Scarratt believe that any commercial production of CFC pearl-nucleated cultured pearls would be readily identifiable by X-radiography.

Detailed results of this study will be published in an upcoming issue of GIA's quarterly professional journal, *Gems & Gemology*.

Sharing pearls of wisdom

Tevita Taumaipeau feels at home pampering oysters on Orpheus Island. The clear dry weather reminds him of Savusavu, on the Fijian island of Vanua Levu, where he works as a senior fisheries assistant at a fledgling black cultured pearl farm.

He has spent the past three weeks at the James Cook University (JCU) research station on Orpheus Island, east of Ingham, learning how to maximise production of oysters that produce the valuable pearls. The Fijian government has set up a model farm with 10,000 hand-picked blacklip oysters, inspired by the success of the black pearl industry in French Polynesia.

Tahitian black pearls sell for up to US$ 10,000 each, and earned French Polynesia US$ 150 million last year. The French Polynesian industry, developed during the past twenty years, has exploited the prolific blacklip oyster (*Pinctada margaritifera*), found widely through the Pacific, including the North Queensland coast.

Left alone, blacklip oysters rarely produce pearls – one in 15,000 manage it, according to Perles de Tahiti, which promotes Tahitian black pearls worldwide.

French Polynesia's central Pacific neighbour, Cook Islands, joined the industry in 1995, initially with technical help from the United States and later Australia, through JCU. Black pearls have since grown to become a major export, worth US$ 6 million a year.

Now four other island nations, Fiji, Kiribati, Marshall Islands and Solomon Islands, want to make the pearl-loving world their oyster.

Mr Taumaipeau and a colleague from the University of the South Pacific in Suva, are among eight Pacific Islanders enrolled in a five-week training course at Orpheus Island.

The others are from Kiribati, Cook Islands and Solomon Islands. They are helping with day-to-day operations at JCU's oyster hatchery and nursery, and, in the process, learning and sharing some new husbandry techniques.

The course is being sponsored by the Australian Centre for International Agriculture Research (ACIAR), an Australian government authority operating within the Ministry of Foreign Affairs and Trade. The black pearl programme is one of 19 current fisheries project in Southeast Asia and the Pacific supported by the Centre, which was set up in 1982 to promote research and improve sustainable agricultural production in developing countries.

The government set aside AU$ 43.2 million for ACIAR in the 1999–2000 budget — $ 33.5 million for research, development and training and $ 9.7 million for international agricultural research centres. The organisation has spent $ 1.3 million on the pearl oyster project since 1993.

It commissioned JCU scientists to devise and coordinate the project on the strength of their work during the 1980s on developing culture methods in giant clams for the Cook Islands, Solomon Islands, Fiji, Tonga, Tuvalu and Kiribati.

JCU's brief with the blacklip oysters was to develop and refine hatchery techniques and to develop and refine nursery and juvenile culture methods suitable for use in Pacific atolls and open reef systems.

Dr Southgate said that in effect this meant devising ways of maximising production of top-quality pearl oysters, using simple, low-technology procedures.

He and his team have set up a prototype hatchery and nursery at Orpheus Island, where the visiting fisheries officers have been working for the past three weeks.

"We deliberately have not run the course in laboratories on campus; we are running under similar conditions to their's at home," he said.

Dr Southgate said each country represented at the workshop had reached a different stage of development. Fiji and Solomon Islands relied on blacklip youngsters, found in the wild. Kiribati was spawning and breeding oysters from broodstock in line with the JCU programme at Orpheus Island and Cook Islands use both methods.

The Kiribati team, which includes JCU masters student Jamie Whitford, had achieved great success in spawning blacklip larvae, with a record 2.3 million in a single batch earlier this year. But a voracious gastropod has subsequently eaten large numbers of the small shelled creatures on their submerged nursery tracks. One of the Kiribati visitors, Beero Tioti, is studying the biology of the gastropod as a masters project at JCU, in an attempt to learn whether they are attracted by algae on the racks or to the young oyster shells, and so reduce the mortality they cause. The Kiribati team aims to seed 5000 to 8000 nursery bred oysters by June next year.

Solomon Islands fisheries officer Cletus Oengpepa is planning an experiment comparing the growth of "spats" collected from the sea with hatchery oysters. Mr Oengpepa, assistant manager of the Solomon Islands project, said his government has banned export of blacklip shells 10 years ago, after a dramatic decline in numbers. Spawning the oysters offered a way of replenishing stocks as well as the possibility of a new export industry. He said he enjoyed the informal exchange of ideas between visiting officers.

Cook Islands hatchery manager Mataora Marsters is studying husbandry techniques to try to improve the settlement and growth of spawned juvenile oysters. Professor John Lucas of the JCU School of Marine Biology and Aquaculture and staff from the Department of Primary Industries (DPI) in Townsville have been involved in a separate project to improve the quality of Cook Islands cultured pearls. Mr Marsters said interaction with JCU researchers has been invaluable. "We are here to gain more experience," he said.

Mr Taumaipeau agreed. He has had the chance to share his experience from 20 years as a fisheries officer in Fiji. He said Fiji's fish stocks were under pressure and blacklip oysters offered hope for new export industry. At present, chilled and frozen tuna exports are worth AU$ 100 million a year. He had helped to seed some of 10,000 "wild" oysters that would produce pearls in about 18 months' time. Mr Taumaipeau said he was enjoying life on Orpheus Island. "It is much like home," he said.

Adapted from: *Townsville Bulletin*, 23 October 1999

The coconut pearl

Editor's note: We include this excerpt, provided by a friend, so that those of you there still engaged in this roaring debate can at last settle your bets.

It was really an exciting morning when Kilkenny, who was always making friends on shore, placed in my hand a large pearl and said, "It's a coconut pearl, Doctor. It comes from inside a coconut." I had never even heard of such a thing until a few days before, when Captain Diedrich, with whom Daan and I had been lunching on his little K.P.M. steamer, had spoken of them. Now I could scarcely believe my eyes.

Kilkenny's friend, Mr Wong, who was one of the principal coconut buyers of Celebes, called later and told me that in fifteen years he had been able to get only four or five pearls like the one he gave Kilkenny, although all the growers from whom he bought his dried coconut meat, the "copra" of commerce, knew that he would pay a good price for them.

The pearl turned out to be of extraordinary interest. My friend O.F. Cook dug up an article about it that had been buried in the literature – mention of its existence not seeming to have gotten into the books on the coconut – and this substantiated the accounts of its rarity. I abstracted from this story of Dr Hunger and his hunt for the coco pearl the fact that it is a growth in the interior of the coconut, apparently induced by an abnormality of the nut itself, whereby no hole or pore in the shells is formed; usually there are three of these pores, although only one is open. There being no hole, the embryo inside of the nut cannot push its leaves out into the sunlight, a diseased condition results, and sometimes a pearl is produced. It is composed of carbonate of calcium, like the pearl of the oyster. The abnormal nuts occur very rarely, so rarely in fact that poreless coconuts bring high prices in the

Orient and are found only in the collections of the wealthy Radjas and merchants. Indeed, it is said that formerly all "blind" or poreless coconuts belonged to the Radja and were not the property of those who found them. The coco pearls are even greater curiosities. Their beauty alone entitles them to the high place they hold as jewels.

When we discovered how rare it was, we locked it up, and now we bring it out only for exhibition on state occasions. The last ones being when an armed policeman guarded it, at the "Tropical Ramble" held by Mongomerys as a benefit, and again at a show at the Four Arts Exhibition in Palm Beach.

Source: Garden Islands of the Great East: Collecting Seeds from the Philippines and Netherlands India in the Junk "*Cheng Ho*", David Fairchild, 1943. New York: Charles Scribner's sons. 239 p.

ABSTRACTS, REVIEWS AND CURRENT CONTENTS

Kunz and Stevenson, 1908, and Streeter, 1886: A topical review of two classics, with hints on how to find them

Beatrice L. Burch
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Kunz, G.F. and C.H. Stevenson. 1993. The Book of the Pearl: the History, Art, Science and Industry of the Queen of Gems. 548 pages, 183 illustrations, unabridged edition. New York: Dover Publication. First published in 1908 by New York: Century Co.

Over the 548 pages, this impressive unabridged book extends an enormous amount of intriguing information in a most readable way to a general audience, as well as to the pearling world of 2000. Illustrations are in black and white in this publication rather than in the original colours, and there is some rearrangement acknowledged by Dover Publications for ease in presenting this edition. A massive bibliography includes 496 cited references, some similar to those of Streeter in 1886 who was also included. Many more are from the remarkable reference library of Kunz. Because this book contains nearly twice the amount of text than the 1886 book by Streeter, Kunz and Stevenson could expand on both later and earlier references. Kunz is a gemologist, and Stevenson is an USA government fishery expert. Increased pearl fishery information in a time of tremendous activity is included, especially in Ceylon of the 1890s as well as references in the early 1990s.

Well-organised chapters cover ancient literature and early history to medieval and then modern history, biology and the structure and formation of pearls. In addition, sources of fine and poor quality pearls, mother-of-pearls from Asia, East Africa, Europe, and the Pacific Islands are presented neatly and enjoyably. Other chapters include pearls from the Americas, pearl culture, mystical properties, treatment and care of pearls, pearls as ornaments, decoration, famous pearls, freshwater and marine pearls, and aboriginal use of pearls. All chapters are illustrated. The foreword includes the names of numerous collaborators and the sources of assistance, which generously facilitated the work by these authors. Dover Publications, Inc. republished this fine book from the original first published in 1908 by Century Co., New York.

Streeter, E. 1886. Pearls and Pearling Life. George Bell and Sons (Eds). York Street, Covent Garden, London. 329 p., 11 fig., 1 map of pearling regions.

Streeter, a British jeweller during the late 1870s and early 1880s, financed a successful pearl and pearling fleet from a mother ship, a 112-ton brigantine. This was purchased, equipped and directed by dedicated Captain E.C. Chippindall, RN and capable shipping agent, Mr T.H. Haynes. The vessel worked throughout the Pacific Ocean, from northwest Australia to Ceylon, and through the Torres Straits and the 150

islands of the Soo Loo (Sulu) Archipelago off the Philippines. This involved differing political Pacific Ocean areas and thousands of local peoples, government inspectors, permits and permit restrictions with "tips" up and down the system.

The mother ship, the *Sree-Pas-Sair*, also carried the, then modern, deeper water diving dress for the first time in those waters of the pearling fleets. Matter-of-factly, the chapters recount ship activities that included local divers, thousands of local lowest caste pearl sorters of many races and customs and who were frequently in miserable conditions. One trip alone in 1883 in Torres Straits sent 621 tons of pearl shell and a few magnificent to low-quality pearls to Great Britain. It involved 1500 men, and 53 licenses had to be negotiated with different local governments. Through it all, Captain and ship agent dealt capably with government officials while monitoring and improving the health and well-being of the crew and workers through hurricanes, Malay pirates and shark attacks in numerous island groups.

Other chapters include a review of pearls from ancient times through 1885, in Persia, China, Europe and America with both marine and freshwater pearl-bearing molluscs.

The condition of this book at the Bernice P. Bishop Museum of Natural and Cultural History was so poor, (crumbly paper tearing when I opened the fragile book) that I was dismayed and decided to ask the librarians if they knew of an antique book conservation centre. Librarians BJ Short and Chief Librarian Dwayne Wenzel suggested the superb Etherington Conservation Centre. Happily my husband and I furnished funds to obtain magnificent copies for the library and for us. The yearlong wait was well worthwhile. Collectors interested in using antique fragile books on pearls or on any subject have a wonderful resource available in the Etherington Conservation Center. First at Brown Summit, North Carolina and now in expanded facilities at neighbouring Greensboro, North Carolina at 7609 Business Park Drive, Greensboro, North Carolina 27409, USA. Phone is free at +1877 3971917 for the USA or regular phone and fax are at +1 3336 665 1317, e-mail: ecc@icibinding.com.

The superb replication of E.W. Streeter, 1886, "Pearls and Pearling Life" from the fragile paper volume is outstanding. Now this beautiful replica is available for this generation of pearl lovers with its information on the pearling world of 120–160 years ago with illustrations in black and white and in colour.

Abstracts

Status of commercial mussel shell industry

Don Hubbs
Tennessee Wildlife Resources Agency, P.O. Box 70, Camden, TN 38320. e-mail: TNMussels@aol.com, phone: +1 901 584 8548

The Tennessee Wildlife Resources Agency (TWRA) proposed changes to its commercial mussel regulation this April (1999). After three hours of presentations from the Agency staff and comment from the public, the Wildlife Resources Commission was divided in supporting the proposed changes. Some members sided with the commercial shell industry which had support from the local Tennessee State Representative. Other members of the Commission were more conservation minded and backed the Agency's proposal. Most controversy centered on the proposed expansion on mussel sanctuaries to protect endangered mussel species. The shell industry also opposed increasing the size limit on washboards to four inches.

In the end a compromised proposal was passed that increased the size on washboard mussels 1/16" per year for four years to reach a four-inch size limit in March 2003. The only mussel sanctuary expansion approved by the Commission was the inclusion of the lower 100 miles of the Duck River. Recent surveys on the Duck River have revealed approximately 45 species remain.

The shell market has remained weak this summer. Tennessee has sold less than 200 harvester licenses this year. Ebony shells (*Fusconaia ebena*) continue to dominate the harvest. Prices ranged from US$ 0.20/lb for 2 3/8" to $ 0.85/lb for 2 2/4" and larger. Most shell buyers did not offer a price for low quality washboards unless they were 5" shells which brought $ 5.50/lb live, $ 8.50/lb open.

Given the low number of harvesters and shell prices, the annual harvest tonnage should be around 600 tons again this year. Shell industry sources do not expect the market to significantly improve in the fore-

seeable future. There is some increased interest from shell buyers from China, but it is for the low-priced ebony shells. All of this decreased harvest pressure is paying off for the beleaguered mussel populations. Our survey data has documented increases in the percentage of legal sized mussels, which now range from 15% to 40%. In the past (1992–96), the percentage of legal sized mussels ranged from 2% to 15%. Diehard shell harvesters have also noticed this increase and are requesting TWRA implement a quota system to regulate the number of shellers. This would be beneficial to both the long term survival of the resource and the fishermen. This system is opposed by the industry because "it would limit their ability to produce containers of shell in a timely manner."

Distribution, recruitment and growth of the black-lip pearl oyster, *Pinctada margaritifera*, in Kane'ohe Bay, O'ahu, Hawai'i [1]

S. Ku'ulei Rodgers[2], Neil Sims[3], Dale J. Sarver[3] & Evelyn F. Cox[2]

1. Research was funded by an internship to S.K.R. from the State of Hawai'i Department of Land and Natural Resources and the Sea Grant Program at the University of Hawai'i.
2. Hawai'i Institute of Marine Biology. P.O. Box 1346, Coconut Island, Kane'ohe, Hawai'i 96744.
3. Black Pearls. Inc., P.O. Box 525, Holualoa, Hawai'i 96725.

Stock of Hawaiian black-lip pearl oyster, *Pinctada margaritifera* (Linnaeus, 1758), appear to have been depleted by overfishing and environmental degradation. Permanent survey transect sites were set up in Kane'ohe Bay in 1989 to monitor changes in the status of stock. Only 17 pearl oysters were found in 1989. Transects were resurveyed in 1997, and 22 pearl oysters were counted. Most were found on the slopes of patch reefs around the Sampan Channel in 2–6 m depth. Recruitment is low. Standing stock estimated from observed densities on transects in 1997 and the extent of available habitat is about 950 individuals. The size distribution of pearl oysters on transects indicates that they are fished, despite legal protection. Growth of *Pinctada margaritifera* in Kane'ohe Bay is comparable with that in other locations. The prospects for commercial culture of black pearls in Kane'ohe Bay are limited by environmental constraints and the heavy recreational use of the bay.

Source: *Pacific Science* (2000), 54(1): 31–38

PEOPLE, PRODUCTS AND PROCESSES

New product for treatment of boring sponges

A common problem in many regions is the infection of shells by boring sponges. These red sponges, generally identified as *Cliona* spp. or *Piona* spp., bore through the shell, eventually resulting in mortality and pearl loss.

PearlSafe is a newly developed product to treat these infections, so the shells survive until pearl harvest and are available for re-seeding. Developed by Wattyl Australia, in collaboration with Australian universities and pearling companies, the product has been used successfully to stop sponge infections in the Australian *Pinctata maxima* industry.

For treatment, the shells are cleaned and allowed to air dry for approximately 15 minutes. The lower half of each shell, where the sponges typically bore, is then dipped into the PearlSafe coating. The coating is given 15 to 30 minutes to dry, and the shells re-immersed. Experience in the Australian pearling industry shows that the infection stops in 90 per cent of shells after the first treatment.

PearlSafe is manufactured by Wattyl Australia Pty Limited. For further information contact Dr. Stephen Hodson, at P.O. Box 679, Launceston, Tasmania, Australia 7250 (or by Fax on +61-3-6331-4280; e-mail: stevehodson@ozemail.com.au).

POIB's Pacific Pearl Seeding Technician Registry

Personal information:

Name: . . . . . .
Mailing address: . . . . . (No. & Street)
. . . . . (Town or City)
. . . . . (Zip code) (Country)

Phone: Country Code first (. . . . . .) . . . . . .
Fax: Country Code first (. . . . . .) . . . . . .
E-mail: . . . . . .

Alternative contacts :

Phone: Country Code first (. . . . . .) . . . . . .
Fax: Country Code first (. . . . . .) . . . . . .
E-mail: . . . . . .

Past seeding experience:

Species	Country/Region	No. years
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. . . . .	. . . . .	. . . . .
. . . . .	. . . . .	. . . . .

References:

Name	Company	Contact (Phone, Fax, E-mail)
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. . . . .	. . . . .	. . . . .
. . . . .	. . . . .	. . . . .

Authorisation

I hereby request that my name, contact information and other professional details shown above be placed on **POIB's Pacific Pearl Seeding Technician Registry**. I understand that this information will be provided to people who represent themselves as bona fide pearl farmers, for the purposes of increasing my professional contacts. I do not hold SPC or BPI, or any of their employees liable for any misuse or abuse of this information.

Signed: . . . . . Date: . . . . . .

Send the form back to:

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This registry is designed to facilitate links between newly developing farms and seeding technicians. This basic information will be provided to bona fide Pacific pearl farmers who request it. It is then up to the individuals to pursue the matter further. Copies of this registry will be held both by the Editor of this bulletin in Hawaii and by the SPC Fisheries Information Section in New Caledonia. Please fill this out yourself, if you are a seeding technician, or pass it along to someone who is, and send it back to one of the addresses indicated on the form. Thank you.