OASIS OR MIRAGE: THE FARMING OF BLACK PEARL IN THE NORTHERN COOK ISLANDS

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By the late twentieth century, small island states in the Pacific faced severe problems resulting from the ways in which they had become integrated into the world capitalist economy since the early nineteenth century. Generic environmental, economic, and social problems follow from dependence on the production of a relatively small number of crops for sale in the world economy, out-migration and remittances, and foreign aid. Most states have sought to reduce their dependence and to move toward greater degrees of economic self-sufficiency. In the case of atolls, opportunities for development are typically regarded as minimal because of fragile ecosystems and a shortage of land, fresh water, and local energy. Black-pearl farming is an environmentally sustainable activity that has led to higher incomes and repopulation in the Northern Cook Islands. While it is not the solution for all atolls, its success warrants careful examination.

The Pacific Development Dilemma

In the late twentieth century, small island states in the Pacific came to face a series of problems that stem, in large part, from the ways in which they have become integrated into the world capitalist economy since the early nineteenth century (Howard et al. 1983). They now face a variety of generic environmental, economic, and social problems (Connell 1991), which follow from having concentrated on the production of a small number of crops for sale in the world economy.

Improved public health has resulted in improved survival rates, longer life spans, and growing population pressure (South Pacific Commission 1998: 6–15). The increasing populations put pressure on resources, which are

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exploited more intensively to support them (ibid.:30–31). The intensification of land use in turn leads to resource depletion, environmental degradation, and declining production potential (ibid.:32–33). The clearing of forest in watersheds and the widespread use of herbicides in plantation agriculture produce a variety of effects including silting, flooding, depletion of marine stocks, and reduction of biodiversity.

Overproduction of commodities for which there is declining or unstable demand leads to falling commodity prices, which leads in turn to declining profitability, farmer discouragement, and falling per capita agricultural production levels as farmers and farm families move to urban areas in search of higher incomes (South Pacific Commission 1998:34–35). In some cases it also leads to circular migration between homes and other places in which employment is available (ibid.:26–27). In other cases it results in the permanent or semipermanent loss of parts of the able-bodied population through internal and international migration (ibid.:36–37). The resulting age-selective depopulation of remote or rural areas often leads to a "social malaise," which results in turn in further rural depopulation.

Increasing urban population densities that follow rural-urban migration mean that governments are faced increasingly with escalating costs to provide urban infrastructure for rapidly growing urban populations that are making a relatively minor contribution to production and to the national economy (ibid.:34–35).

The Growth of Dependence

In an attempt to provide for the needs of growing populations with steadily increasing material aspirations, small Pacific states have tended to adopt policy mixes that have resulted over time in growing dependency on metropolitan states with which their economies have become increasingly integrated. This policy mix has resulted in varying, but generally increasing, degrees of dependence on metropolitan labor markets for access to wage economies; emigrant populations for remittances in cash and kind; metropolitan states for aid of various types, technologies, manufactured goods, food and beverages, and fuel; and international business for air and sea transportation and telecommunications links (Hughes 1998).

In the Pacific microstates these mixes have produced what have been characterized, by Bertram and Watters (1985), as MIRAB economies, which depend almost solely on migration, remittances, aid, and the growth of bureaucracy (Poirine 1998; Bertram 1999). While the relative importance of each of these elements and the mix varies from state to state, all face most of the problems to varying degrees. Of all of the Pacific islands that have be-

come enmeshed in this sequence, the worst hit have been the atolls, which start from smaller, more fragile resource bases and more easily destabilized ecosystems.

The Search for a Panacea

These problems are well understood throughout the Pacific. Most governments have, albeit for different reasons, sought to reduce their dependence and to move toward greater degrees of economic self-sufficiency. Even larger states, such as Fiji, with large, well-established, and profitable agricultural bases are having to rethink their strategies as longstanding preferential trading relationships are threatened by the increasing push to trade liberalization by the World Trade Organization and Asia-Pacific Economic Cooperation (APEC) (Grynberg 1993).

Many states have tried to reduce dependence by diversifying their economic bases, opting for some combination of import substitution activity and the development of niche activities such as the production of a small range of export crops for specific markets (Tongan squash, Samoan taro, Vanuatuan kava [Seneviratne 1997], new nut crops in western Melanesia [*Islands Business* 1998]), and, more recently, ecotourism (Fiji and Cook Islands), assembly work (Yazaki in Samoa), garment manufacturing (Fiji), resale of excess telecommunication capacity (Tuvalu), training of seamen for multinational shipping companies (Kiribati, Solomons), sales of stamps (Tuvalu, Tonga, and the Cook Islands) and passports (Tonga, Nauru), and provision of offshore banking and financial services (Cook Islands, Vanuatu, and Samoa).

The temporary gains from adopting such specific, niche-oriented strategies may be offset by longer-term risks. These countries become vulnerable because the conditions that produce "winners" are constantly changing. Thus, as modern aircraft are able to fly greater distances nonstop, last year's tourist destinations become this year's overflown outposts (American Samoa). Most recently the Asian "meltdown" has served as a reminder to states that became increasingly dependent on Asian capital and tourism that even large and apparently robust economies can contract suddenly and dramatically (*Islands Business,* July 1998, 9).

This is also true in primary production and other areas. This year's wonder crop in the Pacific has so often proven to be next year's catastrophe. Witness Samoa's economic decline since the taro blight struck what had become its largest export crop. As patron states take exception to the provision of tax avoidance schemes by recipients of their aid, they are likely to retaliate by penalizing either the states themselves or the companies that take advantage

of their services. The sale of national passports to nonnationals by Samoa, Kiribati, and Nauru has led to threats by larger states to withdraw recognition of their passports (*Islands Business,* July 1998, 17).

Furthermore, even if small states were able to discover and implement strategies that produced significant short-term advantages, it is likely that corporate interests in larger states would either acquire or copy highly profitable activities. Vanuatu and Tonga, for example, increased commercial production of kava to supply the North American health pharmaceutical market.[1] It now appears that with market demand established and profits beginning to flow into Vanuatu and Tonga, American interests are using biotechnology to produce pharmacologically superior strains of the plant, which will be grown on a large scale in plantations on former sugar lands in Hawai'i to take advantage of economies of scale and relative closeness to markets.

Furthermore, if small states engage in activities that are seen to threaten the interests of dominant states or aid donors, they are likely to find themselves under pressure to reformulate or relinquish these schemes so that they comply with dominant states' interests or risk losing access to aid. Those states in which trust companies were providing corporations domiciled in aid donors' countries with means of reducing or avoiding tax found themselves under various forms of pressure to regulate businesses. Thus microstates find it increasingly difficult to find means of reducing dependency.

Finally, the Port Vila Declaration has placed increasing pressure on these states by enacting a requirement that governments support activities that are sustainable (South Pacific Commission 1994), which places increasing pressure on the range of available alternatives.

Faced with these problems, a general shortage of high-valued mineral resources,[2] a declining demand for unskilled and semiskilled labor in metropolitan economies, and evidence of declining interest in the Pacific by traditional aid donors and second- and third-generation overseas-born children, Pacific Islands governments are having to look for new forms of productive activity that address various environmental, economic, and social issues.

The environmental issues, set out in the Port Vila Declaration on Population and Sustainable Development in 1993, are arguably the most important, since they constitute the basic parameters of all activity on small and relatively fragile ecosystems (South Pacific Commission 1994:43–53). The environmental imperatives call for activities that use indigenous resources where possible, do not require large imported energy inputs, can be managed on a sustainable basis, do not threaten biodiversity, and reduce pressures on currently heavily exploited land and marine environments that are generating environmental and resource degradation. The commodity and associated production regime must be able to withstand natural disasters such as

cyclones and tsunamis that periodically devastate plantations and disrupt production in the tropics.

The economic imperatives call for activities that produce nonperishable commodities that are not currently oversupplied in world markets; employ relatively inexpensive, low to intermediate technologies; produce higher returns on labor investment than existing ones; generate both direct and indirect employment in the activity itself and in downstream industries that add value to the basic product; reduce dependence on foreign aid and borrowings, which are increasingly difficult to obtain and repay and which result in the capture and repatriation of profits to the owners of foreign capital; and, finally, that do not depend heavily on bulk transport services that are provided by, and can be withdrawn by, international providers without consideration of the consequences.

The social imperatives are crucial because, unless social objectives are met, the nations will be destabilized and all forms of action will be futile. Among these imperatives are the requirement that activities will produce higher and equitable income distribution without dramatic and disjunctive social and economic transformation; the repopulation of rural areas and a reduction of pressure on overloaded urban physical infrastructure and social services; the restoration of rural social infrastructures; the prospect of relatively inexpensive entry into and widespread participation within the activity and maintenance of local ownership; and control of the industry and profits therefrom.

For many Pacific states an activity that addresses these concerns remains illusive. For atolls, with limited physical resources, relatively fragile ecosystems, and little prospect of supporting much more than traditional mixed subsistence with some cash cropping, the search has seemed even more futile until recently. There is, however, a commodity that seems to meet many of the criteria set out above and to offer an alternative, more prosperous future for a small number of Pacific states and, paradoxically, the poorest of all of those states. It is the farming of the black-lipped oyster *(Pinctada margaritifera)* for the production of cultured "black" pearls.

Pinctada margaritifera: The Next Wonder Crop?

The oyster, *Pinctada margaritifera,* occurs naturally in tropical waters in many areas from the Gulf of California to the eastern Mediterranean Sea, but it "reaches its greatest abundance in the atoll lagoons of Eastern Polynesia" (Sims and Gervis 1992:5). The oyster has always had a significant place in the culture and economy of eastern Polynesia. Naturally occurring black pearls were said to be the tears of a goddess. They were occasionally used as

ornaments, and Queen Pomare of Tahiti is said to have played marbles with them. The meat of the oyster has been a source of food and protein that is both relatively plentiful and largely immune to storms, droughts, and other climatic exigencies. Natural whole pearls and half pearls have always been found in oysters harvested for meat *(korori parau).* The oyster shell has been used in the production of items of material culture and has, more recently, been harvested and sold as a cash crop for the manufacture of buttons and jewelry.

The farming of the oyster for black-pearl production has a short history.[3] The industry was established in French Polynesia in the mid-1960s using a process developed by Japanese technicians contracted by the French colonial administration (Rapaport 1995). Commercial farming became established in the 1970s in French Polynesia, when the Rosenthal brothers, Jean-Claude Brouillet, and Robert Wan established farms and demonstrated their commercial viability (DIXIT 1996:254). Since 1983, Territorial Fisheries Service (Le Service Territorial de la Pêche) has disseminated material on farming and seeding, and the industry has become the biggest export industry in the French Polynesian economy with some 3,800 concessions now being managed for different products (ibid.:255).

Black-lipped oysters are now farmed commercially in parts of French Polynesia and the Northern Cook Islands and experimentally or in trials in the Solomon Islands, parts of Micronesia (South Pacific Commission 1996: 16), Kiribati (ibid.:15), and Iran (Doroudi 1996:17). While the organization of the industry differs in French Polynesia and the Northern Cooks, the basic processes are similar, and the associated social issues—lagoon tenure rights, license allocation, reversal of migration flows, increased incomes, and family production units—are similar.[4]

The farming of the pearl in French Polynesia and some of the social issues that it has produced have been described elsewhere (Rapaport 1995, 1996). The social and political history of the Cook Islands industry has been extensively described by Newnham (1989) and more recently by Flintoff (1994), and the marine biology and management of the industry is discussed in reports by Sims and Gervis (1992) and Asian Development Bank consultants (RDA International 1997). This article focuses on the development of pearl farming in the Northern Cook Islands to highlight the possibilities and risks of black-pearl farming as a development strategy for atoll states.

Black-Pearl Farming in Manihiki

Manihiki is an atoll in the Northern Cook Islands, lying 1,204 kilometers northeast of the capital, Rarotonga, at 10 degrees south latitude and 161

degrees west longitude. The atoll has a land area of some 544 hectares with a maximum elevation of 5 meters above mean sea level. The land consists of a series of islets, or *motu,* around the lagoon, which has an area of 48 square kilometers and is 8 kilometers wide in places. The 1991 population of Manihiki was 663 people, who lived in or around two villages, Tauhunu and Tukao. It is presently served by a weekly air service from Rarotonga and a scheduled interisland shipping service.

The pearl-farming industry was introduced into Manihiki in the mid-1950s by an Englishman, Ron Powell—described by some as an armchair marine biologist—who introduced the idea of spat collection as part of an effort to reestablish stocks of the wild oyster, which had been depleted by diving for pearl shell in the Manihiki lagoon. His ideas were largely ignored by the New Zealand administration of the day, and it was not until later that anything else was heard of pearl farming (Newnham 1989).

An Australian, Peter Cummings, obtained a permit from the Cook Islands Ministry of Marine Resources to establish a farm in the Manihiki lagoon in the early 1970s. The Cook Islands government used its power to grant the license, asserting that the lagoon fell under its jurisdiction, in the face of opposition from the Manihiki Island Council, which believed that the lagoon was, and always had been, under its exclusive control. The Cummings venture eventually foundered in 1982 (Torrey 1996).

The revival of the industry was the consequence of interest from two groups with different visions of the way to develop the industry and of Manihikians' roles within it. The principal obstacles to establishing pearl-farming operations were a shortage of capital and an absence of oyster-farm husbandry skills. While Manihikian incomes, derived principally from diving for pearl shell and to a lesser extent from cutting copra, were higher than those of other atolls, they limited the scale of farming and rate of growth. Low local incomes limited the possibility of saving the capital necessary to both enter and expand oyster-farming operations. Before the industry could grow, new capital and credit were necessary. Each group proposed to overcome these obstacles in different ways.

The member of parliament for Manihiki, Ben Toma, encouraged the Manihiki Island Council to license a single, large-farm development program managed by a non-Manihikian with experience in large-scale pearl farming in Tahiti. That operation was to provide a source of capital for Manihikians who wished to start small farms. To ensure that aspiring small farmers had access to capital, the Island Council prohibited the company from diving for pearl oysters and required it to purchase its oyster stock. In the first two years of operation, Cook Islands Pearl purchased NZ$1.2-million worth of oysters from Manihikian divers. The government's Ministry of

Marine Resources was at the same time working with a group of eight Manihikian family-farming operations that had begun pearl farming using assets and skills that had been deployed in pearl diving and capital from pearl-shell sales, from work overseas, and from family networks.

Two methods were proposed to train aspiring farmers, who already had many of the necessary diving and boat-handling skills, in the farm management practices necessary to produce and maintain healthy stock. One group proposed using a private company to establish a large operation that could provide Manihikians with training. The company subsequently employed seventy local people. The second argued that a large, non-Manihikian–run venture was unnecessary. This group argued for the development of smaller farms with assistance and technical guidance from the Ministry of Marine Resources, and it employed its own management, technical, and marketing resources. These family farms could also provide training, albeit for smaller numbers of people.

Through 1987 tension existed between the advocates of these approaches. The arguments had less to do with oyster farming than with politics. The Manihiki Island Council believed that it had the right to manage the lagoon and the obligation to develop it in the communal interest (Kaitara 1988). Private farmers believed that they too enjoyed the right, as Manihikians, to farm in the lagoon and did so with the guidance of the Ministry of Marine Resources.

The tension persisted even after the Manihiki Island Council licensed a part-Tahitian, part–Cook Islander, part-Chinese entrepreneur, Yves Tchen Pan, who had established pearl-farming operations in Tahiti.[5] This tension was in fact heightened at times by such things as the suggestion by Tchen Pan that local farms should be limited to 2,000 oysters each, while he enjoyed the right to farm up to 200,000, and led to local anger (Kaitara 1988). It was clear from this point that significant effort would need to be invested in conflict resolution during the early stages of the new industry (Dashwood 1992).

Despite the tension, the Island Council formed the Manihiki Island Trust, which purchased the Cummings farm's assets in 1987 for use as a training establishment in a program to get Manihikians into pearl farming on their own farms. Tchen Pan then entered into an arrangement under which he would be allowed to operate a large farm in the lagoon at Manihiki in return for provision of management for the Island Trust's own training establishment. For a while Tchen Pan provided advice and ran his own farm, but the Island Council eventually discontinued the Trust's farming operation as farmers gained experience and wished to set up their own farms.

A new arrangement, known as the 60:40 agreement, replaced the original one. The agreement was put together by Ben Toma, Yves Tchen Pan, the

Island Council, and a local lawyer and businessman, Reuben Tylor. The Crown Law Office represented the interests of the Island Council, and Reuben Tylor acted for Cook Islands Pearl. Under the terms of this agreement, Manihikians dived for oysters, which were taken to Cook Islands Pearl's farm. The farmers, who tended their own shells with advice from Cook Islands Pearl, gained knowledge of farm husbandry practices, access to management advice, access to technicians, and a market for their pearls. In effect the shells were managed, seeded, harvested, and marketed on their behalf by Tchen Pan's company, Cook Islands Pearl Ltd., in return for 40 percent of the proceeds.

With proceeds from sales of shells, proceeds of their own crops' sales, and the above arrangement, Manihikians could become established on their own farms relatively easily. The number of farmers with necessary capital and skills who wished to farm independently grew steadily. Under pressure from farmers who did not wish to participate in the Island Council–Cook Islands Pearl agreement but wanted access to experienced technicians, the company set up another program and seeded shell at Cook Islands Pearl's farm for $12 per shell for independent farmers who returned the shells to their own farms.[6]

The eight pioneering family-farming operations grew alongside Cook Islands Pearl and provided a model for others who wished to enter small farming without dependence on Cook Islands Pearl. The Ministry of Marine Resources granted a permit to one large farmer to seed his own crop. His group brought in technicians and seeded their shells in 1987 with the assistance of the Ministry of Marine Resources. This enterprise was said to contravene an exclusive right granted by the Island Council to Cook Islands Pearl and generated tension between the two groupings, which culminated in attempts to prevent the independents from seeding their own pearls in 1988 and to constrict their cash flow.

Despite these initial tensions, it was increasingly clear that pearl farming offered Manihikians an opportunity to earn higher incomes and enjoy greater autonomy. With proceeds from diving for pearl shell and casual labor along with government wages and assistance from kin who were already in farming, the way was clear for more Manihikians to enter farming on a scale that would provide a significantly better income than that available from the main employer, the Cook Islands government, or the erratic subsistence income from pearl-shell diving and the harvest and sale of copra.

Since these early days, Manihiki and neighboring Penrhyn (Tongareva) have developed into the Cook Islands center for the commercial production of black pearls. In the region in 1987 eight operations farmed a total of 10,000 seeded oysters. Nine years later there were 150 farming some 225,000

seeded oysters.[7] The numbers of active operations and oysters farmed vary from year to year for a range of social, biological, and commercial reasons. The success of spat-collection techniques in Manihiki, for instance, has meant that the once-obvious dichotomy between large and small operations has been eroded.[8]

In Manihiki there are approximately sixty-nine operations of various sizes farming oysters (Sutton 1996). The largest operation, Cook Islands Pearl, seeds between 50,000 and 60,000 oysters in a season, an estimated fifteen to twenty locally owned commercial operations seed between 10,000 and 40,000, an estimated thirty to forty operations seed between 5,000 and 10,000, and an estimated thirty to forty smaller farmers seed between 500 and 3,000. Leases have now been assigned over a significant portion of the parts of the lagoon most suited to farming (Newnham, cited in Sutton 1996:60).

The Farming of the Pearl Oyster

Farming involves the capture of oyster spat on lines suspended in areas where natural oyster populations spawn or the selection of juvenile wild stock.[9] Selected juveniles from either source are grown out on banks near oyster farms until they reach a condition and size at which they can be transferred to farms. The shells of the selected oysters are drilled near the hinge so that they can be suspended from lines. The shells are then carefully separated and held open 1 to 2 centimeters with a small wedge to allow a 1 to 2 centimeter incision to be made in the oyster's gonad. A spherical nucleus made of Mississippi mussel shell is inserted into the gonad with a small section of the live mantle of another sacrificial oyster.[10] The nucleus provides an inert core over which the oyster deposits a colored nacre with material from the mantel tissue.

The "seeded" oyster is then placed in a nylon net "catch bag" and suspended, by either stainless steel wire or nylon, upside down to discourage the animal from rejecting and ejecting the nucleus. The seeded oysters are suspended on lines of ten, known as chaplets, which are in turn suspended, between 1 and 2 meters apart, on underwater lines floating at between 5 and 7 meters below the sea surface. The lines, which vary in length according to the size and shape of the farm, are fastened by vertical lines to coral heads or artificial anchors on the lagoon floor. Flotation is provided by buoys, which are adjusted to keep the lines at the selected depth.

The seeded animals are checked after six weeks to establish whether they have retained the implanted nuclei. The catch bags are inspected for rejected nuclei and oysters that have rejected the nucleus are killed and those that have retained it are cleaned and reattached to chaplets, which are in

turn resuspended from the lines. The retainers are periodically brought to the farm, where they are cleaned manually and checked before being returned to the lines until they are harvested and reseeded after some eighteen months.

The harvested pearls are graded on the basis of size, shape, color, surface quality, and luster. The pearls are sold in various ways. In 1990 and 1991 pearls were sold at auction, but now most are sold either directly by the farmer, through the technician who seeds the pearls, or through agents in Rarotonga.

Black Pearls and Development

The recent history of commercial black-pearl farming has established that this is a viable industry but not whether it is a realistic answer to the problems faced by Pacific microstates at the start of the twenty-first century. These problems are not purely technical but are also social, economic, political, and environmental. To establish whether the farming of *Pinctada margaritifera* for the production of cultivated black pearls represents an answer to the problems of Pacific atolls, the imperatives set out above can be used to identify costs and benefits. I will attempt to answer the question with data from the Northern Cook Islands, where the industry has been established in its present commercial form since 1985, and to provide a comparison with the French Polynesian operation.

Environmental Costs and Benefits

Pinctada margaritifera are being farmed sustainably using oyster stock and physical resources that occur naturally in certain lagoons throughout the Pacific. The introduction of exotic stock and the attendant risk of introduction of disease are therefore avoided. In fact, the existence of a profitable marine-farming activity may increase popular awareness of the need to maintain the lagoon health to ensure that the industry on which people become reliant is maintained (Torrey 1996). Two lagoons, Manihiki and Penrhyn, are currently producing pearls, and others, Pukapuka, Rakahanga, and Suwarrow, have been identified as possible sites for the establishment of further farming operations.

Because wild stock is periodically harvested from the lagoon floor for farming operations, biodiversity is not threatened, and because layers of water separate the "farmed" stock from the "natural" stock, the latter is to some extent insulated from the possibilities of diseases in the farming operations. The existence of profitable marine farming reduces pressure on the

land-based economic activities that lead to environmental degradation. Pearl farming provides income that can be used to purchase imported food and takes pressure off fragile atoll soil, although it does create a minor waste-disposal problem.

Farming, seeding, and harvesting operations do not require large amounts of energy, fresh water, land, or fossil fuels that frequently go with land-based development. Nor does oyster cultivation require the use of introduced, dedicated chemical sprays and fertilizers, which are frequently associated with land-based crops. The phytoplankton on which the oyster feeds occurs naturally in the lagoon, and routine oyster health can be maintained by a series of well-understood farming practices.

Economic Costs and Benefits

The black pearl is a nonperishable commodity that is not presently oversupplied in world markets. The pearls are easily and inexpensively transported from production sites to markets. The pearls have potentially high unit values. The best pearls can fetch as much as US$5,500, and even imperfect grades have a limited range of uses in jewelry. A crop typically yields 10 to 15 percent rounds; 25 to 35 percent drops, pears, and buttons; 15 to 20 percent baroques; and 40 to 50 percent circles (Torrey 1996:6).

Furthermore, the value of a pearl can, in some circumstances, be manipulated by withholding supplies from flat markets and selling them in more buoyant ones. Until recently, promotion of the pearl in jewelry manufacturing markets was hampered by the absence of a significant stock of good quality pearls with which to meet a suddenly escalating demand. With marketing it is possible that the demand for the black pearl could be increased, while supply is likely to be limited by the number of sites in which stock occurs naturally alongside a population in lagoons with the necessary characteristics.

The value of pearls is significantly higher than that of alternative commodities. The price of copra to the grower after handling and transportation charges is around NZ$345 per tonne, and the gross price of pearl oyster shell, used in the manufacture of buttons, is around NZ$7,000 per tonne, from which handling and transportation charges must be deducted. By comparison, the value of a tonne of pearl would be around NZ$113 million and, while production costs are significantly higher, handling and transportation charges are significantly lower.

The farming of black-lipped oyster involves relatively limited amounts of fairly basic technology and equipment that is readily available. The lines, buoys, wire, boats, outboard motors, generators, water blasters, drills, air

compressors, and diving gear can be bought easily in extremely competitive world markets. The farming does not require expensive specialized equipment that is constantly being upgraded and that requires the latest generation to remain competitive. Some parts of the equipment, such as spat collectors, can be produced from locally available resources.

Even the equipment used for seeding and harvesting is readily available. Stands in which oysters are held during the operation, dilators that open the oyster, wedges that hold it open during the operation, scalpels, tweezers, probes, and sundry other equipment used to insert the material and retrieve the pearl can be readily acquired in an open market as can antibiotic solutions used to ensure postoperative animal health.

Although in populations with low incomes even the costs of this fairly basic equipment inventory may seem high, expenses can be financed and repaid with relatively small development loans over reasonably short payback periods. Furthermore, these costs can be reduced in various ways by purchasing secondhand equipment to start and using farm income to increase the size of the operation gradually. The relatively limited capital inputs that are required to establish a small entry-level farm allow the eventual possibility of widespread popular participation and explain the growth in the number of operating farms in the past ten years.

The return on pearl farming can be further increased by improving the retention rate in seeded pearls, improving the quality of the pearls, and retaining the part of the profits that are currently disbursed to technicians. The means of improving retention rates and pearl quality are the subject of experimentation and cannot yet be achieved consistently because of the number of variables involved. The mastery of the technical skills of pearl farming by Manihikians and the retention of profits currently disbursed are, however, more advanced.

Two significant skills, seeding and harvesting, are in short supply and do reduce the return to farmers. Seeding and harvesting, which are crucial to the retention rate and ultimately to the quality of the pearls and the profitability of the industry,[11] have been largely carried out by Japanese and Australian technicians who are contracted by Manihikian farmers. These skills, which are the product of formal training in marine biology and in seeding and harvesting practices, are presently costly but can be acquired by Manihikians. One Manihikian is presently centrally involved in the industry; several others are said to be experimenting,[12] and at least one other is in training in Australia.

In addition, in the last three or four years the growth of the industry has resulted in a growing demand for spat as replacement stock. The industry kills some 500,000 oysters per year that must be replaced. A training pro-

gram for people interested in spat collection has been started, and some are collecting spat, which they sell to established farmers for around NZ$2.50 per shell. If demand grows, the return from this downstream activity would be expected to grow.

Social Costs and Benefits

Pinctada margaritifera are being farmed relatively easily using skills and knowledge that either are readily available or can be developed within the local population. The farming operations require three basic sets of skills. The basic husbandry requires a set of technical skills for maintenance of the farming infrastructure and management and husbandry of oyster stock. Such skills involve a mix of boat handling, diving, basic technical skills such as equipment maintenance and repair, and basic marine biology. A second set of management, clerical, and accounting skills is needed to ensure that tasks take place at required times and within budgets. The third set of skills involves periodic seeding and harvesting of pearls. These latter skills, which are crucial to the profitability of farming, have until recently been controlled and closely guarded by technicians who have served their time in the industry elsewhere.

Only small amounts of imported labor are currently required for seeding the shells and harvesting the pearls, which ensures that the social dislocation that often goes with labor importation can be avoided. Certain skills must, for the meantime, be imported, but even this labor used in seeding and harvesting is not especially disruptive, because it typically involves small numbers of technicians who are present for relatively short periods of time and who typically live on the farms and away from the centers of population. In French Polynesia, and now in the Northern Cooks, these tasks are being mastered by local people who may eventually come to control this area of the operation.

The black-lipped oyster can be farmed within existing forms of social and economic organization. Family units have been traditional units of economic activity, and they can manage most of the labor demands of routine farming operations, supplemented occasionally by casual labor at certain times in the farming cycle and by technicians for seeding and harvest. All but one farm are family owned and operated businesses (Torrey 1996), which is significant because those working on the farms have a vital interest in the success of the industry.

The industry is organized on the atoll by the Manihiki Island Council, composed of elected Manihikians. The council's duties are set out in law and include regulation of lagoon management, issue of farm licenses, allocation of license areas, certification of pearl seeding technicians, and dispute reso-

lution between farmers. This organization means that those who manage the industry can understand and represent local interests effectively. The Cook Islands government, which once took a central role in the industry through its Ministry of Marine Resources, has now withdrawn to a more specialized role in such areas as the provision of technical advice. Government ownership of farms has been phased out.

Farming of the black pearl in the Northern Cooks has produced a modest repopulation in atolls with formerly declining populations. The 1996 Cook Islands census showed an 8.1 percent intercensal increase between 1991 and 1996 in the population of the northern group compared with a 1.9 percent increase in Rarotonga, the former population magnet, and 1.5 percent for the nation as whole.[13] The prospects of significant incomes from farming have attracted people back to the Northern Cooks from the southern islands of the group and from New Zealand and Australia (Torrey 1996).

The Downside

Can any one industry offer so much potential for Pacific Islands atoll development? Might this be a mirage? There are clearly various environmental, technical, economic, political, and social risks associated even with apparently successful activities. In the case of oyster pearl farming, the major risks would seem to be environmental, economic, and social.

Environmental dangers might come from increasing the stocking levels within the lagoon to a point at which the stock becomes stressed, which could lead to widespread death of stock, rejection of nuclei, or production of large numbers of inferior pearls. These risks have been minimized by a two-year research program focused on lagoon monitoring by marine biologists supported by the Asian Development Bank. This program has produced new data on the lagoon's carrying capacity and health and established an ongoing program of lagoon monitoring and management that may have limited the potential of this risk (RDA International 1997).

The risk may be further reduced by the growing awareness that farming returns may be increased by strategies other than increasing stock numbers. These possibilities involve focusing on areas of farming that can improve returns without increasing labor costs and include the use of the most successful technicians and better animal husbandry and farm management practices. While these measures alone will not guarantee better crops, because other sets of factors also influence quality, a marine biologist who worked on Manihiki for the Asian Development Bank believed that growers would embrace these strategies because they increase returns without increasing labor costs (M. Anderson, pers. com., 11 March 1997).

A second danger would involve the spread of an endemic or introduced

disease to which oysters have no immunity, as occurred in French Polynesia, which could cause similar problems. If such problems were to persist for any length of time, farmers deprived of pearl income could be forced to resort to land-based activities that would put pressure on the terrestrial environment. Public availability of the findings of the research that followed in the wake of the French Polynesian epidemic and public awareness of the dangers of the introduction of disease are likely to minimize these dangers.

Both stocking and lagoon management decisions can be overseen by those with a vital interest in the health of the lagoon and the industry that it supports. Personal dependence on the lagoon would be expected to ensure that they manage it in ways that minimize threats to the lagoon and the industry. But there is another set of global environmental factors that cannot be managed with any certainty.

Global climatic change could also threaten the industry in several ways. First, in the event of general sustained ocean warming, the oysters, which are most healthy and grow most quickly at between 26 and 28 degrees Celsius, would have to be farmed at greater depths where water temperatures are lower, with associated increased costs. In 1992, surface water temperatures in the Manihiki lagoon rose to 31 degrees Celsius. Cook Islands Pearl tried various means of handling the temperature rise, including lowering the farm, but in the end suffered a drop in revenue from NZ$9 million to $3 million as a consequence of reduced production.

Second, if El Niño events were to become more frequent and more intense, the atoll could be exposed to more cyclones. The most recent cyclone, Hurricane Marten, which struck Manihiki in late 1997, resulted in nineteen deaths, the loss of harvested pearls, and damage to villages and farming operations. While damage to the actual underwater farming operations was limited, production was severely disrupted by loss of equipment, damage to the above-water infrastructure, and a loss of income. Loss of life in a small, close community and loss of income have serious impacts on the viability of the industry for different reasons. If such events were to become a more frequent feature of life, it could well be that people would abandon the industry and look for safer places to live and to earn a living.

Economic risks would include oversupply of established markets and the collapse of returns to a level at which farming became uneconomic. Supply and demand must always involve a risk, but in this case the risk is presently mediated by the existence of several developing markets and relatively limited volume of available production. Furthermore, for reasons outlined above, it will be some time before production volumes will increase significantly.

Until recently the Japanese have been the largest buyers of black pearls,

but demand from Southeast Asian nations grew in the wake of the Kobe earthquake, which disrupted Japanese domination of the market. Demand from this wider market has fallen temporarily in the wake of the "Asian meltdown," but there is untapped demand in both European and United States markets. Italy, which manufactures 70 percent of Europe's jewelry and 20 percent of the world's, has been targeted by producers from French Polynesia and is becoming a major user of the pearl.

Other threats include the culturing of more "spectacular" pearls from other marine animals like abalone, but experiments with such products as the mabé pearls produced from one of New Zealand's three species of native abalone *(Haliotis iris)* suggest that these can never produce large amounts of product (*Pearl World* 1996:9).

Social risks result from the fact that, historically, wealth was relatively evenly distributed in Manihiki. The organization of the pearl-farming industry is such that those families that entered the industry early and approached production commercially have received significant returns on their activity, and there are now probably significant disparities in the wealth of individuals on the atoll. The emergence of disparities in the wealth of individuals and groups in societies in which disparities have not been present historically may create social tensions resulting from awareness of and sensitivity to new forms of inequality. These tensions may manifest themselves in various ways, including political and social instability, in different circumstances.

There is always the possibility of tension between groups over the definition and allocation of use rights where resources assume new use values as has been the case in Manihiki. Where the prospect of significant wealth leads to the return of expatriate islanders, tension may develop between residents and returnees over the nature and quality of the latter's rights. This tension may lead in turn to friction between the relations of returnees, who support them out of family solidarity, and those who would challenge their rights to reside and use resources. It may also lead to tension within families as long-absent members seek to establish claims to resources that have been used by resident members. All of these and other tensions have been evident at various times in Manihiki.

Several factors seem likely to limit the probability of sustained conflict. First, while such tensions are almost inevitable, the benefits of exploiting the resource place a premium on early resolution of conflicts. Second, the disparities of wealth are not readily apparent and are not reflected in conspicuous consumption on the atoll. Members of the community who have made significant amounts of money from pearl farming do not appear wealthier than those around them. There are no palatial homes, expensive

cars, or boats on the atoll to draw daily attention to the disparities in wealth. The wealthy live alongside less wealthy people, to whom they are related in many cases, and are connected by multiplex bonds to many other members of the community in many contexts. Third, those who are wealthier are, from limited observation, in many cases still actively engaged in farming operations and work alongside those whom they employ daily. Those employed are frequently related and are not simply wage workers. Since most are aware of the significant effort that is required daily to operate a successful farm, those who continue to work when they are wealthy and need not work may enjoy respect rather than envy.

Those who are less wealthy believe that they too could be wealthy if they chose to become involved in farming and argue, in support of this claim, that they too have leases that they could work if they chose. Thus, following this rationale, people can choose to farm and become wealthy or not. The greater wealth of some is not seen as a cause of the lesser wealth of others. The existence of some large, profitable farms is not seen as a barrier to the entry of others into the industry.

Finally, Manihikians' lives and fates are all bound together by the dangers and vicissitudes of life on a remote atoll. The wealthy cannot, as one young man noted, protect themselves from hurricanes or other acts of God any more successfully than the poor and indeed cannot even insure themselves against them, so they have more to lose. For all of these reasons, the tensions that might be expected to accompany emerging disparities in wealth in a small society do not seem as likely to surface.

Conclusion

The pearl-farming industry meets a series of criteria that make it well suited for the atoll environment. It employs readily available marine resources and technical skills, relatively inexpensive intermediate technology, and it does not require large amounts of land, energy, or fresh water. Since there are few profitable industries that are actually well suited to the atoll ecosystem, these factors warrant considerable interest from aid agencies. While economies of scale are available, it is possible for family units to manage profitable pearl-farming operations with limited amounts of paid labor.

Farming of the black-pearl oyster at Manihiki in the Northern Cook Islands appears to be a remarkably successful form of sustainable atoll development for a range of environmental, economic, and social reasons. While it is not without its risks, it promises a more significant and more sustainable income than any of the other currently available alternatives and meets most of the criteria for "appropriate development" for atoll societies, which have

the necessary combination of an appropriate lagoon, oyster stock, and population. This ideal combination does not occur widely. Not all atolls have suitable lagoon ecologies, and without these farming is impossible, although both population and stock can be moved to appropriate sites with some risks.

Populations from atolls facing population pressures could be resettled on uninhabited, but otherwise suitable, atolls if and when marine tenure and other well-understood sources of potential social and political tension have been considered and planned for. A growing body of material from social scientists' studies of marine organization and tenure in the Pacific is now readily available. Existing ecological knowledge and technical skills are, as the Manihikian experience has shown, readily transferable, and a growing body of technical and scientific knowledge about the industry, which can be used to minimize risk, is also available.

The possible benefits of moving excess spat and juvenile stock to other atolls in which *Pinctada margeritifera* does not occur naturally seem readily apparent. Such a development, managed properly, could produce significant income possibilities for spat growers in Manihiki, for atoll dwellers who currently have little prospect of significant income, and for microstates seeking paths to sustainable development. Hatchery technology, which is now well developed, could produce a crop for other atoll societies, such as the nearby Tokelaus, that currently exist largely on copra sales, remittances, and aid from New Zealand.

NOTES

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1. Kava is the powdered root of the plant *Piper methisticum.*

2. The exceptions among the smaller states with which this article is concerned are Fiji, which has gold and other minerals, and New Caledonia, which has significant nickel deposits.

3. What is known as the "black" pearl includes a number of shades of pearl from darker grey hues to iridescent greenish-black. The range of colors that designers and consumers can choose from increases the product's value in high fashion.

4. I am indebted to Raymond Newnham, former secretary to the Cook Islands Ministry of Marine Resources, now a pearl farmer, businessman, and consultant, for these observations.

5. There is a dispute over whether the final decision to sign the contract that licensed Tchen Pan was ratified by the full Island Council. The final terms were supposed to have been taken back to Manihiki for ratification by the council but were in fact signed by a council representative in Rarotonga.

6. The 60:40 agreement continues and is still used by small farmers.

7. If unseeded shell and shell on spat collectors is added to seeded shell, the current total is around 700,000 (Newnham, pers. com., 1998).

8. By contrast, disparities between larger and smaller farms persist in Penrhyn, where, estimates suggest, of the approximately eighty active farmers, one seeds between 10,000 and 15,000, three or four seed between 500 and 3,000, and the remainder seed between 50 and 500 shells.

9. Hatchery technology has now been developed that increases the success rate and extends the possibilities of introducing stock into areas in which it does not occur naturally.

10. The size of the inserted nucleus is determined by the seeding technician on the basis of observed size and health of the animal and the number of times it has already been seeded. Mississippi mussels are found naturally in the Mississippi, Missouri, and several other midwestern U.S. rivers. While various natural and synthetic alternatives have been tried, none has been as successful as Mississippi mussel shell. The search for a less expensive synthetic alternative continues.

11. There are several ways of calculating the retention rate (Torrey 1996), but the most frequently used counts the number of nuclei retained when the pearls are first checked after seeding by examining the catch bags for rejected nuclei as a proportion of all pearls seeded.

12. It is estimated that it takes 10,000 "practice seedings" to achieve consistent success in seeding and harvesting. This is an expensive investment in the short term, because returns from these practice seedings may be low for some time. However, the longer-term returns from mastery are potentially high.

13. The Cook Islands population grew to 18,904 from 18,617. Austerity measures and economic restructuring undertaken by the Cook Islands government since 1996 have led to major outflows of population, believed to be on the order of 3,500, as redundant public servants and their families have moved to New Zealand in search of work.

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