

# Freshwater Mussel Management in the Mississippi River and Pearl Culture in Pacific Atolls: An Obligate Symbiosis?

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**Abstract.** This presentation gives a synopsis of Pacific pearl culture developments and examines their relationship with the American freshwater mussel industry. Black pearl culture represents a lucrative development opportunity for many isolated Pacific atolls, where the only alternative activities are copra drying or fishing. The typical pearl farm operation in these lagoons is described. Some of the recent and impending developments in the industry are reviewed, and their possible effects on the small-scale Pacific island pearl farmer are also examined. The status of the American freshwater mussel industry could have some significant impacts on these farmers and on the development of pearl culture across the Pacific. With the increasing involvement of small-scale independent farmers in Pacific pearl culture, there might also be potential for direct links with the United States. Rather than just being a passive host, the American mussel industry could look more closely at the opportunities for mutual benefit.

Good evening, ladies and gentlemen. Before I launch into my presentation this evening, I want to offer a few words of thanks to the UMRCC for making it possible for me to be here at this conference. Kurt Welke and Leroy Koch deserve a special word of thanks for all of their efforts and assistance. Gentlemen, thank you very much. It is a real pleasure to be here.

Thank you also, all of you, very much for your warm hospitality and for sharing your knowledge and wonder about freshwater mussels. Tonight I want to reciprocate in some small way by sharing with you the other side of the bivalve business—pearl culture.

It has certainly been an educational couple of days for me—and for any other molluscivorous marine mammal. I have found this whole world of freshwater bivalves to be fascinating. I have been very impressed by the quality of the science that has been demonstrated here. I am pleased to see the progress that is being made toward conservation and management of mussel resources.

However, I still remain a little awed by the challenges that these fickle creatures present. Those of us who believe in a Creator of the Universe must really wonder about how clearly he was thinking when he built these things. It must have been fairly late in the afternoon of the sixth day, and he was doing some fairly frantic, last-minute mix-and-matches. Those of us who subscribe to Darwinian theory have stared blankly off into the corner of the room when the question has been raised of the selective advantages of some of the more ornate

curlicues and embellishments in the life cycles and biology of these magical mussels.

So, all of you, I admire your perseverance, your diligence, and your scholarship. Looking out over the Mississippi River this afternoon, as the wind whipped up a chilly spray, I couldn't help but admire the fortitude and dedication of the scientists and the divers that work in this industry—who actually immerse themselves in that water. And this is still October! My mind boggles at the thought of what February must be like. I imagine a diver out there with mussel bag in one hand and ice-pick in the other.

Each of us faces his or her own challenges, however. Consider the arduous tasks and inclement conditions faced by the average pearl farmer in the South Pacific. Incessant sunshine, glaringly blue aquamarine lagoons, tepid-bath water temperatures, coconuts falling from swaying palm trees, the distractions of the soft strumming of ukeleles and swaying hula skirt—it's tough, I know. But they bear their crosses bravely—and certainly wouldn't wish it on anybody else.

There is more than a gentle jest in the romantic ideal of the isolated atolls of the South Pacific. This vision I conjure up is really just that—an ideal, a dream.

The atolls of the Pacific Ocean are isolated, often hundreds of miles from their nearest neighbor. Natural resources are scarce; there is little that a thin strand of sand and coconuts can offer the outside world. The communities on these atolls are being gutted by rural-urban drift to the larger islands and

overseas. Their sons and daughters leave for New Zealand, Australia, California, or anywhere else they can earn a decent wage and live with hope for the future.

In the past these communities have struggled to make a living out of smoking fish or drying copra. Their sense of cultural place and pride has been eroded by western contact, their populations decimated by disease; traditional cultural and religious systems have been stomped out by colonial arrogance and missionary zeal. These destructive processes continue today with the paternalism of the western model of socio-economic development, aid-dependency syndromes, and the pervasive corrosion of Coca-colonialism.

In reality, the people in these communities aspire to the same simple pleasures that we all do: family, security, hope for the future, cold beer. Without even beginning to crank up the North-South political debate, it is enough for us all to recognize that everyone wants to improve his or her lot. Everyone wants to hand over to the next generation something that's a little better, a little easier. And everyone wants to be able to drink a cold beer with his or her family gathered around to watch football on TV. This is part of the quintessential human condition.

Now, finally, these atoll islands have hope—a real development potential, something more than being a testing site for hydrogen bombs or case studies for anthropologists. These islands are the center of the booming black pearl industry.

The French Polynesian black pearl example is the one that almost every South Pacific island nation would love to emulate. There, the direct value of the black pearl industry is well over \$50 million per year. In Manihiki, in the Cook Islands, where I have done most of my work, the fledgling industry of a few years ago is now worth somewhere around \$3 million. This may not seem like a lot of money, but this is just one small atoll of a few hundred people.

I want to now just show a few slides to give you an idea of the islands of the South Pacific, the black-lip pearl oyster, *Pinctada margaritifera*, and the methods used in this industry.

These are tiny islands, often from 1 to 10 miles in diameter. They are sometimes hundreds of miles apart. Each island consists of a string of small islets laced around the central lagoon. Narrow passages connect the lagoons to the ocean.

The islands' vegetation consists mainly of coconuts, with a coconut canopy and an underbrush of coconuts. The communities are small, clustered villages, generally built around a passage or a harbor and a church. Now, with a growing pearl culture industry, airstrips have been recently built on many atolls.

Small boats are the main mode of transport, and fishing is the principal occupation. The fisherman, Tekake Williams, was the first local Cook Islander to begin pearl farming. The photographs I will show later are of his farm.

The black-lip pearl oyster, *P. margaritifera*, is cultured in the Cook Islands and French Polynesia (with a few small farms in Fiji and Okinawa). It is so-named because of the black tinge to the nacre and the black non-nacreous border. *P. margaritifera* is found naturally attached to rocks inside lagoons, down to a depth of about 120 feet. In shallow water they are rare because they are heavily fished. Most of the oysters occur at a depth of about 90 to 120 feet.

These giant clams also occur in great numbers in shallow water. There is also some research now looking at the aquaculture potential of these tridacnid clams.

Historically, the oysters were fished for their pearl shell. Some of the lagoons produced over 200 tons of shell a year, but stocks are now fairly depleted. The traditional pearl shell divers of Penrhyn used floating logs with a basket underneath for the oysters. A rope and lead weight is also used to aid the diver's descent. Some of the divers can reach a depth of 120 feet. The oysters collected for pearl shell are around 5 to 6 inches in diameter, and each yields ½ lb to 1 lb of shell—about \$1 to \$2 per oyster.

Pearl culture provides much better returns; even half-pearls, or mabes, can bring up to \$20 per piece. Farm prices for round black pearls may average about \$100 each. These half-pearl earrings and necklaces are produced by local craftsmen to sell to passing yachts or to export overseas. Up to seven half-pearls can be implanted onto a single oyster valve. Plastic beads are usually used for half-pearls, but others are produced using the hemispherical operculum of a reef snail as a nucleus.

Pearl culture requires the collection of good healthy oysters—usually by spat collectors. These are bundles of twigs, ropes, plastic or shade cloth, tied onto long-lines buoyed below the surface. Black materials work best, but no one really knows why. The plastic mesh bags protect the spat from predators such as fish, but they are often not used. They are not always needed, and sometimes the spatfall is better in unbagged collectors.

The oysters have protracted spawning periods, usually with a couple of months of greater intensity when spatfalls are heaviest. The development of the pearl oyster larvae is relatively uncomplicated, compared to some of the larval development stages in the freshwater mussels we have seen here. After 26–30 days, a pediveliger, with a long foot, starts to search for a suitable settlement site.

The spat stick directly onto the rope or plastic. In

very heavy spatfalls, they will even attach onto the buoys themselves. This buoy has become negatively buoyant with the weight of the spat as they have settled and grown. Spat-collected oysters are usually removed when they are about 1–2 inches in shell diameter; others are left on the shade-cloth collectors for two years until they are 4 or 5 inches. These oysters still show good growth, as evident by the long growth processes on the border of the oyster.

When the oysters are about 2–3 inches in diameter they are drilled, tied together in pairs, and hung on downlines. The downlines are then hung from a platform or from a long-line where they will be allowed to grow until they are 4 to 5 inches in diameter and are ready for seeding.

Farmers now prefer to hold their oysters on long-lines, buoyed beneath the surface much like the spat collectors, where they are spaced further apart, and are clear of the bottom. Oysters on long-lines show better growth. The risk of disease outbreaks on the farm is therefore also reduced with long-line culture.

A platform in Manihiki lagoon, in the Cook Islands, held around 40,000 oysters back in 1985, when pearl farming was just beginning in Manihiki. The farmer, the man with the fish at the start of these slides, is now farming around 80,000 pearl oysters and producing excellent quality black pearls.

I don't have any photographs of the actual pearl implantation procedure because many technicians are still very protective of their methods. Basically, however, the oyster is pegged open, and an incision is made near the foot of the oyster. The nucleus of Mississippi mussel shell is placed into this pearl sac alongside a piece of mantle tissue from a donor oyster. If the mantle graft takes, and the oyster doesn't reject the nucleus, then in 18 months to two years a fine black pearl should result.

The methods used for pearl farming are not complicated. Though you will often see reference to it being "more art than science," it is basically just growing another bivalve. Whenever people talk about "art" in biology, I always suspect that it just means they haven't looked long enough or carefully enough at what is happening. This is certainly true for pearl culture; there has been surprisingly little money spent on pearl oyster research. In Australia, pearl culture is the single-most valuable aquaculture industry, yet there is not a single publicly funded research program looking at pearl culture questions.

Although black pearl culture is presently mainly confined to these eastern Polynesian atolls, some recent advances in culture techniques have led to a greater development push in the other island countries. Palau, Micronesia, Marshall Islands, Papua New Guinea, the Solomon Islands, Kiribati, Tuvalu, Tonga, Fiji—all have potential for black pearl development.

Beyond the South Pacific region, my company and others are looking at the feasibility of land-based pearl culture in Hawaii. The black pearl potential is also being pursued in Mexico, Central America, Australia's Great Barrier Reef, India and the Seychelles, Tanzania, and the Sudan.

Virtually anywhere the pearl oysters are found has now become a potential pearl farm site. The breakthrough that will allow this expansion has been the refinement of hatchery culture techniques for the pearl oyster spat. There are hatcheries for the black-lip pearl oyster now operating in French Polynesia and in Okinawa. My company in Hawaii has also recently had successful settlement on a small scale with the Hawaiian variety of the black pearl oyster. These hatcheries now remove the main limitation to expansion of pearl farming. Pearl oyster spat will become increasingly available as the production increases and the hatchery technology spreads.

The same is also happening with South Seas pearl culture, using the silver-lip or gold-lip pearl oyster down in Australia and Southeast Asia. Hatcheries are springing up everywhere, in Darwin, Torres Strait, and the isolated islands of the Indonesian archipelago. Where previously pearl farms made do with quotas of 10,000 or 20,000 oysters each year, the hatcheries can now produce 100,000 or more, right there on site!

What will this mean for the future of the cultured pearl industry, and for the future of the Mississippi mussel industry? No one knows. At best, the pearl culture industry and its markets have been a mysterious black box. We can only speculate as to what will happen over the next 10 to 15 years.

Some pessimists fear a massive market slump, as more and more pearls pour onto the market, but then there are always such fears when you own a golden goose, and you see someone else with a goose as well. Others project that black pearls and South Sea pearls will see a significant price drop—let's say somewhere around 25%—but that this will then make black pearls affordable to a far broader market. Where many women have now had to settle for freshwater or Akoya pearls, they could then be able to wear a black pearl necklace, without having to win the lottery or rob a bank.

There are some obvious limits to the rate of growth of the industry. The principal one will be the availability of skilled technicians to seed the oysters. With the abundance of pearl oyster hatcheries, it is only a matter of time before increasing numbers of South Pacific local islanders become sufficiently skilled in the implantation operation. Already, some self-taught Cook Islanders are reportedly achieving a post-seeding retention rate of over 50%, which is considered very good. The number of Tahitian

technicians is also increasing with the establishment of a technicians' school on Rangiroa.

As well as the increase in production, hatchery technology also allows for selective breeding of pearl oysters—building them bigger, brighter, and faster growing. There have already been significant advances made in selective breeding techniques using the Japanese Akoya oyster. The potential for the larger oysters, the black-lip and the silver-lip, is immense. Hatchery-bred oysters may have better disease resistance or be more able to withstand the stresses of pearl nucleus implantation. They may deposit nacre faster, making more pearls, or making them faster. More importantly, the preferred pearl oyster shell shape might be selected for, to provide a deep-valved oyster capable of producing pearls of 25 mm diameter, or even greater.

What does all this mean for the Mississippi mussel industry, and for us sitting here tonight? What new opportunities does this present, and what responsibilities or pitfalls? Is it really, as I claim, an obligate symbiosis? For the nonbiologists in the audience, I probably should explain the term: obligate symbiosis means that two species need each other to be able to survive.

Certainly, South Pacific pearl culture needs mussel nuclei. There is simply no suitable alternative to the Mississippi mussel bead for pearl culture. For this very reason, pearl farmers down there have both an academic and a pecuniary interest in the status of these mussel resources. There is a pervasive fear among Pacific pearl folk that their industry's reliance on this single source of supply leaves them vulnerable. They are worried that their new-found prosperity could founder. They recognize that their long-term success somehow depends on our findings from the past few days.

But does the U.S. mussel industry also need South Pacific pearl culture? Let's be honest—these atolls could probably all sink beneath the Pacific and your mussel market would still be buoyant. But it is an opportunity for you. If the South Pacific's pearl culture potential wilts on the vine, because of its reliance on a failing Mississippi mussel industry, then, like all missed opportunities, it will be a real tragedy.

Let's look again at possible scenarios for the expansion of pearl culture across the Pacific. Not only are mussel beads needed, but they will be needed in ever-increasing quantities and larger sizes. The beads must also remain relatively inexpensive and freely available.

There is always talk of alternatives to the mussels; people often suggest giant clam shells (such as tridacnid clams), thermo-ceramics or other artificial aggregates. They have already looked at this question extensively, however, and nothing yet

has proved as good as your mussels. Anyway, if suitable alternatives *are* developed they will first appear in pearls of lower value—the Japanese, Chinese, and Indian white pearls, around 7–8 mm and smaller. The larger, more valuable black pearls and South Sea pearls will still demand the very best beads.

The Pacific islands will still need your beads, they will need them to be bigger, and they will need them in increasing numbers.

If beads become more expensive, there will be less incentive to train local seeding technicians. The spread of technicians' skills will be severely restricted, and their services will become more and more expensive. Farmers will not want to risk valuable nuclei in the hands of an inexperienced technician. Seeding skills will remain dominated by the Japanese experts, and the development of the industry across the Pacific could be constrained.

If mussel stocks dwindle, bead supplies will dry up, and they will become harder to obtain. It is easy to then see a situation in which the smaller local farmers, or those hoping to develop a farm, will be outbid by the established farms, or by those with the backing of foreign capital. Expansion will be stifled. The industry will remain a small clique, under the control of a powerful few. Local farmers will give up hope of establishing a local industry. They will resign themselves to seeing their sons and daughters leave the island and will go back to fishing or to copra, or will themselves leave.

These, then, are the repercussions of the conservation issues in your industry. We all depend on you and your resource. It is a wide and delicate web.

But . . . give the Pacific pearl culture industry a good, reliable supply of medium to large beads at a reasonable price and without any other marketing strings attached. Sell them yourselves, if you want. You have a ready-made demand, open opportunity for direct marketing, with great potential for adding value to your export product.

Give these few things to Pacific pearl culture, and watch the industry take off. Then sit back and watch the demand for your mussels boom with it. This is mutualism—a symbiosis where we both can benefit from exploiting an available niche. It is not parasitic, not predatory. Everyone benefits. It's not an obligation; it's simply a great opportunity.