

FROM SINGLE SOURCE TO GLOBAL FREE MARKET: THE TRANSFORMATION OF THE CULTURED PEARL INDUSTRY

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Over the past 15 years a combination of market forces, environmental events, and scientific research has radically changed the cultured pearl industry from a single commodity dominated by one producer to a highly diverse industry operating throughout the Pacific region. The new products, consistent quality, and broader marketing programs in turn led major designers and retailers in the United States and Europe to take a much greater interest in cultured pearls. During this period, consumer interest has expanded from the traditional small and medium white round Japanese akoya cultured pearl to the larger South Sea and Tahitian goods, as well as numerous previously “undesirable” shapes and colors.

Environmental and economic forces have transformed the cultured pearl industry (figure 1) since the early 1990s, when Japanese akoyas constituted more than 70% of global pearl production by value. (*Note: Because the recovery of natural pearls is now negligible, all uses of the term pearl in this report will refer to cultured pearls unless otherwise indicated.*) At that time, Japanese firms and individual farmers kept a tight hold on the grafting techniques they had pioneered decades earlier. Both black pearls from French Polynesia and South Sea pearls from Australia, Indonesia, and the Philippines were rising in popularity, but these were generally sold through long-established Japanese firms that purchased entire crops and marketed them worldwide. Freshwater pearl culturing in China was still in its infancy as far as higher-quality goods were concerned.

By the mid-1990s, infectious diseases had killed an estimated three-fourths of the oysters being operated in Japanese waters, while the best Chinese freshwater cultured pearls (FWCPs) began to rival the mid-range akoyas in quality. As the Japanese pearl producers struggled to recover, a severe economic

downturn hit other parts of Asia, pressuring Japanese banks to tighten the credit they had been giving local distributors to purchase large quantities of South Sea and black pearls. As a result, large pearl farms throughout the Pacific region broke out of their role as “contract” producers for the Japanese firms and began conducting auctions under their own auspices.

These larger producers also sought to differentiate their goods through marketing and branding initiatives, particularly for the top qualities. Eventually, new grafting techniques led to an entirely new array of products for a category that had been known for nearly a century for its sameness and simplicity—round and white. These new pearls included fancy colors such as pastel pinks, violets, “golds,” and browns, and featured previously less desirable shapes such as baroques and ringed goods (“circles”).

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Figure 1. Since the early 1990s, the pearl industry has seen dramatic change, as new types of pearls and new sources challenge the former domination of Japanese farms and dealers. The traditional 6–7 mm akoya product (bottom two rows) has been joined by new ones from French Polynesia (top two rows), China (third row), and the South Seas. Some of the newer producers and distributors are focusing on higher-end products, such as the diamond and Tahitian cultured pearl earrings shown here. Earrings courtesy of Mastoloni, New York; South Sea strand (9–12 mm) courtesy of The Collector Fine Jewelry, Fallbrook, Calif. Photo by Harold & Erica Van Pelt.

Yet these developments have not been without new challenges, as the greater number of pearl farms throughout the Pacific (figure 2) has led to overproduction and precipitous price fluctuations in some sectors of the market.

This article will chart how a combination of diversified production, economic and ecological events, and intensive branding and marketing efforts transformed the pearl industry. Once defined by a single basic product with a staid fashion image, it now embraces an array of colors and shapes that have captured the interest of contemporary jewelry designers and major retailers.

BACKGROUND

Japan Dominates 20th Century Pearl Culturing. The cultured pearl industry began in Japan in the first years of the 20th century, after Tatsuhei Mise and Tokichi Nishikawa developed the basic technique still used today for bead-nucleated pearls (a bead inserted into the gonad of the mollusk along with a piece of mantle tissue). Over the ensuing decades, their innovations were parlayed into a major commercial enterprise by pearl entrepreneur Kokichi Mikimoto (figure 3). Few of the early products resembled the round, lustrous gems associated with Japanese cultured pearls today; most were small and irregular or mabe (half) pearls. By the 1920s, howev-

er, round pearls 2–3 mm in diameter had become more common and helped fuel a worldwide fashion boom (figure 4). In addition, limited numbers of South Sea pearls were being cultured by Japanese firms operating primarily out of Indonesia and the Philippines.

In 1931, a total of 51 Japanese farms produced over one million pearls. During that decade, farmers began experimenting with collecting spat (embryonic oysters) and raising them in tanks so they would not have to rely on oysters collected from the wild. This change contributed to a major increase in production: Within seven years, 289 farms cultured 11 million pearls, nearly all for export (Muller, 1997b).

In the 1940s, World War II devastated the pearling industry along with the rest of the Japanese economy, with only one-third of the farms able to remain in business at even a subsistence level. During the post-war reconstruction, however, Mikimoto's internationally renowned brand helped the nation recover (Strack, 2006). Pearl production exploded through the 1950s, reaching 300 million shells in operation by 1962, with another 100 million added by 1966, when official production peaked at an all-time high of 39,522 *kan*, or 148.2 metric tons (tonnes). Some estimates placed this number much higher, in the neighborhood of 65,000 *kan*, or 243.8 tonnes, largely because of a 47-fold increase in



Figure 2. Originally confined to a few areas in Japan, cultured pearl production has now spread across the Pacific region. This map indicates the approximate areas where major pearl farming now takes place. The *Pinctada maxima* oyster produces white and golden pearls, and the *P. margaritifera* produces black pearls.

the number of pearl farms between 1951 and 1966 (Strack, 2006). (Most pearl production is still reported in traditional Japanese weight measures: 1 *kan* equals 1,000 *momme*; 1 *momme* equals 3.75 grams, or 0.13 oz.)

During the 1950s and '60s, Japanese companies established the basic sales and distribution procedures that most saltwater pearl producers use to this day: Farmers divide their goods by quality and sell them at competitive auctions conducted by one of the several producers' organizations (Muller, 1997). Back then, the buyers at these auctions were large Japanese wholesalers who sent the goods for processing (technically treatments—see Box A), which included tumbling to improve luster, bleach-

ing to remove some blemishes, and the coloring agent cosin to create the valued pink overtone (Muller, 1997; Strack, 2006).

As demand increased in the United States and elsewhere, Japanese exporters established close ties with pearl dealers in many regions (figure 5). These included Mastoloni, Honora, Albert Asher, and Imperial-Delta in the U.S., and Schoeffel and Golay Buchel in Europe, then the two major consumer markets. By the time sales peaked in the mid-1960s, the pearl industry had established deeply entrenched distribution channels (many of which remain in existence today), even through a severe decline in sales and production at the end of that decade (Muller, 1997b).



Figure 3. Japanese pioneer Kokichi Mikimoto revolutionized the pearl industry by launching its first internationally recognized brand. Mikimoto drew on the efforts of his son-in-law, zoologist Tokichi Nishikawa, and carpenter Tatsuhei Mise to develop the pink-to-white round akoya cultured pearls with which the Mikimoto name became synonymous. Photo © Horace Bristol/Corbis.

Because the pearl industry was so vital to Japan's post-war economy, Kokichi Mikimoto spearheaded an effort to keep pearl culturing technology and marketing in the hands of his countrymen (Strack, 2006). The result was the so-called Three Principles enacted by Japan's Administrator of the Fisheries Agency based on the Foreign Exchange Act. These principles were:

1. The technology of pearl culturing and manufacturing should not be given to foreign countries.
2. All pearls cultured in foreign farms should be exported to Japan, regardless of the country in which they were produced.
3. Any Japanese company that plans to culture pearls in foreign countries should submit to the Fisheries Agency their plans as to the oyster species, number of oysters to be operated,

and culturing areas. The culturing of akoya pearls in foreign countries is prohibited (S. Akamatsu, pers. comm., 2007).

These principles had a profound effect on pearl production worldwide. Although culturing operations would emerge in Australia, Indonesia, the Philippines, French Polynesia, and China, their production and especially distribution were largely controlled by Japanese firms (Muller, 1998). And there was no real challenge to Japanese supremacy until the mid-1990s, when economic and natural forces would combine to create a free market and diversified industry throughout the Pacific region. These forces would affect pearl production in much the same way that world events have diminished the once-dominant role of the De Beers Diamond Trading Company (Shor, 2005). As with the diamond industry, the trend toward globalization, free markets, and resource producers seizing greater

Figure 4. Aggressive marketing by Mikimoto helped return pearls to fashion in the 1920s. Famed silent film actress Louise Brooks is shown here wearing a dramatic pearl rope. Photo © Sunset Boulevard/Corbis.



BOX A: PEARL TREATMENTS

Like many gem materials, akoya cultured pearls have a long history of “accepted” treatments. In the early years of the 20th century, Japanese producers developed a number of processes to improve the appearance of their pearls before placing them on the market. None of these were disclosed, and they remain undisclosed to this day. In recent years, however, some of these processes have grown more sophisticated, blurring the boundary between an “acceptable process” and a “treatment”—as foreign substances are employed in some cases to improve or change color or add luster.

The first step in traditional akoya processing, called *maeshori*, involves immersing the pearls in a solvent, usually methyl alcohol, for cleaning. Originally performed before bleaching to make that process more effective, it is now used alone on virtually all cultured pearls to improve their luster (Akamatsu, 2007). In some cases, however, luster-enhancing coatings are applied. Typically, such coatings are considered a treatment.

The next step in the traditional process is bleaching (figure A-1), which removes dark organic compounds and creates a purer white. This usually involves immersing the cultured pearls in dilute hydrogen peroxide under low heat in controlled lighting conditions. After bleaching, some are treated with an additive to create the slightly pinkish overtone seen in many akoyas. In the 1920s and 1930s, the Japanese producers used cosin, a vegetable dye; today, they employ a variety of coloring agents (Strack, 2006).

The final step in traditional processing is tumbling, which improves luster. CIBJO does not require that the steps in the traditional process be disclosed (CIBJO, 2006).

However, dyeing and irradiation have been used for many years to alter pearl color (figure A-2). Typically, the bright, obvious colors that result from most dyes do not resemble anything found in nature. Yet some dyes can simulate attractive natural colors. One of the most common agents is silver nitrate, which has been used on both saltwater and freshwater cultured pearls to chemically darken the nacre and imitate naturally colored black pearls (Crowningshield, 1988) as well as fancy colors (Hurwit, 1998). This treatment is detectable by X-ray fluorescence analysis (Komatsu and Akamatsu, 1978). Irradiation of both freshwater and saltwater cultured pearls is also used to simulate black pearls and, in some cases, enhance the appearance of orient (Crowningshield, 1988; Li, 2001).

In the late 1990s, increasing amounts of dyed “golden” South Sea pearls began appearing in the market, which also caused alarm within the trade (“Treatments cause concern in industry,” 1997; Strack, 2006). Some companies used heat treatment to create this color. Still other such pearls were found to be both heat treated



Figure A-1. Virtually all akoya cultured pearls are bleached to improve whiteness. The process involves immersion in a heated hydrogen peroxide solution combined with fluorescent illumination. Photo by Niels Ruddy Hansen.

and dyed (Elen 2001, 2002). Most recently, bleaching of some black Tahitian cultured pearls is believed to create fancy colors, such as the popular “chocolate pearls” currently in the marketplace (Wang et al., 2006), though dyed pearls of that color are in the market as well.

As with all gem treatments, some methods of enhancing poor-quality material to improve appearance and increase value remain a challenge for identification and disclosure.

Figure A-2. Large quantities of inexpensive freshwater cultured pearls are dyed to achieve different appearances and sometimes unnatural colors, such as the broad spectrum of products shown here at a trade show. Photo by Robert Weldon.



control over distribution proved the catalyst to unraveling a century-old system.

The Mid-1990s: A Turning Point for Japan. Into the 1990s, Japanese-produced akoya cultured pearls (from the *Pinctada martensii* oyster) remained the industry mainstay. In 1993, for example, the total production value of Japanese akoyas was estimated at \$600 million, while the white South Sea goods totaled \$120 million and French Polynesian black cultured pearls totaled \$75 million (Muller, 1998).

Consumer demand for pearls had revived from a lull in the United States and Europe during the 1980s, and was further stimulated by growing Asian economies. While prices for akoyas rose strongly as a result, production from Japanese farms was actually declining: By 1993, it had fallen to about 35% of 1962 levels. To accommodate demand, some producers began rushing their goods to market in as little as six months after implantation. Although Japanese akoyas had historically been cultivated to a nacre thickness of 1 mm on average, complaints of nacre peeling from pearls with coatings less than 0.2 mm thick began to surface, largely in Japan (Shor, 1994a). The Japanese government's Pearl Inspection Office did not permit export of akoyas with such thin nacre, but there were no corresponding restrictions on domestic sales.

Also in the mid-1990s, with prices reaching record highs, Japanese pearl farmers began facing their first significant competition in lower price ranges—from Chinese freshwater cultured pearls. Once predominantly small and irregularly shaped, these were now being produced as semi-rounds in sizes similar to those of medium akoyas (6–7 mm). Japanese farmers were also facing increasing land and labor costs, as well as stronger pollution-control measures. At the same time, a fluctuating yen caused prices of better-quality pearls to increase fourfold for U.S. consumers—their primary market—in less than a decade.

To deal with these challenges, many Japanese producers and distributors decided to focus on the higher-quality market (figure 6) by increasing minimum nacre thickness and concentrating on pearls larger than 7 mm, which prior to 1990 had constituted only 5% of Japanese goods. Consequently, by the early 1990s, 8–9 mm akoyas accounted for about 25–30% of Japan's total production (Shor, 1994a; Strack, 2006).

Soon, however, Japanese domination of the cultured pearl industry would be assaulted by three

forces: cataclysmic natural events, the Asian financial crisis, and the growing independence of non-Japanese producers.

Natural Forces. In November 1994, pearl dealers and producers assembled in Kobe, Japan, where many of the large Japanese pearling companies are headquartered. The primary aim of this convention was to establish a fund to support global advertising and marketing for pearls and pearl jewelry. Tragically, less than two months later, while participants still mulled over the proposal, a large earthquake (7.3 on the Richter scale) destroyed much of the city and killed more than 6,400 people. Although the earthquake did not affect the pearl farms, it did cause delays in the *ham-age* (unprocessed akoya pearl) auctions ("Kobe earthquake," 1995).

Figure 5. Collaboration between Japanese producers and pearl dealers in the U.S. and Europe helped make akoya cultured pearl necklaces and earrings a classic jewelry staple by the middle of the 20th century. Photo courtesy of Mikimoto & Co.





Figure 6. Faced with challenges from Chinese and other producers, many Japanese akoya farmers reoriented their businesses to concentrate on the higher end of the market. These 7 mm akoya cultured pearls have a tsavorite and diamond clasp designed by Ilka Bahn. Courtesy of The Collector Fine Jewelry; photo by Harold © Erica Van Pelt.

In addition, unusually warm ocean temperatures, which can affect luster, and attempts to increase production by operating too many shells in areas too small to properly nurture them (Muller, 1997a) resulted in a poor 1995 harvest. While the Japanese industry spoke of recovery (“Earthquake, strong yen slow sales,” 1995), further disasters awaited—events from which the industry has not yet recovered.

In the summer of 1996, a sudden and mysterious malady began killing pearl oysters in farms near Shikoku, a small island off southern Honshu. Within a few weeks, mortality was running at one million mollusks per day. By fall, the illness had spread to the primary pearling area of Mie, eventually killing two-thirds of the 300 million shells in operation there. No one in the Japanese pearl industry or government could agree on a concrete reason for the mass deaths. Some blamed ocean pollution caused by other industries, or weather conditions that diminished the pearl oysters’ chief food source, plankton. “Red tides”—massive invasions of plankton that smothered the mollusks by depleting oxygen levels in the water—were cited in some circles. Still others speculated that overreliance on hatchery-bred oysters had left crops less resistant to disease and pollution. However, nearly everyone noted that the high cultivation density was the catalyst for the widespread devastation (Federman, 1997; Strack, 2006). By 2001, production from Japanese farms had fallen to \$120 million (Strack, 2006), a

mere 20% of 1993 levels. Ultimately, the National Research Institute of Aquaculture in Japan concluded that the massive mortality of the akoya oyster was caused by an infectious disease (S. Akamatsu, pers. comm., 2007).

By the early 2000s, the mortality rate had decreased to a (still high) 20–30% and production appeared to have stabilized, partly because a significant percentage of the cultured pearls represented as “Japanese” were actually imported from South Korea and China, primarily Hainan Island (R. Torrey, pers. comm., 2007). Japanese production, or akoya cultured pearls from the *P. martensii* mollusk that are marketed as Japanese, has stabilized at a level of about 25 tonnes, a far cry from the almost 150 tonnes reported for 1966.

A Financial Crisis. With the collapse of Japan’s 1980s “bubble” economy beginning in 1990, most of the country’s large banks had to cope with billions of dollars in nonperforming loans. This caused the nation’s economy to stagnate, although the national government averted a full-blown depression by subsidizing some of the banks’ losses. The rest of Asia continued to boom through the 1990s, allowing many Japanese banks to reap returns from outside the country’s borders. Then, in 1997, the Asian boom ended abruptly after several very large corporations in Indonesia and Thailand defaulted on loans, touching off runs on those nations’ stock markets. Within three months, the currencies of

Thailand, Indonesia, South Korea, and several other nations collapsed, leaving many Japanese banks—which had financed major infrastructure projects in those countries—caught in the middle. The banks had no choice but to cut their credit facilities to many Japanese industries, including pearl producers and distributors (N. Paspaley, pers. comm., 2007). As a result, producers outside the country lost some of their biggest customers—who no longer had the financial resources to buy up entire harvests—and were forced to develop their own distribution channels.

Emerging Producers. All of these developments meant that by the end of the 1990s the Japanese distributors, though still significant buyers, no longer held direct control over a large majority of the world's pearl production (R. Torrey, pers. comm., 2007). The once-dominant akoya pearl was now sharing the market with competitors, as the late 1990s also saw increased production of other types of pearls. Today, the main types of cultured pearls on the market, besides akoyas and akoya-like goods, are:

- South Sea cultured pearls from the *Pinctada maxima*, a large saltwater oyster primarily found and cultivated in Australia, Indonesia, the Philippines, and Myanmar (Burma). These cultured pearls range from silvery white (predominantly Australia and Myanmar) to creamy white (Indonesia and the Philippines). Typically, they are much larger (routinely over 10 mm in diameter) and significantly more costly than akoyas.
- “Black” cultured pearls from the *Pinctada margaritifera*, an oyster primarily cultivated in the waters around French Polynesia. While the most costly appear black with high iridescence, they actually vary greatly in color, shape, and size, and thus have a wide price range.
- Freshwater cultured pearls, primarily from *Hyriopsis cumingii* mussels native to China. These generally are much less expensive than the other types, because the pearling operations in China are so prolific. The vast majority of FWCPs are white or off-white, though recently some farms have cultivated fancy colors and many are dyed or irradiated. Unlike producers elsewhere, most of the Chinese cultivators do not implant the mollusks with

beads, but only with pieces of mantle tissue, which yield primarily baroque pearls—and occasionally rounds.

Most recently, “golden” pearls from the gold-lipped *P. maxima* are being cultivated in the Philippines, with some coming from Australia, Indonesia, and Myanmar. Like the South Sea goods, these are sold in the luxury market.

SOUTH SEA WHITE CULTURED PEARLS

For the purposes of this article, all pearls cultivated in the *P. maxima* oyster are referred to as *South Sea pearls*. There are two major types of *P. maxima*: the white lipped, found mainly around Australia, Myanmar, and parts of Indonesia; and the gold lipped, found farther north, primarily around the Philippines, though some also occur around Indonesia.

By some accounts, pearl culturing in Australia predates culturing in Japan. An Australian, Queensland fisheries commissioner William Saville Kent, has been credited with culturing mabe and even spherical pearls as early as 1890, but he did not document his techniques before his death in 1906, and there are no records of his farm after a 1910 *Journal of Science* reference to the purchaser succeeding “in growing spherical pearls using techniques bought with the farm” (O’Sullivan, 1998).

What is known is that, in 1917, shortly after Mikimoto started mass production of cultured akoyas with the Mise-Nishikawa method, the Mitsubishi company of Japan established a *P. maxima* pearl farm in the Philippines. Others followed, and several survived until the outbreak of World War II. Although these farms were abandoned during hostilities, the decade following the end of the war brought a revival of *P. maxima* pearl culturing activity.

Australia. Pearling in this region dates back more than 400 years, when aboriginal populations harvested *P. maxima* shells and natural pearls, which were sold to Indian traders and ultimately ended up in Persia (present-day Iran). After the Europeans arrived in Australia, pearling fleets went to the western and northwestern coasts to harvest the shells for mother-of-pearl, then an important material for creating decorative objects, buttons, and inlay. The natural pearls themselves were a serendipitous by-product. The fleets were also active around Indonesia, the Philippines, and Burma (now Myanmar).

In 1954, a joint pearl culturing venture between Tokuichi Kuribayashi (founder of Pearl Shell Fishing Co., which harvested *P. maxima* shells along Australia's coast in pre-war years) and Alan Gerdau of the Otto Gerdau Co. (an Australian-owned firm in New York) began operation in what is now Kuri (after Kuribayashi) Bay in Western Australia. Called Pearls Pty., it was headquartered in Broome, some 386 km (240 miles) south of Kuri Bay. Kuribayashi also established a Tokyo branch called Nippo Pearl Co. (Muller, 1997b).

The technical team at Kuri Bay was led by Junichi Hamaguchi, who perfected a method of creating substantially bigger pearls by inserting a larger nucleus into the oyster without rejection. This enabled the Kuri Bay pearls to be harvested after

only 18 months of cultivation (N. Paspaley, pers. comm., 2007). As a result, Kuri Bay became very profitable, and Nippo Pearl Co. dominated production and supply of South Sea pearls until the mid-1980s.

A number of other pearl farms followed soon afterward in Western Australia, where oysters were more plentiful; among the operators were Paspaley, Broome Pearls, Arrow Pearls, and Roebuck Deep Pearls. Through most of the 1960s, Australian producers sold their entire output in bulk lots to Japanese wholesalers (N. Paspaley, pers. comm., 2007).

The first highly publicized "branding" opportunity for the Australian product came in 1964, when Van Cleef & Arpels sold the Duchess of Windsor a necklace featuring 29 Australian cultured pearls, graduated in size from 11 to 15 mm (Sotheby's, 1987; figure 7). Twenty-three years later, the necklace brought \$198,000 at the Sotheby's auction of her jewels (Strack, 2006).

During the early years of Australia's industry, Japanese grafters, many of whom worked for or owned pearling firms, traveled there to implant the nuclei into the local mollusks (figure 8), as they did in other pearl-producing countries. They usually brought their own nuclei, made from the Mississippi River freshwater mussel. For their work, the technicians received a portion of the resulting crop. In accordance with Japanese code (discussed above) that forbade the transfer of pearling techniques to non-Japanese—and their desire to protect their own livelihoods—the technicians refused to train Australians (Strack, 2006).

In the 1970s, a number of Australian farms experienced severe problems with mollusk mortality and declining pearl quality. Although the situation had stabilized by the end of the decade, mortality rates remained very high—60% to 70% through the 1980s—primarily due to neglect during the implantation operations and outmoded grafting and harvesting practices. In 1984, for example, the entire harvest from all producers totaled only 40 *kan*, or 150 kg (Strack, 2006).

A 1988 study of the pearling industry by the Western Australian government, which noted the problems with overharvesting (Shor, 1995b), resulted in a licensing system that imposed limits on the number of firms permitted to collect wild oysters and quotas on the numbers of mollusks that could be collected and operated. As part of this 1990 industry regulation package, the Western Australian government issued permits to 16 firms that limited

Figure 7. The Duchess of Windsor, who was known for her stylish jewelry, helped establish South Sea cultured pearls as a fashion item when she purchased the necklace shown here (center strand) in this photo with the Duke of Windsor that was taken in the 1960s. Photo by Maurice Tabard, Camera Press Ltd., London.



their catch quotas and—to prevent rapid spread of disease and blight—restricted the number of oysters operated from hatchery stocks. The legal limit was 570,000 for wild oysters under operation, plus an additional 320,000 from hatcheries, with the result that some 700,000–770,000 shells were in operation at any particular time (Tisdell and Poirine, 2000), or approximately one-thousandth the estimated number of akoya oysters that were under cultivation in Japan in 1988. Another reason for favoring wild oysters is that they tend to produce the extremes in quality, while pearls cultured from hatchery oysters tend to be more uniformly medium quality (N. Paspaley, pers. comm., 2007).

In cooperation with Hamaguchi, Paspaley's farms had introduced new pearl culture technologies during the 1970s and '80s, including techniques that allowed the use of young pearl oysters and the insertion of a second nucleus into a pearl sac produced by harvesting of the first pearl. Although initially there were some problems with these second insertions in terms of oyster mortality and the quality of the pearls, these were overcome by making the incision to extract the first pearl in a different area of the mollusk, and changing the mantle tissue used in the second grafting (N. Paspaley, pers. comm., 2007). With current methods, the initial grafting yields pearls averaging 11–12 mm and has a success rate (with the oyster surviving to yield a commercially viable pearl) generally over 90%, comparable to akoya. For the second grafting, a shell bead the size of the just-extracted pearl is inserted, yielding a pearl that ranges from 14 to 16 mm. However, the yield is lower, 65% on average, and the quality of color and luster is not always as high as the first pearl. Some oysters are operated a third time to yield 17–20 mm pearls, but the quality and success rate are often lower still (Strack, 2006).

By 1989, Australian production had climbed to 140 *kan* and was poised for a sharp increase. In October of that same year, Paspaley purchased Pearls Pty. and its Australian parent, the Otto Gerdau Co., to become the dominant producer in Australia. That same month, Paspaley conducted the first auction of South Sea pearls outside Japan. The sale of 24 *kan* at the Darwin, Australia, event brought \$35 million, with prices for the top qualities surpassing their estimates by 40–100%. For the first time, Japanese buyers faced major competition from firms in other countries, including Hong Kong and the United States (Torrey, 2005; Strack, 2006).



Figure 8. The skill of Japanese technicians was instrumental in establishing the South Sea cultured pearl industry in Australia. Here, the technician is preparing to implant a bead in the oyster. Photo by R. Shor.

Extreme top qualities of South Sea pearls over 15 mm are estimated to be a tiny minority of production (figure 9), which accounts for their value. Round and nearly round pearls below 15 mm account for about 20% of Australian production, less in Indonesia and the Philippines. Symmetrical shapes (primarily drops) account for about 50% of Australian production, 20% in Indonesia and the Philippines. Baroque shapes account for about 30% of Australian production and as much as 70% of Indonesian and Philippine production (Strack, 2006; Branellac, 2007).

In the 1980s, the Australian government had expanded the number of pearling licenses, which attracted a number of new operations—including Clipper Pearls and Blue Seas Pearling. Following the slump in demand from Japanese buyers after the Asian financial crisis in the late 1990s, most of these new Australian pearl farms (which accounted for 20% of the country's production) decided to



Figure 9. Large, top-quality South Sea cultured pearls such as these are very rare. Courtesy of Paspaley.

market their pearls through Australian wholesale agents (N. Paspaley, pers. comm., 2007). Since the mid-1990s, Australian production has increased in measured steps; by 2005, total output had reached 850 *kan* (3.19 tonnes), six times the amount recorded for 1989 (Muller, 2005).

Indonesia. Although Japanese firms started culturing pearls in Indonesia during the 1920s, it was not until the early 1970s that an industry took shape—again with Japanese involvement. During the 1980s, a number of Japanese and Australian companies began operations in the island nation with *P. maxima* oysters. Indonesia's pearling operations are located on small islands throughout the archipelago. In 2006, there were 107 documented farms; Japanese and Australian companies operated nearly half of them; the remainder were locally owned, the most dominant being Concorde Pearls (Sertori, 2006; N. Paspaley, pers. comm., 2007). Yet there were, and still are today, many undocumented farms, some encroaching on areas claimed by established operations (Sertori, 2006). Since the government's ban on harvesting wild *P. maximas* in 1997, all pearls are cultured from hatchery-bred oysters. These pearls tend to be more uniform in quality and smaller in size—8–12 mm on average, though they can be as large as 16 mm. In addition, the colors tend to be warmer than the Australian goods, at their best showing tints of yellow, pink, and "gold" (Muller, 1999).

Indonesia's pearl production has fluctuated dramatically over the past 15 years. Violent storms and a catastrophic earthquake in December 1992 devastated much of the oyster population (Muller, 2005), causing production to fall from an estimated 600 *kan* in 1991 to 300 *kan* in 1994. It continued to slide over the next four years to 200–250 *kan*. By 2000 output had rebounded to 600 *kan*, but an earthquake again brought disaster and the following year's crop amounted to about 400 *kan*. Some observers believed the earthquakes altered the nutrients in the water, while others maintained that El Niño cycles changed the water temperature around the islands. Still others blamed the overpopulation of prime pearling areas (Muller, 2005), since Indonesia—unlike Australia—does not impose limits on the number of shells in operation or the number of farms in any specific area.

By 2005, however, output had jumped to 1,022 *kan* (3.83 tonnes) worth \$85 million (Muller, 2005; Strack, 2006), with qualities from established farms rivaling the best Australian goods. While substantially higher by weight than Australia's production of 850 *kan*, this was still well below Australia in value (\$123 million). Most of Indonesia's output is marketed generically by dealers from Australia, Europe, Hong Kong, and Japan.

Serious challenges remain, however. Theft has become a significant problem, as most of the farms are located in remote areas with no law enforcement and are difficult to guard effectively. In addition, most of the illicit pearls are stolen before the culturing process is complete, then sold as Indonesian goods, which gives buyers a poor impression of Indonesian pearls (Sertori, 2006).

Myanmar. Burma was once known as the source for the best South Sea cultured pearls because of their large size (17+ mm), subtle color, and high luster (figure 10). That was before neglect, disease, and government seizures all but halted production by the end of the 1980s.

During the 1950s, a Japanese firm, the South Seas Pearl Co., began a joint venture to produce Burmese pearls. With the expulsion of Japanese businesses following a military coup in 1962, the Burmese government assumed control of the industry and employed local Australian and Japanese technicians to keep the farms running. The first commercial harvest under the new regime, in 1969, yielded 3,485 cultured pearls weighing just over 1.92 *kan* (7.20 kg). During the 1970s and '80s, the

country continued to produce relatively small quantities of pearls, but of extraordinary quality. Production peaked in 1983 at just over 17 *kan* (63.75 kg; Myanmar Pearl Enterprise, 2003). All the pearls were sold at government-sponsored auctions in the capital Rangoon (now Yangon).

Explanations for the exceptional quality of these Burmese cultured pearls vary. The most common is that very small nuclei were used to prevent nucleus rejection, and the beads were left in the oyster for four years. Hence, the resulting pearls had very thick pearl nacre and closely resembled natural South Sea pearls.

The industry suffered, however, after another military coup in 1988 (as a result of which the country was renamed Myanmar in 1989) and a failed 1990 attempt to restore democracy brought waves of social and economic upheaval. The pearl farms fell into neglect, and the mollusks suffered from bacterial infection. By the early 1990s, production was negligible.

Later that decade, however, the Japanese firm S. Tasaki Shinju and an Australian joint venture with the government, Myanmar Atlantic Ltd., established new operations. These and other enterprises have since revived production to some degree, but the newer Burmese cultured pearls have not achieved the extraordinary quality of the earlier goods (Strack, 2006). Myanmar's production totaled 179 *kan* in 2005, 102 *kan* of which was produced by the S. Tasaki Shinju operations ("Myanmar expected to produce 220 *kan* in 2006," 2006).

Philippines. Like other Pacific locales, the Philippine pearl industry has its roots in the *P. maxima* mother-of-pearl fishing industry that flourished during the 19th century. Attempts to establish operations date back to 1914, but pearl culturing in the Philippines did not begin in earnest until the South Seas Pearl Co. became involved there in 1962. Several non-Japanese companies launched operations in the nation's southern islands during the late 1970s, and by 1994 the Philippines' 120 *kan* production ranked third behind Australia and Indonesia, with 20 large and medium-sized farms (Strack, 2006). Unlike Australia, where most of the culturing is done with wild oysters, the vast majority of Philippine pearls are cultured from hatchery stock (Torrey, 2005).

In 2005, there were 37 farms that produced an estimated 450 *kan*, valued at \$25 million. Although Philippine farms produce many fine-quality goods,



Figure 10. Although their total production has never been great, Burmese South Sea cultured pearls are renowned for their size, luster, and color. The loose pearl is approximately 16.5 mm in diameter. Courtesy of The Collector Fine Jewelry; photo by Harold © Erica Van Pelt.

the average per-*momme* value of Philippine production (\$55) that year was about one-third that of Australia's producers (Muller, 2005). It is important to reiterate, however, that the *P. maxima* found in Philippine waters, mainly around the southern islands, has a gold-lipped shell, as opposed to the white or silvery lip of the Australian or Indonesian variety, which imparts a warmer, creamy character to the resulting white pearl. However, at least one major farmer used the gold-lipped *P. maxima* to consistently produced bright "golden" pearls, which will be discussed below.

BLACK PEARLS

Natural black pearls from the black-lipped *P. margaritifera* oyster were part of Polynesian culture and legend long before European explorers first arrived in the 16th century (see, e.g., Goebel and Dirlam, 1989). After the Marquesas Islands became a French protectorate in 1842, a mother-of-pearl fishing industry flourished under the colonial government through the rest of the 19th century. Natural pearls were a valued by-product of this industry, though it was estimated that only one oyster in 15,000 would yield a pearl of any size (Tisdell and Poirine, 2000). The only other major source of black pearls was several

thousand miles across the Pacific—along Mexico's Baja California peninsula around La Paz (Goebel and Dirlam, 1989), where the Spanish commenced pearl fishing from the *Pteria sterna* oyster in the 16th century (Cariño and Monteforte, 1995).

In 1961, the Fisheries Service of the French Polynesian government began a trial culturing project in conjunction with two Japanese firms: Nippo Pearl Co., which had provided technical assistance to Australia's early producers, and Tayio Gyogo Ltd., which also operated in Australia. That pilot project on Bora Bora, approximately 240 km (150 miles) northeast of Papeete, the French Polynesian capital on the island of Tahiti, produced a number of good-quality black pearls, but there was no commercial follow-up (Tisdell and Poirine, 2000).

In the early years of culturing with *P. margaritifera*, the public's lack of familiarity with black pearls led to rumors that they were dyed. In addition, there was widespread belief that colors other than white were simply not marketable (Tisdell and Poirine, 2000; Strack, 2006). One pearl farmer, Jean Claude Brouillet, carried an array of black pearls to top jewelers in London, Paris, New York, and Tokyo in the early 1970s, and later described how the president of Cartier in Paris "used them as playthings" during their meeting (Tisdell and Poirine, 2000).

A turning point came after Robert Crowningshield (1970) reported on his examination of a black cultured pearl in *Gems & Gemology*, finding the color to be natural. GIA's decision in the mid-'70s to offer identification reports stating the origin of color gave these pearls much-needed credibility (Moses and Shigley, 2003).

The French Polynesian government, seeing potential employment for people on the outlying islands, aggressively encouraged the development of new pearl farms. Two entrepreneurs stepped in: Robert Wan, a French Polynesian resident of Chinese descent; and Salvador Assael, a New York importer born in Italy. Wan purchased and enlarged Tahiti Perles, an operation begun by Australian William Reed, while Assael worked with Brouillet to expand his concern by building infrastructure and hiring expert Japanese technicians. By 1976, the Wan farm was on its way to becoming one of French Polynesia's largest producers (figure 11), acquiring Brouillet's farm nine years later.

Assael began marketing his pearls in the U.S. in 1973 and soon became one of the largest distributors for a number of producers, including Wan. This

marked the first measurable success of a producer and distributor of any type of pearl who had no Japanese affiliation (Goebel and Dirlam, 1989).

Then, in 1979, the smaller farms grouped together in a cooperative called Groupement d'Intérêt Economique (GIE) Poe Rava Nui, under an initiative by the government's Fisheries Service (Luke, 2005). The GIE provided economic support for small pearl farmers and organized a central auction of its members' harvests in Papeete that continues to the present day (Strack, 2006).

All this progress came at a price, however. The market's growing acceptance of black cultured pearls and the high prices realized for top-quality goods, coupled with government incentives to develop the industry, launched a "pearl rush" that saw hundreds of new farms start up during the early 1980s. The overexploitation of the waters around certain atolls caused massive mortality—an estimated 50% of the seven million oysters under operation in 1985–1986. Inspectors found no specific bacteria or disease and concluded that overpopulation and slow currents were responsible. In those two years, there were 69 cooperative units and 20 larger private farms located across 18 islands—and this was only a fraction of what would come in the 1990s (Tisdell and Poirine, 2000).

As Australian and French Polynesian pearl production increased to sustainable levels, the next step would be to establish these goods in the marketplace.

BREAKING AWAY—FROM JAPAN AND "GRANDMOTHER"

With other transitions in the 1990s, South Sea and French Polynesian pearl producers accelerated their efforts to cultivate and market their goods independently of the Japanese. They also worked to dispel the conservative fashion image of pearls.

By the middle of the decade, these producers were selling nearly all of their pearls worldwide through competitive auctions held in Hong Kong and Kobe, in a variety of currencies. Unlike akoya auctions, where the only significant buyers were Japanese, buyers at these auctions came from every corner of the globe (Shor, 1995b; M. Coeroli, pers. comm., 2007). Now that they had largely separated themselves from the distribution channels for akoyas, the next step for South Sea and French Polynesian pearl farmers was to establish unique brands for their products.

Global advertising was a central issue at another



Figure 11. After overcoming a variety of economic and technical challenges, pearl farms in French Polynesia were producing commercial quantities of black pearls by the late 1970s. Shown here is a pearl boat working a Robert Wan farm on the island of Marutea Sud, approximately 1,850 km (1,000 nautical miles) east of Tahiti. The workers are cleaning marine life from the oysters prior to returning them to the water for further growth. Photo by Amanda Luke.

landmark pearling convention in 1994. Although this Honolulu conference, “Pearls 94,” was boycotted by Japanese producers, dealers, and researchers, it was truly an international gathering, with 645 participants from 38 countries (Strack, 2006), and provided a unique opportunity for the exchange of technical and market information.

The main proposal to emerge from Honolulu was a \$2 million program to educate consumers about the different types of pearls and stimulate demand to offset the increased yield anticipated from China (discussed below) and other producers (Shor, 1994b). It would have been funded by a “tax” from each producer on the value of their exports.

While that proposal was never adopted, producer organizations embraced the need to inform consumers, and many soon developed educational and promotional efforts of their own. Specifically, in 1995 Australian producers established the South Sea Pearl Consortium to promote their product as a luxury pearl cultured in Australian waters. At the same time, French Polynesian producers, with government support, began marketing programs through their own organization, Perles de Tahiti, to heighten awareness of black pearls. Implicit in the messages of both organizations was the fact that their products were distinct from the Japanese akoya: the Australians’ by size and limited production, the Tahitians’ by color.

South Sea Pearl Consortium. This group began as an alliance of Australian producers (Paspaley and Broome Pearls) and international wholesalers (Nippo Pearl Co. and Hamaguchi Pearling Co. of Japan, Cogent Trading of Hong Kong, and Assael International of the United States). Seeded with an initial contribution of \$2 million from its members, the consortium began a consumer advertising campaign that stressed the luxury aspects (large size and top color) of South Sea pearls. Later in 1995, the members of the Pearl Producers Association of Western Australia joined the consortium and agreed to fund its ongoing promotions with a contribution of 1% of all proceeds from their pearl auctions (Shor, 1995a). The consortium, which opened membership to Indonesian and Burmese pearling firms after 2000, also worked to improve grafting techniques and to safeguard quality by prohibiting its members from treating their pearls (Strack, 2006).

Perles de Tahiti. Unlike the early Australian pearling industry, producers in French Polynesia for the most part did not operate under direct Japanese ownership, though they relied on Japanese expertise for grafting and maintenance of the oysters. For a time, French Polynesia sold the vast majority of its production to Japanese distributors. Once again, however, independence had a price, which was to be paid in the 1990s.

The French Polynesian government, anxious to increase employment and gain critical foreign trade, had maintained a very liberal policy toward granting pearl farming licenses. As a result, the number of farms—most of them small and undercapitalized—multiplied tenfold, from 69 in 1986 to more than 700 in 1994. However, many of these did not employ skilled technicians or follow the culturing process long enough—some less than 18 months (Tisdell and Poirine, 2000)—to produce a good-quality pearl (e.g., figure 12). Thus, production climbed dramatically from 575 kg (153.3 *kan*) in 1990 to 11,364 kg (3,030.4 *kan*) in 2000, while the average price per gram declined from \$42 to \$13.65 over the same period and continued sliding to a low of \$9.58 in 2003 (Coeroli and Galenon, 2006).

In the mid-1990s, however, Perles de Tahiti launched a campaign to promote “black” pearls as a product distinct from Japanese or South Sea pearls. The initial budget of US\$650,000, financed by a 2.5% “tax” levied on producers, went toward cooperative advertising with luxury retailers in the United States, France, Italy, and Japan. As part of the branding process, Perles de Tahiti named their product “Tahitian” cultured pearls, despite the fact they were cultivated on islands throughout the French Polynesian archipelago (again, see figure 2). Around the world, the name *Tahiti* conjured up favorable images of a pleasant, exotic locale (M. Coeroli, pers. comm., 2007).

A key step in establishing the Perles de Tahiti brand was to impose quality standards. In 1999, the

government introduced a minimum quality standard for exports: a nacre layer at least 0.6 mm thick (to take effect September 1, 2001), to be increased to 0.8 mm (effective July 1, 2002). At least 80% of the shell bead nucleus had to be covered and heavy blemishes could affect no more than 20% of the surface (M. Coeroli, pers. comm., 2007). Roundness and color were not addressed. The government also restricted the number of producers through a licensing system that limited the number of operations in a particular area, as well as the number of shells that could be operated (Tisdell and Poirine, 2000).

Results were slow to come, however, since there was considerable excess inventory, and initially the government did not have sufficient resources for comprehensive inspection. Not until 2004 did the French Polynesian government fully enforce the quality control measures it had enacted in 1999. Production declined to just over 8,000 kg (2,133 *kan*) that year, and it has remained fairly stable since then, while the average price began to increase substantially (M. Coeroli, pers. comm., 2007). At least 35% of the pearls produced during this period were not cleared for export (Strack, 2006).

The second step in the Perles de Tahiti marketing plan was to work with jewelry designers and manufacturers to create fashion-forward products that would update the image of cultured pearls (e.g., figure 13). The global jewelry design competition it launched in 1999 represented a sharp break from previous pearl marketing efforts, which concentrated on strands because they made the most extensive use of the product. By 2006, the annual contest was attracting 6,000 entries from 39 countries (Coeroli and Galenon, 2006). Perles de Tahiti also believed that showing celebrities wearing fashionable pearl pieces would dispel the “grandmotherly” image of pearls. In 2007, Perles de Tahiti budgeted \$6.4 million for marketing: \$2 million in the United States, \$2 million in Japan, and the remainder divided between Europe and emerging markets such as Brazil, India, China, and the Middle East.

The efforts of producers to market their goods independently of Japan, coupled with the disasters besetting the Japanese pearl farms, showed tellingly in U.S. pearl imports. In 1996, Japan was the source of 62% of all pearls imported into the United States. By 1999, that portion had fallen to 45%, and by 2001 it had dropped to 35%. Over the same period, direct imports from Australia increased from 12% to 20% and imports from French Polynesia rose from 5% to 9%.

Figure 12. Overproduction and lax controls caused a flood of poor-quality black cultured pearls on the market in the 1990s, hurting prices and forcing the government to impose quotas and quality standards. Photo by Robert Weldon.



CHINESE CULTURED PEARLS

Freshwater. During the first century of pearl culturing, nearly all of the product came from saltwater mollusks. In the 1930s, freshwater cultured pearls became a relatively small segment, consisting primarily of small, irregularly shaped Japanese goods from Lake Biwa near Kyoto and Lake Kasumigaura near Tokyo (Strack, 2006). In the early 1990s, however, round and semi-round freshwater cultured pearls from Chinese producers emerged as a low-cost alternative to akoyas and, by the end of the decade, to South Sea pearls. One important distinction was that unlike the saltwater products, which were grown with a bead and a piece of mantle tissue, Chinese FWCPs were grown using only mantle-tissue implants, with no beads. Another was that dozens of pearls could be cultured in a single freshwater mussel—as opposed to typically one or two pearls per oyster for saltwater pearls.

Chinese FWCP production began in the early 1960s under the auspices of Shanghai University and the Fisheries Institute of Zhanjiang, in Guangdong Province. Typically these pearls, which were cultured using the *Cristaria plicata* mussel, were small, irregularly shaped goods (commonly referred to in the trade as “rice krispies,” because of their resemblance to the breakfast cereal; figure 14). At first, Japanese dealers purchased the entire production, mixing them into Biwa goods and marketing them as such, even as output soared from an estimated 155 *kan* (581.3 kg) in 1974 to 3,109 *kan* (11,659 kg) in 1979 (Strack, 2006).

However, Chinese production continued to skyrocket, reaching approximately 80 tonnes during the mid-1980s, a level the Japanese dealers could no longer absorb. The unfettered flow of pearls sent prices plummeting, particularly as millions deemed unsuitable for fine jewelry use were dyed various colors and fashioned into costume jewelry (Akamatsu et al., 2001). Still, these “rice krispie” pearls were a vastly different product from the traditional akoya spheres that had been the mainstay of the pearl industry, so the oversupply from China had little effect on the traditional market. That would soon change.

A number of farms (e.g., figure 15), now financed by large Hong Kong traders and several major Japanese producers, began to experiment with the *Hyriopsis cumingii* (triangle) mussel, which could produce a semi-round to round, akoya-like piece (Akamatsu et al., 2001). The first crops of “potato” pearls (so called because of their off-round shape and



Figure 13. In an attempt to raise the profile of black cultured pearls and broaden their appeal beyond traditional strands, Perles de Tahiti sponsored a series of design contests that led to innovative black pearl jewelry. The suite shown here (8.0–11.0 mm), designed by Mari Saki of Nagahori Corp., Tokyo, was an award-winning submission in 2006. Courtesy of GIE Perles de Tahiti.

Figure 14. The flat baroque shape of early Chinese freshwater cultured pearls led to the moniker “rice krispie” pearls. Advances in culturing technology and a change to a different species of mussel brought about dramatic improvements in quality in the 1990s. Photo by Maha Calderon.





Figure 15. Chinese freshwater pearls are produced from pond farms large and small across the country, such as the one shown here in Zhuji, Zhejiang Province. Photo by Valerie Power.

the fact their color resembled that of a peeled potato) were approximately 3–6 mm in diameter, with a fairly dull luster. They appeared in the market in 1992, the same year the Chinese government removed export controls on all pearls.

This development caused great concern in the Japanese industry. A strand of round Chinese FWCPs cost 10–30% of a similar-size akoya necklace, and the quality was improving with each harvest. In addition, as with the *C. plicata* mussel, several tissue insertions could be made in a single mollusk (figure 16), which resulted in multiple pearls from each mussel. A delegation of Japanese pearl producers journeyed to China in late 1993 to seek that government's help in imposing production limits and export restrictions on both freshwater and saltwater (see below) pearls. A key member of the delegation said that while the Chinese government did promise to impose export limits (Shor, 1994a),

the mission was ultimately unsuccessful because exports continued to climb.

Round Chinese FWCPs made their major U.S. debut in 1995, at the JCK Las Vegas trade show (Torrey, 1995; Shor, 1995b). Estimates of Chinese FWCP production ran as high as 500 tonnes that year, and doubled again by 1997 (Strack, 2006). As larger (7+ mm) goods appeared in the market, controversy erupted after claims began circulating in the trade that these pearls were nucleated with reject FWCPs rather than being formed by tissue implants only. However, a comprehensive study by Scarratt et al. (2000) found no evidence of such nuclei. In recent years, though, some Chinese pearl farmers have had considerable success with shell bead nucleation of hybrid (*H. cumingii* and *H. schlegelii*) mussels to better control shape (Fiske and Shepherd, 2007).

By the end of the decade, Chinese FWCPs had improved significantly in shape, size, and surface

Figure 16. Much of the enormous production of Chinese freshwater cultured pearls is due to the fact that the mussels used can produce dozens of pearls at a time (left); akoya oysters (right) typically produce no more than one or two pearls each. Photos by Doug Fiske (left) and Valerie Power (right).



quality, with substantial advances in grafting and cultivation techniques. Although the culturing of 7–8 mm pearls could take anywhere from five to seven years (and larger pearls required the use of fewer implants), the sheer volume that could be produced from a single mussel meant that the quantities of such goods would remain high.

Investors from Hong Kong began organizing producers, especially those that turned out finer-quality goods, into a centralized distribution operation. One of the largest of these firms, founded in 1983, was Man Sang Holdings. Man Sang invested heavily in building a pearl-processing infrastructure within China, particularly in Shenzhen, approximately 160 km (100 miles) north of Hong Kong. In 2006, Man Sang reported sales of \$48.5 million (Man Sang annual report, 2006).

Since 2004, when output exceeded 1,500 tonnes, many Chinese FWCP producers have strived for innovations at the top end (figure 17). Some examples are pastel-colored and South Sea-sized (12–14 mm) products with high luster that command exceptional prices (“HKPA enhances freshwater pearl promotion,” 2007).

At an average weight of 0.7 g per cultured pearl, that 1,500 tonnes equates to 2.14 billion pieces. However, production estimates note that only about half of these are suitable for adornment (many poor-quality pearls are crushed and used in cosmetics and other products). About 2% are round and near-round, regardless of other value factors such as color or blemishes. Very high quality, truly round goods over 8 mm that can compete in appearance with akoyas or even South Sea pearls are a minute percentage, about 0.0025% of the total. Only one in 500,000 is of exceptional quality (Shou Tian Guang, pers. comm., 2007).

Saltwater. The Chinese saltwater cultured pearl (SWCP) industry dates back to 1958, when the Zhanjiang Fisheries Institute began an experimental project near Hainan Island in the South China Sea. Employing the *P. chemnitzii*, a slightly different variety of oyster from the Japanese *P. martensii*, the project reportedly had a small but consistent output through the 1960s, though production statistics were never released. Japanese dealers purchased entire harvests and marketed them as akoyas from Japan (Strack, 2006).

In the late 1980s, as the Chinese economy began to liberalize, entrepreneurs started farms all along the country’s southern coast. By 1993, China’s

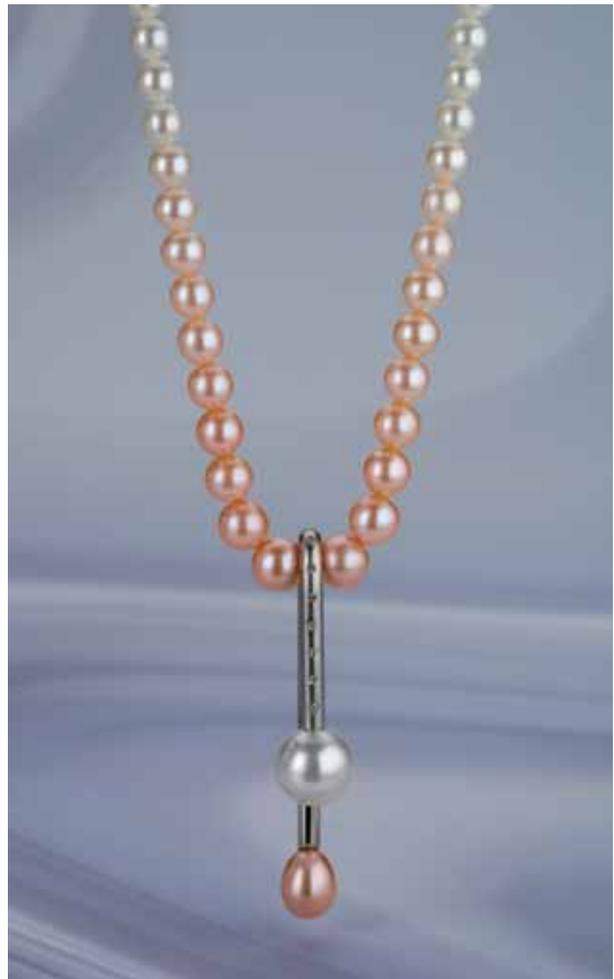


Figure 17. After years of quality improvements, the best Chinese freshwater cultured pearls are capable of competing with top products from Japan and other areas. This necklace (4–8.5 mm) and pendant (8.5 and 11 mm) were designed by Cornelis Hollander Designs, Scottsdale, Arizona. Photo by Robert Weldon; courtesy of the American Gem Trade Association.

annual production of SWCPs—some with a nacre thickness of 2 mm, more than three times that of most Japanese goods—had reached 5–10 tonnes, compared to Japan’s production of 80–90 tonnes (Strack, 2006). Because of the long cultivation periods (two to three years), a large percentage of these goods were irregularly shaped.

When the oyster mortality crisis struck akoya pearl farms in the mid-1990s, Japanese importers became even more dependent on Chinese farms to augment their supplies. Chinese SWCPs were similar in size (4–6 mm) to the average Japanese akoya pearl and very similar in appearance. Also during the mid-1990s, Chinese farmers began using *P.*

martensii to produce true akoyas and became a major supplier of oyster stocks after the destruction caused by infectious disease ("Japan buys oysters in China," 1997). However, bad weather and disease created problems in China as well, eventually forcing as many as one-fourth of the 3,000–4,000 farms out of business.

By the late 1990s, Chinese SWCP production, now more than 20 tonnes a year, was approaching that of Japan, which had continued to fall (from 40 tonnes in 1997 to 25 the following year). The more advanced farms were routinely producing goods as large as 8.5 mm, but quality remained an issue. The locally produced nuclei tended to be more blemished and more difficult to fashion into near-perfect spheres than the beads from the American *Unio* mussel that the Japanese preferred. In addition, the Chinese farmers now rushed the pearls to market much more quickly than in previous years, and the often thin nacre (under 0.4 mm) tended to make Chinese pearls less lustrous (Strack, 2006). As with the FWCP producers, however, the more sophisticated SWCP operations worked to improve the overall quality of their product. Hong Kong firms, later joined by the Japanese, began establishing large processing centers in the SWCP centers as well—and sharing many Japanese quality-enhancing techniques (Strack, 2006).

OTHER PRODUCERS

Pacific Rim. South Sea pearls are produced in other Pacific nations such as Thailand, New Zealand, and Papua New Guinea, some as government-sponsored pilot projects and others under the aegis of large corporations such as Man Sang, Golay Buchel, Tasaki, and several large Australian firms.

During the 1990s, the Cook Islands began to steadily increase production of black pearls, the vast majority of which were irregular in shape and bore a distinctive ribbed pattern. The main pearling island of Manihiki was home to about 75 pearl farms (some 60% of the total), most of them selling to Australian dealers through local cooperatives (Strack, 2006). However, many believe that the Cook Islands' industry is actually much more extensive, as large quantities of pearls are smuggled out of the country each year to avoid customs duties (Stanley, 2003).

Note, too, that Okinawa has produced small quantities of black cultured pearls intermittently since the 1920s (Muller, 1997b). The Ryukyu Pearl



Figure 18. American entrepreneur John Latendresse was successful in producing freshwater cultured pearls (fancy shapes, for the most part) in the U.S. during the 1980s and 1990s, but the last substantial harvest was in 2002. This freshwater cultured pearl fish pin set with sapphires and rubies was designed by Glen J. Engelbrecht. Courtesy of the American Pearl Co., Nashville, Tennessee.

Co., founded in the 1960s, is still cultivating high-quality black pearls in that area (S. Akamatsu, pers. comm., 2007).

Since 1999, small quantities of akoya-like pearls have been produced in Vietnam by several locally owned firms, as well as Japanese and Australian companies (Strack, 2006). South Korea also supports a relatively small akoya production, largely under Japanese ownership (R. Torrey, pers. comm., 2007).

North America. Black pearls have been found along the Gulf of California (also known as the Sea of Cortez) since pre-Columbian times, and were noted by Spanish explorer Fortún Jiménez as early as 1533. Natural pearls were a major export from Baja California until the oyster beds were nearly depleted at the beginning of the 20th century. Although several attempts were made to culture pearls in the Gulf of California, not until the 1990s did an operation yield commercial quantities of round cultured pearls from the native *P. sterna* oyster. In 2006, Perlas del Mar de Cortez produced about 5,000 cultured pearls in a wide variety of darker colors. The firm markets half of its production to local jewelry manufacturers and the remainder to wholesalers, primarily in the U.S. (Kiefert et al., 2004).

Freshwater cultured pearls from Tennessee have received a great deal of press attention over the years—far more than actual production would normally warrant. After many years of experimenting

with different grafting methods and mussel species, American Pearl Company founder John Latendresse succeeded in creating a wide variety of pearls with fancy shapes—bars, buttons, drops, and coins—determined mainly by the shape of the bead nucleus (figure 18). Since Latendresse's death in 2000, the company has undergone many changes. The farm's last substantial harvest was in 2002, resulting in 87,294 cultured pearls from approximately 75,000 mollusks, the smallest harvest in 15 years. During the 20 years of production, Latendresse kept about 15–20% of the harvest for "rainy days," leaving the firm with considerable inventory (G. Latendresse, pers. comm., 2007). Today, the pearl farm in Camden, Tennessee, is primarily a tourist attraction.

CULTURING IS NO LONGER A BLACK-AND-WHITE ISSUE

"Golden" Pearls. It has long been known that the gold-lipped *P. maxima* in Philippine waters creates, on rare occasions, bright yellow or "golden" pearls. Before the 1990s, these colors were not considered desirable in many markets, particularly Asian ones, and most farmers tried to develop grafting methods that would avoid them (R. Torrey, pers. comm., 2007). Nevertheless, Jewelmer, a partnership between French-born pearl farmer Jacques Branellac and Manila businessmen Eduardo and Manuel Cojuangco, spent most of the 1980s breeding *P. maxima* in a hatchery in Bugsuk on Palawan Island to develop an oyster that would consistently yield golden pearls and result in a brandable product very different from other South Sea pearls (Torrey, 2004).

Once researchers found the best combination of nutrients and other factors to increase the likelihood of creating golden pearls (figure 19), they began breeding large numbers of spat in hatcheries, then raised them in sea beds. Jewelmer's golden pearls averaged 11–13 mm after 18–24 months of culturing (Torrey, 2001, 2003). Although the company's production figures are proprietary, its 2006 production has been estimated at 70% of the total Philippine production of 450 *kan* (R. Torrey, pers. comm., 2007). A 2007 report stated 30% of the pearls Jewelmer produced were golden, but less than 10% were "deep golden" in color (Parels-AEL, 2007).

Beginning in 1999, Jewelmer started marketing golden pearls as a glamour item by staging lavish fashion shows annually at the mid-September Hong Kong Jewelry and Watch Fair—chosen because it

attracts most of the world's key pearl buyers, who attend the major pearl auctions held in conjunction with the fair (Torrey, 2004). The company also advertises extensively (its marketing budget is confidential) in trade publications and some consumer magazines around the world, again stressing the golden pearl as a fashionable luxury item. Jewelmer was one of the first producers to launch a major effort to brand and sell its pearls downstream to jewelry designers and retailers through world trade shows instead of marketing them all generically to wholesalers through auctions (Torrey, 2001).

The push to create trade and consumer acceptance of golden pearls (figure 20) served as a catalyst for the entry of other fancy colors that had once been regarded as undesirable. These new colors

Figure 19. Once an undesirable oddity in many markets, golden cultured pearls became an important product during the early 2000s. Courtesy of Jewelmer.





Figure 20. As dealers and consumers began to appreciate the beauty and fashion possibilities of golden cultured pearls such as these (~12 mm), the door was opened to a variety of other fancy colors. Necklace courtesy of Baumell Pearl Co., San Francisco; photo by Robert Weldon.

would help thrust pearls into the center of the fashion world (Honasan, 2001).

Other Fancy-Colored Pearls. Although Tahitian pearls are typically called “black,” the majority are actually shades of green or gray. On occasion, other colors—including yellow-green, “bronze,” and light blue—show up in production. Like their white pearl-producing counterparts, French Polynesian farmers initially deemed these colors undesirable to the point that many chose not to market them at all (R. Torrey, pers. comm., 2007).

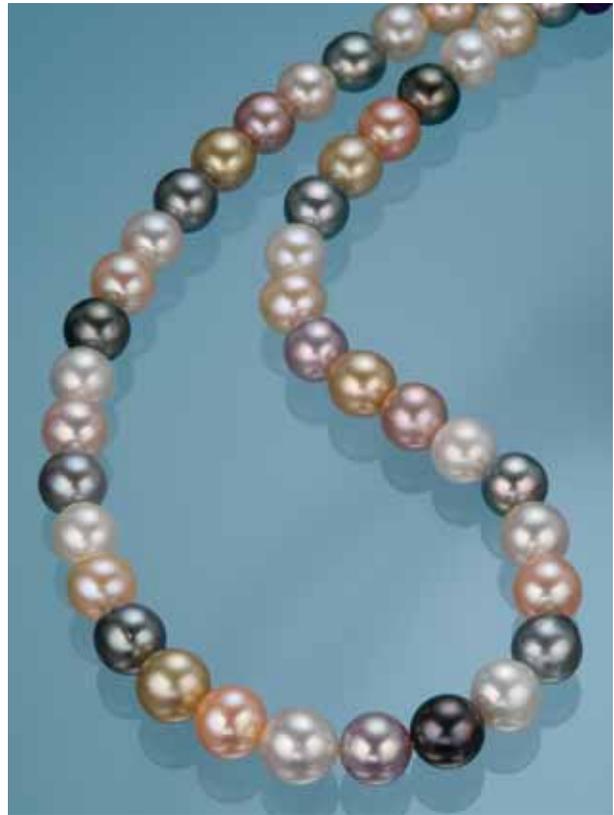
In 1996, however, a number of companies began selling fancy-colored goods. One of these was Swiss pearl wholesaler Golay Buchel, which ran an ad in U.S. magazines touting a yellow-green Tahitian pearl necklace as “pistachio pearls,” shown next to luxury-priced golden and white pearls. The company reported that coupling the yellow-green necklace

with more familiar white and “black” colors helped build rapid acceptance and consumer demand (Federman, 1998a).

About the same time, naturally colored violet, lavender, “apricot,” “copper,” and even purplish red Chinese FWCPs began filtering into the market. As a result, pearl wholesalers such as Schoeffel, Golay Buchel, and others began the hitherto unheard-of practice of mixing saltwater and freshwater pearls together in the same pieces to achieve multi-colored looks (Federman, 1998b; figure 21).

As these colors gained favor in the market, producers began studying how to achieve them more predictably. On the Fiji Islands, J. Hunter Pearls launched a specialty line of fancy colors cultured from the *P. margaritifera* that included various shades of green, blue, gold, and “rose.” The compa-

Figure 21. Improvements in culturing and production led to greater numbers of fancy-colored pearls entering the market. Designers soon began mixing colors to achieve attractive combinations, sometimes even combining salt- and freshwater cultured pearls (~10 mm). Necklace courtesy of Albert Asher Pearl Co., New York; photo by Robert Weldon.



ny, founded in 1999, also specializes in larger sizes, averaging 11 mm (J. Hunter Pearls Fiji, 2007).

BRANDING AND MARKETING

The cultured pearl is the only segment of the jewelry industry that grew from a branded product, thus setting a precedent for others to follow. Kokichi Mikimoto's relentless efforts to popularize cultured pearls were instrumental in creating the Mikimoto brand. In 1899, just three years after the first culturing successes (at that time, primarily mabe pearls), Mikimoto established a retail store in Tokyo's premier shopping district, Ginza. The first overseas Mikimoto store opened in London in 1913, followed by Shanghai, Bombay (now Mumbai), New York, Los Angeles, Chicago, and Paris, all by 1929. Today, Mikimoto remains one of the most recognizable names in the jewelry industry.

In the ensuing years, cultured pearls outside the Mikimoto brand became generic, albeit precious, items, much like diamonds and colored stones. The pearl crises of the 1990s—the loss of most of Japan's akoya crops, overproduction and quality problems with Tahitian goods, and the Asian banking crisis—forced producers to seek large new clients outside Japan and, in many cases, assume the costly burden of holding inventory (N. Paspaley, pers. comm., 2007). As a result, some of these producers, too, faced the need to establish a brand identity.

Fearing a commoditization that would lead to a destructive discounting cycle, and determined to keep inventories from accumulating, large, well-financed producers such as Perles de Tahiti and Paspaley turned to designer jewelry to give their products individuality and shore up demand for the higher end (M. Coeroli, pers. comm., 2007; N. Paspaley, pers. comm., 2007; figure 22). A number of these efforts were successful, drawing attention from the fashion press, and mainstream fashion designers and retailers in the United States and Europe began featuring pearls (figure 23). Pearl specialists such as Heinz and Tove Gellner of Wiernsheim, Germany, and Christianne Douglas of London created innovative pieces, which received substantial fashion press coverage, from necklaces and brooches to long "body wraps" using a mixture of pearl varieties. Robert Wan, the largest producer of Tahitian pearls, commissioned his own designer lines of jewelry, which were displayed at major trade shows around the world (M. Coeroli, pers. comm., 2007).

In Europe, an Italian pearl importer created

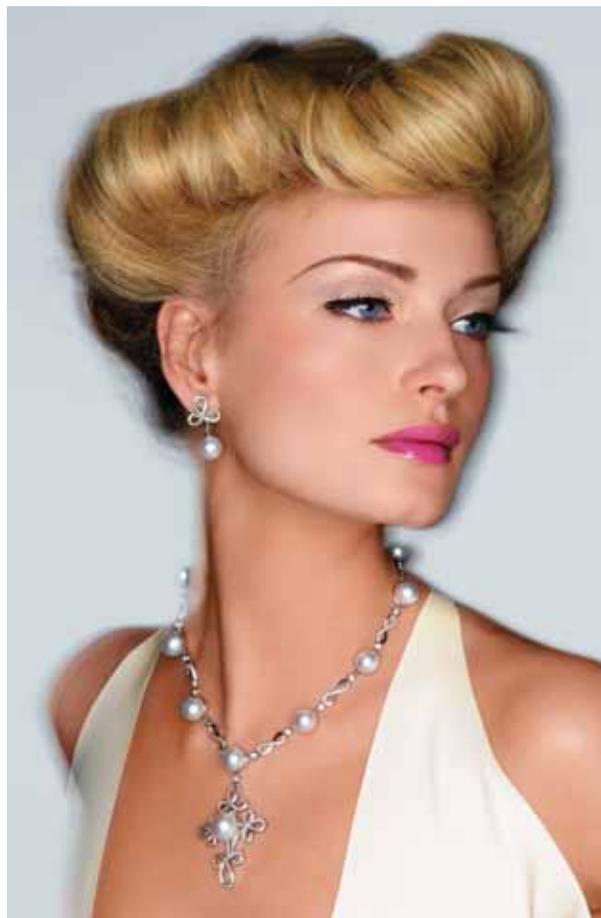


Figure 22. The necklace and matching earrings shown here were part of the White Magic collection commissioned by Paspaley in 2005 to showcase the design possibilities of its South Sea cultured pearls. Jewelry by Gisèle Moore, London; photo courtesy of Paspaley and the South Sea Pearl Consortium.

Utopia, a branded fashionable jewelry line, from South Sea pearls (figure 24). The company launched the brand in 1997 because confusion over different types of pearls and publicity surrounding treatments had begun to undermine consumer confidence (P. Gaia, pers. comm., 2007). It kept custody of the supply chain from farm to inventory, and guaranteed that each pearl was untreated (Johnson et al., 1999). Backed by international marketing, Utopia expanded from a local operation serving Italian retailers to one with a presence in most major world markets within a decade (A. Gaia, pers. comm., 2007).

David Yurman, who in 2004 had more than 200 retail locations, was one of the first to enthusiastically embrace pastel-colored pearls. That year he introduced an extensive pearl line that employed all major varieties and mixed various colors (Zimbalist,



Figure 23. In response to price fluctuations and problems with production quality, black-pearl producers moved to protect demand for high-end goods by working with designers and retailers to create a variety of fashionable designs. Shown here is a suite by J. Grahl Design, Balboa Island, California. Photo by Sylvia Bissonette; © J. Grahl Design.

2004). Such mixing proved difficult because of optical effects. For example, a black pearl placed next to a white one should be 10–15% larger because, side by side, the white appears larger. Yurman continued to feature cultured pearls heavily in 2007 (figure 25), with 69 pieces. He commented on his website that pearls “have become the focus of my collections this year” (David Yurman, 2007).

Pearl retailing also underwent a revolution. In 2004, Tiffany & Co. launched a major pearls-only retail chain operation, Iridesse. While there still was no well-defined or documented consumer rush toward pearl jewelry, Tiffany believed there was substantial unrealized commercial potential for this product, based on a number of factors:

- Advances in pearl farming and culturing techniques were sufficient to guarantee a stable supply of all types of pearls, particularly higher qualities.
- The varied colors, shapes, and sizes of pearls lent themselves to a versatility of design and purpose that was underrealized in the marketplace.
- The wide variation in prices among pearl types allowed development of both distinctive, contemporary jewelry pieces and traditional strands. As a result, Iridesse offers pearl jewelry ranging from \$80 to \$40,000.

Iridesse commissioned several designers, including Christian Tse of Pasadena, California, and Coleman Douglas of London, to create unique pieces and help the chain establish a completely separate identity

Figure 24. Utopia has built its brand on the guarantee that its pearls are untreated. Aimed at fashion-conscious consumers, Utopia uses unconventional designs such as the necklace shown here, which combines white and golden South Sea pearls, fancy-color sapphires, and diamonds. Courtesy of Utopia, Milan.



from its parent company, which historically has offered few pearl pieces (R. Cepek, pers. comm., 2007).

Iridesse had opened six stores by the end of 2005, and nine more followed in 2006. The firm opened its 16th store—in the Century City Shopping Center in Los Angeles—in May 2007, making Iridesse a mid-sized chain in its own right (“State of the majors,” 2007).

The newfound diversity of pearls, coupled with the creations of jewelry designers and the expansion of major retailers into this arena, has widened the public’s perception of this gem beyond the strand of white spheres once worn only on formal occasions. Indeed, keshis, baroque shapes, and ringed pearls, which were traditionally difficult to sell, are increasingly in demand as more designers work with them (Gomelsky, 2007). Today, the no-longer-traditional strand of cultured pearls has assumed an important role in the wardrobe of the strong female professional (figure 26). By late 2006, suppliers of all types of pearls reported that business in the U.S. had increased by as much as 40% in one year on the strength of all the factors mentioned above (Henricus, 2006).

FUTURE

The past 15 years have provided the world’s pearling industry with strong lessons on the benefits and pitfalls of a free market and the challenges that nature can present.

On the demand side of the market—if trends in diamond and colored stone consumption can be used as a reliable guide—it is likely that emerging economies such as India, China, and Turkey will show substantially higher demand for cultured pearls in coming years. Indeed, Asian nations have a strong cultural affinity for them. On the production side, it is certain that new ventures will enter the market, because start-up costs are relatively low. For instance, a saltwater farm with 25,000–30,000 mollusks can be launched for as little as \$200,000, with a break-even point of less than five years (Fong et al., 2005).

This low barrier to entry makes pearl farming attractive to entrepreneurs and governments in countries with long coastlines and high unemployment. A number of nations, primarily in the Pacific Rim, are currently engaged in start-up pearl projects. These include New Zealand (cultured abalone pearls), the Marshall Islands (black cultured pearls), Vietnam (freshwater as well as akoya-like), and



Figure 25. Designer David Yurman has made a significant move into pearl jewelry with products such as this diamond, blue topaz, and cultured pearl necklace. Photo © David Yurman.

Figure 26. Speaker of the House of Representatives Nancy Pelosi, one of the most powerful women in the United States, is known for her attractive pearl necklaces. Photo © Mike Theiler/Reuters/Corbis.





Figure 27. The world pearl market will likely see continued innovations and new products in the years ahead. The diamond and mother-of-pearl pendant shown here is highlighted by an 11 mm carved black pearl that was cultured over an amethyst bead. Jewelry courtesy of Galatea, San Dimas, California; photo by Robert Weldon.

New Guinea (South Sea). However, China's vast production and low operating costs will likely thwart any start-ups that do not attempt to differentiate their products.

One new venture is returning to the area where pearling began some 3,000 years ago: the Persian Gulf. Although natural pearl production there all but ended by the 1960s as oil became the economic focal point, the region retains an intense historical affinity for pearls. In early 2007, the Dubai Multi Commodities Centre formed a joint venture with Arrow Pearls of Australia to culture akoya pearls in the region. The Dubai government granted the venture, Pearls of Dubai, five concession areas to establish pearl farms. In the summer of 2007, the enterprise began a pilot project of 100,000 oysters that will be harvested early in 2009. Ultimately, it seeks to produce a branded

"Dubai" line of cultured pearls, 8–9 mm goods marketed through local jewelers (N. Haddock, pers. comm., 2007). Several ventures in other emirates along the Gulf are in the planning stages.

Moreover, new types of cultured pearl products will certainly enter the market. Faceted pearls were in vogue during the early part of this decade, and in June 2007, a jewelry designer from California introduced black pearls with gemstone bead nuclei, cultivated in Vietnam. The designer, Chi Huynh of San Dimas, uses beads made from amethyst, citrine, and turquoise, then carves the resulting pearl to reveal portions of the stone beneath (Roskin, 2007; figure 27).

Nature, of course, will continue to impact pearl production worldwide. The effects of disease and overexploitation are well documented, as is the damage caused by earthquakes and typhoons. Pearl farms in Asia escaped the devastation of the December 2004 Sumatra-Andaman tsunami ("Tsunami reported to have little impact on industry," 2005). In China, though, a powerful August 2007 typhoon reportedly destroyed nearly half the akoya stocks under operation ("Chinese akoya production plummets after typhoon," 2007). Still other environmental concerns remain. In particular, pearl producers Jacques Branellac and Nicholas Paspaley addressed the issue of global warming at the GIA GemFest seminar held April 14 of this year in Basel, Switzerland (Paspaley, 2007; Branellac, 2007). They expressed their concerns that the future might see an increase in the number of catastrophic storms, rising sea levels, saltwater intrusion into freshwater cultivation areas, a greater incidence of disease and parasite proliferation, and higher water temperatures.

The unpredictability of nature, coupled with the proliferation of producers around the world, will probably result in more supply booms and busts in coming years. Despite the intensive, sophisticated branding efforts of some major producers, pearling remains a highly fragmented industry. However, it is also likely that the popularity of pearls in world markets will grow even more rapidly as the product continues to improve, and pearl farmers, jewelry designers, and retailers promote it to traditional and emerging consumer populations.

CONCLUSION

While Japanese producers, technicians, and distributors remain an integral part of the trade they created more than a century ago, the past 15 years

have seen sweeping transformations in the cultured pearl industry. After decades of Japanese domination with a single product—the akoya strand—two major producers, both with vastly different products, entered the market simultaneously: Australians with large white South Sea pearls and French Polynesians with their exotic black pearls. Early on, both positioned their products as a luxury alternative to the akoya, creating major marketing campaigns to establish distinct identities for their pearls. And both sought control over production and distribution of their own goods.

Meanwhile, producers in other nations—such as Indonesia and the Philippines—began penetrating the market in earnest. The behemoth, however, was China. Drawing from literally thousands of freshwater pearl farms, China first challenged Japan’s traditional dominance at the low end of the market with its huge, largely unregulated flow of freshwater “rice krispie” pearls. In time, the Chinese began producing an array of new products

that offered a more affordable alternative to the akoya. Toward the end of the 1990s and into the 21st century, the global industry introduced new colors, new technical innovations, and branded pearls, while encouraging designers to transform cultured pearls into a much more contemporary fashion product than before.

Yet there have been significant challenges as well. Severe banking problems crippled much of the Japanese industry in the 1990s, as natural forces were inflicting difficult lessons on pearl farmers in Japan, French Polynesia, and Indonesia. Virtually every producer has had to deal with problems inherent in overtaxing local resources, while climatic fluctuations will continue to be a concern for products dependent on a fragile ecology. In recent years, however, most major producers appear to have learned how to balance sustainable growth with attention to the market. And this has contributed enormously to the increasing popularity of cultured pearls worldwide.

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REFERENCES

- Akamatsu S. (2007) Sorting it all out: GIA’s pearl report and industry opportunities. Panel discussion at GemFest Basel, Switzerland, April 14.
- Akamatsu S., Li T.Z., Moses T., Scarratt K. (2001) The current status of Chinese freshwater cultured pearls. *Gems & Gemology*, Vol. 37, No. 2, pp. 96–109.
- Branellac J. (2007) Sorting it all out: GIA’s pearl report and industry opportunities. Panel discussion at GemFest Basel, Switzerland, April 14.
- Cariño M., Monteforte M. (1995) History of pearling in La Paz Bay, south Baja California. *Gems & Gemology*, Vol. 31, No. 2, pp. 88–105.
- Chinese akoya production plummets after typhoon (2007) www.jewellerynetasia.com/industry/news.aspx, Oct. 10.
- CIBJO (2006) *The Pearl Book*. www.cibjo.us/pearl.pdf, Milan, Italy.
- Coeroli M., Galenon R. (2006) Perles de Tahiti newsletter, March/April.
- Crowningshield R. (1970) Developments and Highlights at GIA’s Lab in New York: Black cultured pearl. *Gems & Gemology*, Vol. 13, No. 5, pp. 156–157.
- Crowningshield R. (1988) Gem Trade Lab Notes: Cultured pearls, irradiated. *Gems & Gemology*, Vol. 24, No. 4, p. 244.
- David Yurman (2007) www.davidyurman.com [date accessed 10/15/07].
- Earthquake, strong yen slow sales (1995) *Jewellery News Asia*, May, No. 129, p. 60.
- Elen S. (2001) Spectral reflectance and fluorescence characteristics of natural-color and heat-treated “golden” South Sea cultured pearls. *Gems & Gemology*, Vol. 37, No. 2, pp. 114–123.
- Elen S. (2002) Update on the identification of treated “golden” South Sea cultured pearls. *Gems & Gemology*, Vol. 38, No. 2, pp. 156–159.

- Federman D. (1997) Shell shock. *Modern Jeweler*, Vol. 96, No. 2, pp. 12–13.
- Federman D. (1998a) Pistachio pearl. *Modern Jeweler*, Vol. 97, No. 10, p. 38.
- Federman D. (1998b) Sea change. *Modern Jeweler*, Vol. 97, No. 10, pp. 46–55.
- Fiske D., Shepherd J. (2007) Continuity and change in Chinese freshwater pearl culture. *Gems & Gemology*, Vol. 43, No. 2, pp. 138–145.
- Fong Q., Ellis S., Haws M. (2005) Economic feasibility of small-scale black lipped pearl oyster (*Pinctada margaritifera*) farming in the Central Pacific. *Aquaculture Economics & Management*, No. 9, pp. 347–368.
- Goebel M., Dirlam D. (1989) Polynesian black pearls. *Gems & Gemology*, Vol. 25, No. 3, pp. 130–148.
- Gomelsky V. (2007) Pearls gone wild. *Couture International Jeweler*, No. 279, pp. 112–115.
- Henricus J. (2006) U.S. pearl sales very strong. *Jewellery News Asia*, No. 265, pp. 90–96.
- HKPA enhances freshwater pearl promotion (2007) *Jewellery News Asia*, No. 271, pp. 58–60.
- Honosan A. (2001) *The Ultimate Orient: Philippine South Sea Pearls*. Jewelmer, Manila.
- Hurwit K. (1998) Gem Trade Lab Notes: Cultured pearl, with treated black color. *Gems & Gemology*, Vol. 34, No. 2, pp. 131–132.
- J. Hunter Pearls Fiji (2007) <http://www.pearlsfiji.com> [date accessed 10/15/07].
- Japan buys oysters in China (1997) *Jewellery News Asia*, No. 150, p. 64.
- Johnson M.L., Koivula J.I., McClure S.F., DeGhionno D., Eds. (1999) Gem News: Pearl branding—“Utopia” cultured pearls. *Gems & Gemology*, Vol. 35, No. 2, p. 154.
- Kiefert L., Moreno D.M., Arizmendi E., Hänni H., Elen S. (2004). Cultured pearls from the Gulf of California, Mexico. *Gems & Gemology*, Vol. 40, No. 1, pp. 26–38.
- Kobe earthquake (1995) *Jewellery News Asia*, No. 150, pp. 1, 28.
- Komatsu H., Akamatsu S. (1978) Differentiation of black pearls. *Gems & Gemology*, Vol. 16, No. 1, pp. 7–16.
- Li L. (2001) Production and color changing treatment of Chinese cultured pearls. *Singaporean Gemmologist*, Vol. 8, No. 1, pp. 11–14.
- Luke A. (2005) Cultured in paradise. *The Loupe*, Vol. 14, No. 2, pp. 14–18.
- Man Sang Holdings, Inc. (2006) *Annual Report 2006*. Hong Kong.
- Moses T.M., Shigley J.E. (2003) G. Robert Crowningshield: A legendary gemologist. *Gems & Gemology*, Vol. 39, No. 3, pp. 184–199.
- Muller A. (1997a) Changes needed to revive akoya industry in Japan. *Jewellery News Asia*, No. 150, pp. 60, 64.
- Muller A. (1997b) *Cultured Pearls: The First Hundred Years*. Golay Buchel, Tokyo, 142 pp.
- Muller A. (1998) *Cultured South Seas Pearls, Past and Present 1998*. Golay Buchel, KK, Tokyo, 18 pp.
- Muller A. (1999) *Cultured South Seas Pearls, An Analysis*. Golay Buchel, KK, Tokyo, 18 pp.
- Muller A. (2005) White SSP supply and demand. *Pearl World*, Vol. 13, No. 3, pp. 5–6, 23.
- Myanmar expected to produce 220 kan in 2006 (2006) *Jewellery News Asia*, No. 259, p. 65.
- Myanmar Pearl Enterprise (2003) Historically famous Myanmar South Sea pearl. www.myanmarpearl.com/history.htm [date accessed 10/15/07].
- O’Sullivan D. (1998) Cultured pearls revealed to be an Australian invention. *Austasia Aquaculture*, Vol. 12, No. 4.
- Parels-AEL (2007) Report visit Jewelmer, Philippines. parels-ael.nl/reports/jewelmer/ [date accessed 10/15/07].
- Paspaley N. (2007) Sorting it all out: GIA’s pearl report and industry opportunities. Panel discussion at GemFest Basel, Switzerland, April 14.
- Roskin G. (2007) Black pearls have gemstone bead nuclei. *Jewelers’ Circular Keystone*, Vol. 178, No. 8, p. 50.
- Scarratt K., Moses T.M., Akamatsu S. (2000) Characteristics of nuclei in Chinese freshwater cultured pearls. *Gems & Gemology*, Vol. 36, No. 2, pp. 98–109.
- Sertori T. (2006) Theft, corruption threaten pearl industry reputation. *Jakarta Post*, Nov. 30, p. 21.
- Shor R. (1994a) How Japan will stay #1. *Jewelers’ Circular Keystone*, Vol. 165, No. 8, pp. 88–94.
- Shor R. (1994b) Pearl leaders seek global advertising fund. *Jewelers’ Circular Keystone*, Vol. 165, No. 8, pp. 95–98.
- Shor R. (1995a) Building a new image for Australian pearls. *Jewelers’ Circular Keystone*, Vol. 166, No. 10, pp. 72–76.
- Shor R. (1995b) The pearl picture. *Jewelers’ Circular Keystone*, Vol. 166, No. 1, pp. 88–90.
- Shor R. (2005) A review of the political and economic forces shaping today’s diamond industry. *Gems & Gemology*, Vol. 41, No. 3, pp. 202–203.
- Sotheby’s (1987) *Jewels of the Duchess of Windsor*. April 2–3 auction catalogue, Geneva, 312 pp.
- Stanley D. (2003) Black pearls of French Polynesia and the Cook Islands. *Tok Blong Pasifik*, Vol. 57, No. 1, pp. 18–19.
- State of the majors (2007) Top 50 Retail Jewelers, *National Jeweler* supplement, May, pp. 20–38.
- Strack E. (2006) *Pearls*. Ruhle-Diebener-Verlag GmbH, Stuttgart, Germany, 708 pp.
- Tisdell C.A., Poirine B. (2000) Socio-economics of pearl culture: Industry changes and comparisons focusing on Australia and French Polynesia. *World Aquaculture*, Vol. 31, No. 2, pp. 30–60.
- Torrey R. (1995) JCK Show in Las Vegas. *Pearl World*, Vol. 3, No. 2, pp. 1, 3–6.
- Torrey R. (2001) Philippine SSPs: Among the very best. *Pearl World*, Vol. 9, No. 4, pp. 1, 3–4.
- Torrey R. (2003) Philippine SSPs strengthen niche. *Pearl World*, Vol. 9, No. 4, pp. 1, 5–7.
- Torrey R. (2004) Scanning the pearl world. *Pearl World*, Vol. 11, No. 4, pp. 2–5.
- Torrey R. (2005) Going for the gold. *Pearl World*, Vol. 14, No. 5, pp. 1–6.
- Treatments cause concern in industry (1997) *Jewellery News Asia*, No. 150, pp. 54–57.
- Tsunami reported to have little impact on industry (2005) *Jewellery News Asia*, No. 246, pp. 1, 32–33.
- Wang W., Scarratt K., Hyatt A., Shen A.H.-T., Hall M. (2006) Identification of “chocolate pearls” treated by Ballerina Pearl Co. *Gems & Gemology*, Vol. 42, No. 4, pp. 222–235.
- Zimbalist K. (2004) Love affair with jewelry: David and Sybil Yurman reflect on how they turned a little silver angel into a big business. *Time*, Vol. 164, No. 21, p. 13.