CONTINUITY AND CHANGE IN CHINESE FRESHWATER PEARL CULTURE

Doug Fiske and Jeremy Shepherd

The great majority of Chinese freshwater cultured pearls are produced by implanting tissue pieces in the mantle of *Hyriopsis cumingii* mussels. Farmers have experimented with bead nucleation, but until recently the methods tried did not produce the quantity or quality necessary for economic success. In the late 1990s, Chinese researchers imported *H. schlegelii* mussels from Japan, began propagating them in hatcheries, and started cross-breeding them with native *H. cumingii* mussels. Using the two pure species and the hybrid, Chinese farmers produce tissue-implantation-only cultured pearls and have developed a method called coin-bead/spherical-bead nucleation. This method has yielded significant quantities of jewelry-quality baroque shapes and lesser quantities of jewelry-quality rounds and near-rounds. Continued experimentation is expected to increase the percentage of rounds and near-rounds.

In April 2007, the authors traveled to some of the freshwater pearl culturing provinces in China. One author (DF) had visited the area in 1998, and the other (JS) had visited several times a year since 1996. The authors' purposes were to gather information for the revision of the GIA *Pearls* course (DF) and for the online forum Pearl-Guide.com (JS), and to buy commercial quantities (JS) of Chinese freshwater cultured pearls (CFCPs). The authors found that, like virtually everything in China, freshwater cultured pearl production is changing rapidly. This article reviews the current situation and describes some of the changes. Unless otherwise indicated, the information came from interviews with Chinese pearl farmers, processors, and dealers, and from the authors' observations while visiting pearl farms in Anhui, Jiangsu, and Zhejiang provinces.

PAST AND PRESENT

Since about 1970, when small "rice" pearls first appeared internationally, the overwhelming majority of CFCPs have been produced by implanting tissue pieces from donor mussels in the mantles of host mussels, waiting several years, and harvesting the resulting cultured pearls. At an unknown time after the introduction of this process, farmers began producing a far smaller volume of bead-nucleated CFCPs. Over the years, they experimented with various means of bead nucleation.

Tissue Pieces Only. Today, the great majority of CFCPs are produced by implanting donor-mussel tissue pieces in the mantles of *Hyriopsis cumingii* (triangle shell, *san jiao fan bang* in Mandarin Chinese) mussels, waiting three to five years, and harvesting the resulting cultured pearls. For 2006, the most frequently cited volume was 1,500 metric tons (J. Chan, T. Shou, F. Tian, and W. Zhan, pers. comms., 2007). About 800 metric tons were suitable for use in jewelry (J. Chan, pers. comm., 2007), some of superior quality (figure 1).

See end of article for About the Authors and Acknowledgments.
GEMS & GEMOLOGY, Vol. 43, No. 2, pp. 138–145.

Figure 1. These round (6.5–7.5 mm), natural-color, exceptional-quality Chinese freshwater cultured pearls were grown with tissue implantation only. They were not treated in any way. The authors were not present at the harvest and could not identify the mussel that produced them. Courtesy of PearlParadise.com; photo by Kevin Schumacher.

Bead Nucleation. Akamatsu et al. (2001) reported three bead-nucleation methods then used in Chinese freshwater pearl culture. Of these, the present authors found only "bead nucleation by direct operation" still being practiced by some Chinese freshwater pearl farmers. To understand this method and its results, it is helpful to use the terms *first generation* and *second generation*.

With direct operation, first generation is the implantation of tissue pieces as mentioned above. Generally, the mussel mortality rate at first-generation harvest is 90% (W. Zhan, pers. comm., 2007). At that time, technicians assess the health of the surviving mussels and the quality of the cultured pearls produced. They return some mussels to the water to create second-generation cultured pearls. Technicians implant some of the original pearl sacs with a spherical bead nucleus or a nucleus of one of several other shapes. They leave other pearl sacs empty to produce what Chinese farmers call "keshi"* pearls. The ensuing pearl-growth period is three to four years (W. Zhan, pers. comm., 2007).

With the direct-operation method, second-generation cultured pearl quality is worse than first generation, and there is a lower incidence of rounds and near-rounds. The second-generation harvest contains many buttons and baroques, some with tails (J. Chan, Y. Lou, and W. Zhan, pers. comms., 2007).

RECENT DEVELOPMENTS

During our trip, we learned of two important developments in Chinese freshwater pearl culture. One involved the introduction of a non-native mussel, its hybridization with a native mussel, and the evident use of both pure species and the hybrid in pearl culture. The other development was an innovative bead-nucleation process.

***H. schlegelii* in China.** Some Chinese pearl farmers reported that *H. cumingii* is still the only mussel

*As used by Chinese freshwater cultured pearl farmers, processors, and dealers, the term *keshi* does not fit the CIBJO definition, which refers to a similar product but restricts it to saltwater pearl culture. This article reflects Chinese usage, which defines *keshi* as a second-generation cultured pearl created in a pearl sac that formerly held a cultured pearl or shell bead of any shape.

Figure 2. When the CBSB-nucleated freshwater cultured pearls known as "fireballs" first appeared on the wholesale market in 2002, luster and surface quality were poor, as this strand (10–11 mm) shows. Courtesy of PearlParadise.com; photo by Kevin Schumacher.

they use to culture freshwater pearls. However, a large pearl-farming company in Zhuji said that 80% of its mussels are *H. cumingii* and 20% are *H. schlegelii* (pond butterfly shell, *ci die bang* in Mandarin Chinese). That company estimated that generally in China, 70% of the freshwater cultured pearl production is from *H. cumingii*, while 30% is from *H. schlegelii*. In Japanese, "pond butterfly" is *ikecho*, also called the Biwa pearly mussel.

M. Fujita began culturing freshwater pearls in *H. schlegelii* at Lake Biwa, Japan, in 1914 (*Pearl Museum*, 1998). Freshwater pearl culture continues at Lake Biwa to this day, although pollution has severely reduced the volume (Pawasarat, 2007). Due to their colors and quality, Japanese Biwa cultured pearls have achieved something of a legendary status in pearling circles.

Evidence indicates that some Chinese freshwater pearl farmers have been culturing pearls in *H. schlegelii* and in the *H. cumingii* × *H. schlegelii* hybrid for several years. A search of the Chinese-language scientific literature reveals a strong presence of *H. schlegelii* in China, its superiority to *H. cumingii* as a pearl-bearing mussel, and the superiority of its hybrid with *H. cumingii* to either pure species with respect to pearl culture (e.g., Lei, 2005; Xu et al., 2005; Xie et al., 2006).

Figure 3. The CBSB-nucleation method recently produced these four baroques and one "keshi" (center). They were sieve-sized at 13–14 mm. Excellent luster and variable color are often seen in CBSB-nucleated pearls harvested today. Courtesy of Sea Hunt Pearls; photo by Kevin Schumacher.

Coin-Bead/Spherical-Bead (CBSB) Nucleation. This method involves implanting a coin-shaped bead and tissue piece at first generation, and often only a spherical bead at second generation. The process produces the CFCPs called "fireballs" (figure 2), other baroque shapes, "keshis," "coin pearls," and rounds and near-rounds. The volume is significant and growing rapidly, but producers will not give specifics (J. Chan and W. Zhan, pers. comms., 2007). Rounds range from 10 to 15.5 mm, while baroques can measure up to 25 mm long. Natural colors include "lavender," purple, "peach," "gold," blue, and white (see, e.g., figure 3). Several colors often appear in the same cultured pearl. We believe this method (figure 4) is used with *H. cumingii*, *H. schlegelii*, and the *H. cumingii* × *H. schlegelii* hybrid.

Fireballs first appeared on the wholesale market in 2002. They and other CBSB pearls have been mentioned and shown in some trade publications, and the production method has been touched upon, but not explored in detail (Federman, 2006; Wong, 2006). In standard pearl terminology, fireballs are baroques. They come in an infinite variety of shapes. What they have in common is a bulb somewhere in the cultured pearl and, sometimes, a spiked tail stretching from it. As noted above,

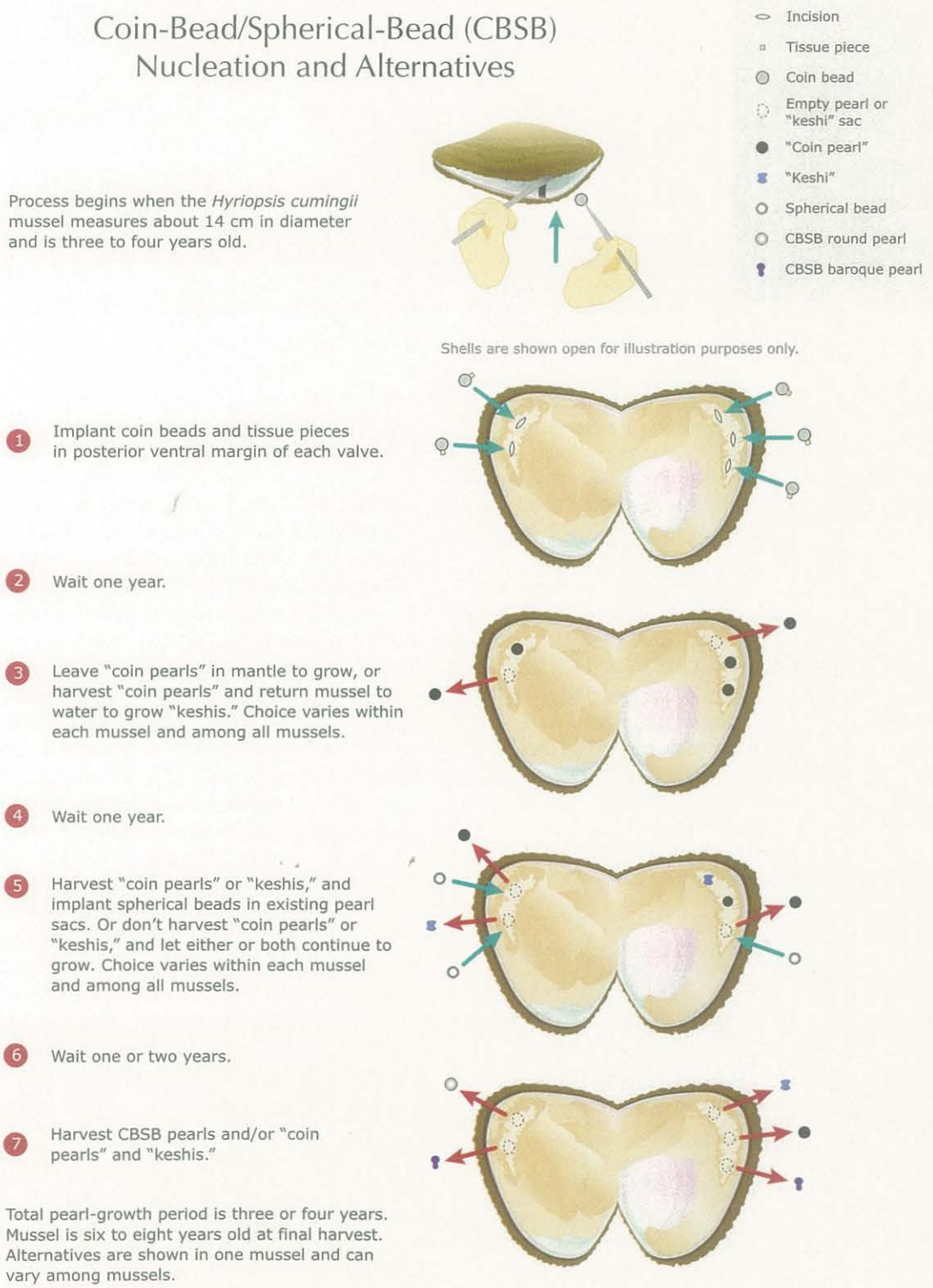


Figure 4. Illustrated here are the various options for coin-bead/spherical-bead nucleation in H. cumingii *as practiced on some freshwater pearl farms in China. Evidence indicates the method is also used with* H. schlegelii *and the* H. cumingii × H. schlegelii *hybrid. Illustration by Karen Myers.*

Figure 5. These "coin pearls" and "keshis" were harvested prematurely for demonstration purposes about 17 months after coin beads were implanted. One year after implantation, the farmer left these "coin pearls" in the mussels to continue to grow. At that time, he harvested other "coin pearls" and returned the H. cumingii *mussels to the water to let them develop "keshis." The "keshis" shown are about five months old. Courtesy of He Jainhua; photo by Valerie Power.*

however, other pearls cultured by the same means are round or near-round.

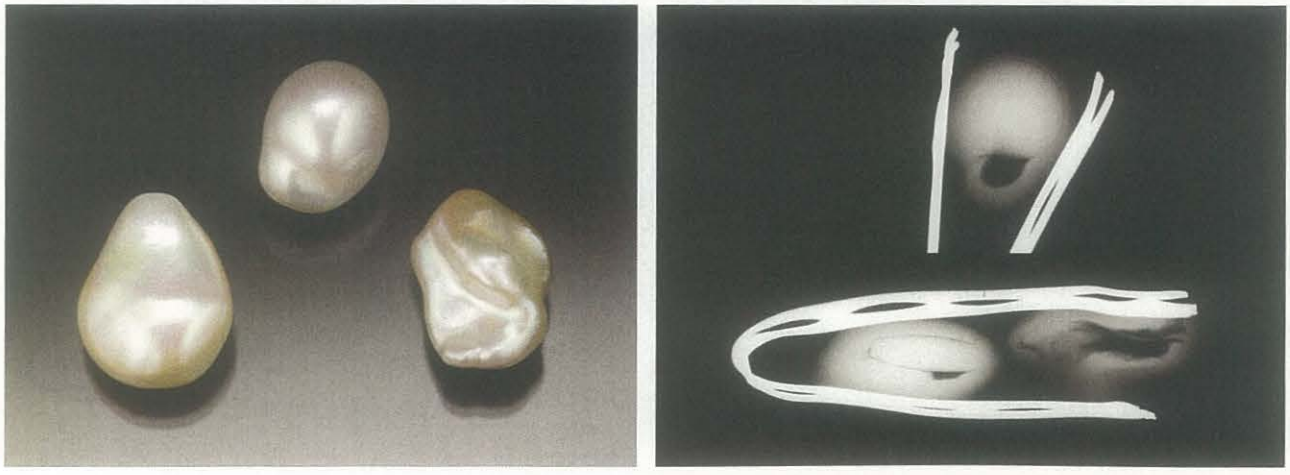
When Chinese freshwater pearl farmers use *H. cumingii* to start the process that yields fireballs and other shapes, the mussel measures about 14 cm in diameter and 19 cm laterally. At that size, it is between three and four years old. Technicians implant two or three coin-shaped shell beads, each accompanied by a 1-mm-square donor-mussel tissue piece, in the posterior ventral margin of each valve. The low number of beads helps ensure bigger and better-quality cultured pearls. The unusually small tissue piece helps minimize or eliminate the tail on the resulting "coin pearl" (J. He, pers. comm., 2007).

After one year, farmers decide on one of two steps to take next. First, their technicians can harvest the "coin pearl" and return the mussel to the water for another year to produce an often petal-shaped "keshi" pearl. Second, they can let the "coin pearl" continue to grow for an additional year (figure 5).

After the second year, farmers make one of three choices for each pearl sac. First, their technicians can harvest the "coin pearl" or "keshi" and place a 9–12.5 mm spherical bead in each of the empty pearl sacs. Second, they can let the existing "coin pearl" continue to grow. Third, they can let the existing "keshi" continue to grow. After the choice is made, technicians return the mussel to the water for one or two additional years. At this stage, a two-year pearl-growth period produces bigger and better-quality cultured pearls (J. He, pers. comm., 2007).

X-radiography at the GIA Laboratory in Carlsbad revealed the internal features of the three different kinds of cultured pearls produced by this method (figure 6). X-ray fluorescence and EDXRF testing of the beads in round and baroque samples proved they were of saltwater-mollusk origin (figure 7). Beads used in saltwater pearl culture and the direct-operation freshwater pearl culture method

Figure 6. The photograph (left) and composite X-radiograph (right) are of the same CBSB-nucleated cultured pearls and are configured in parallel. The top sample shows a spherical bead nucleus, the one on the left shows a coin bead nucleus, and the one on the right is a "keshi" with no nucleus. The samples were sieve-sized at 12–14 mm. Courtesy of Sea Hunt Pearls; photo by Kevin Schumacher, X-radiograph by Cheryl Wentzell.



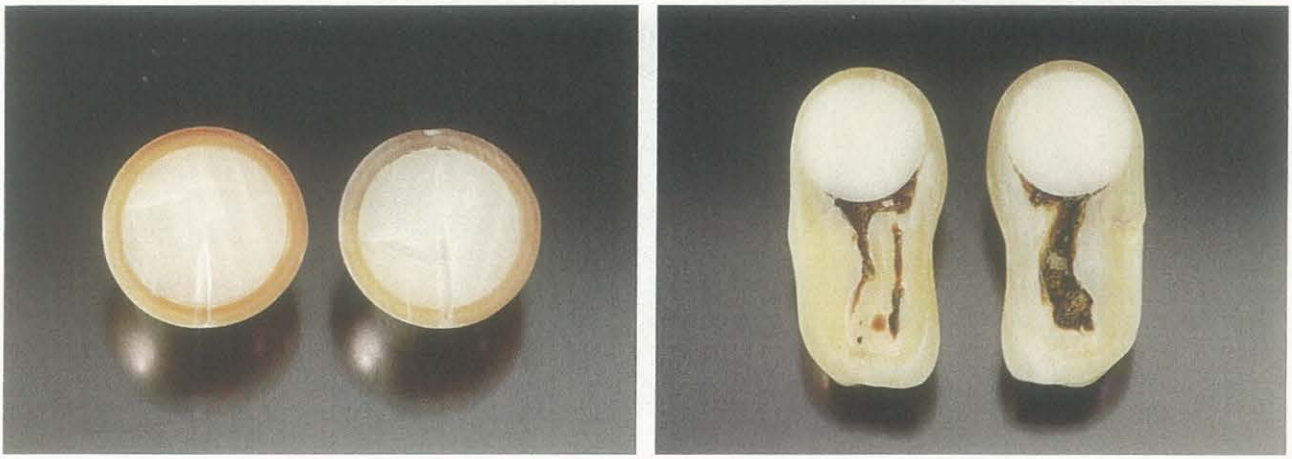


Figure 7. A 13.4 mm CBSB-nucleated round pearl sawn in half on the drill-hole axis revealed a 10.7 mm shell bead (left). An 11 × 23 mm CBSB-nucleated baroque pearl sawn in half on the long axis revealed a 9 mm shell bead (right). X-ray fluorescence and EDXRF tests proved the beads to be of saltwater origin. Courtesy of Sea Hunt Pearls; photos by Kevin Schumacher.

described above are virtually always of freshwater-mussel origin.

During the final CBSB one- or two-year pearl-growth period, *H. cumingii* typically deposits 0.5–0.75 mm of nacre per year on the "coin pearl," on and often adjacent to the spherical shell bead, and on the "keshi." In two years, a 12 mm spherical bead can become a 15 mm round or near-round cultured pearl, or a baroque cultured pearl with or without a tail (J. He, pers. comm., 2007).

How the tail develops or why it does not is not precisely known. Speculation centers on what happens when a technician places a spherical bead in a coin-shaped pearl sac. The result depends on the size of the spherical bead and sac, where in the sac the technician presses the spherical bead, the elasticity of the sac, and how the mantle tissue reacts. The technician's skill and his or her possible introduction of random epithelial cells can also affect the final product (J. He and G. Latendresse, pers. comms., 2007).

The incision that permits removal of a coin bead and insertion of a spherical bead is lateral and faces the technician. If the mussel accepts the spherical bead and heals the incision, the pearl sac closes and the mantle tissue deposits nacre. If the mussel expels the spherical bead, a "keshi" pearl forms in the sac and becomes whatever shape the sac adopts after the incision heals.

If the pearl sac completely conforms to the spherical bead (figure 8), it deposits nacre only on the bead, and a round or near-round cultured pearl results. If the pearl sac does not conform to the spherical bead, it deposits nacre on the bead and in any void that remains in the sac. In that case, a baroque cultured pearl results, with or without a tail. Baroques occur more frequently than rounds and near-rounds.

Figure 8. This spherical bead in an H. cumingii *mussel was on its way to becoming a CBSB-nucleated cultured pearl. The cultured pearl would probably have been round or near-round when harvested, because the formerly coin-shaped pearl sac had conformed closely to the spherical bead. A technician implanted the spherical bead about five months before the photo was taken, along with other spherical beads that had been removed at the time of photography. Photo by Valerie Power.*

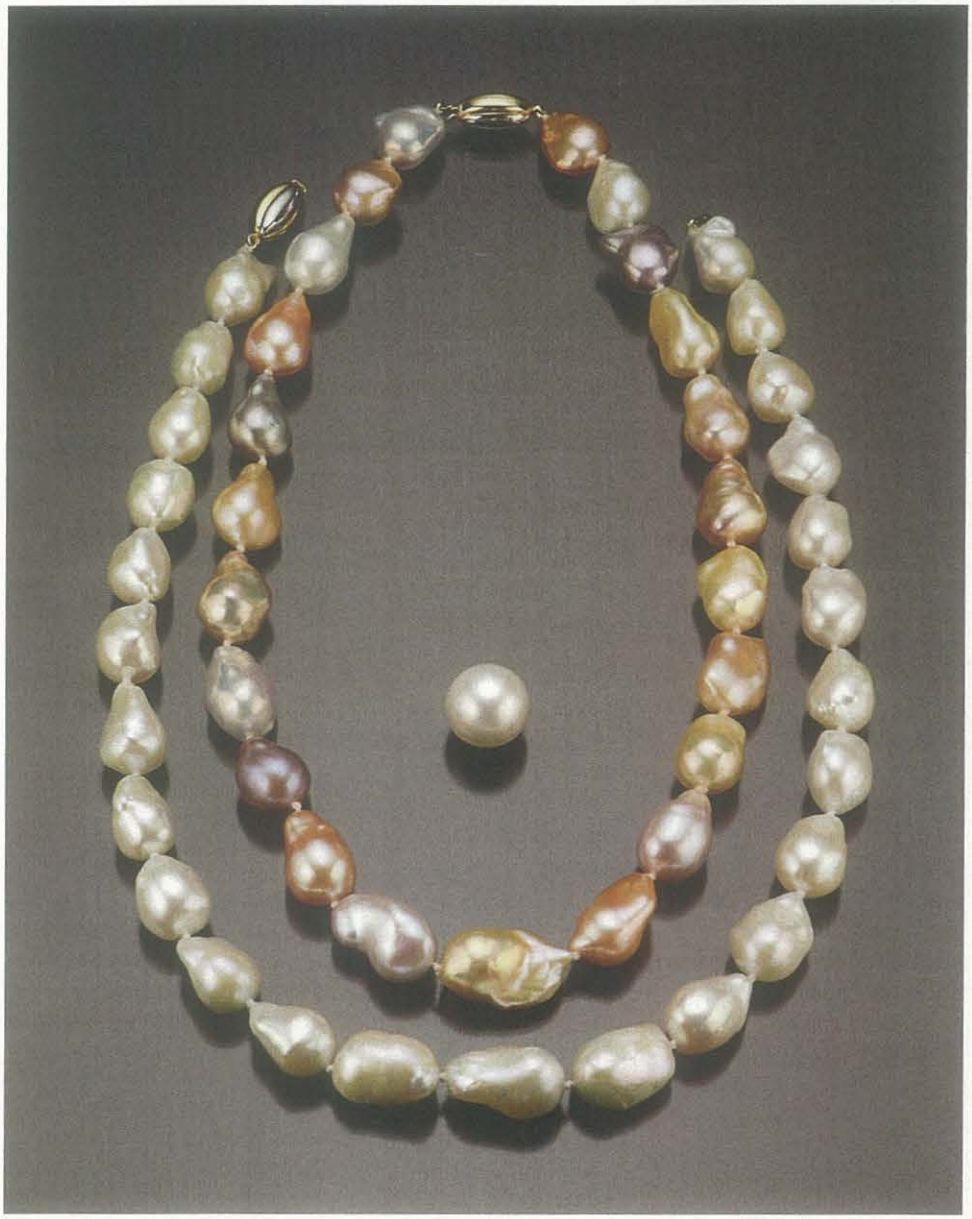


Figure 9. The 12–14 mm baroque CFCPs in these strands were produced using the CBSB-nucleation method. Those in the multicolored strand are natural color, while those in the white strand were bleached. A 15 mm bleached round CFCP is shown for comparison. The authors could not identify the mussel that produced these CFCPs. Courtesy of Sea Hunt Pearls; photo by Kevin Schumacher.

CONCLUSION AND PROJECTION

Chinese freshwater pearl farmers are creative, industrious, and resourceful people. They originated pearl culture about 800 years ago by creating blister pearls in *Cristaria plicata* mussels. In the 1960s and 1970s, they flooded the market with wrinkled, oddly shaped "rice" pearls, also grown in *C. plicata*. In the 1980s, farmers switched to *H. cumingii* mussels, maintained a huge volume, and began improving their product in every value factor. In the late 1990s, Chinese researchers imported *H. schlegelii* from Japan, propagated the species in hatcheries, and produced a hybrid with *H. cumingii*. We believe farmers later began using *H. cumingii*, *H. schlegelii*, and the hybrid to grow tissue-only and CBSB-process cultured pearls (figure 9).

The CBSB method is the latest in a long chain of successes that have resulted from constant experimentation. Some observers now predict that within two years, Chinese freshwater pearl farmers will discover how to control shape using the CBSB method (J. Lynch, pers. comm., 2007), will continue to improve quality, and will consistently produce rounds, near-rounds, and whatever other shapes and quantities the market demands and can absorb.

ABOUT THE AUTHORS
Mr. Fiske (dfiske@gia.edu) is a writer/editor in the Course Development department at GIA in Carlsbad, California. Mr. Shepherd is the founder of PearlParadise.com Inc. and Pearl-Guide.com in Los Angeles.

ACKNOWLEDGMENTS
The authors gratefully acknowledge Jack Lynch of Sea Hunt Pearls in San Francisco for supplying Chinese freshwater cultured pearl samples for examination and photography, and You Hong Qing of Xuwen Jinhui Pearl Co. in Xuwen, China, for research assistance. Special thanks to Faye Tian of Holy City Pearl Co. in Zhuji, China, for being a gracious guide and host. The authors thank Cheryl Wentzell, Sam Muhlmeister, and Dino DeGhionno of the GIA Laboratory in Carlsbad for the X-radiographs/X-ray fluorescence testing, EDXRF analysis, and sawing, respectively. The authors are grateful to Gina Latendresse of The American Pearl Company in Nashville, Tennessee, for her expertise. The authors are especially grateful to pearl farmers Cai Shui Miao, He Jainhua, and Yang Jinlong of Zhejiang Province; to Joyce Pan, Shao Wei Huan, Wang Jian, and Zhan Wei Jiang of Grace Pearl Co. in Zhuji and Hong Kong; to Lou Yongqi and Shou Tian Guang of Shanxiahu Pearl Group Co. in Zhuji; to Lu Ling Hong of Heng Feng Jewellery Craft Factory and Zhou Hai Lin of Joint Venture Pearls Cultivation Holding Co. in Weitang, Jiangsu Province; and to Johnny Chan of the Hong Kong Pearl Association. Thanks also to Melissa Wong of Jewellery News Asia *in Hong Kong for her generous assistance.*

REFERENCES

Akamatsu S., Li T., Moses T., Scarratt K. (2001) The current status of Chinese freshwater cultured pearls. *Gems & Gemology*, Vol. 37, No. 2, pp. 96–109.

Federman D. (2006) Fireball cultured pearls. *Modern Jeweler*, Vol. 105, No. 6, pp. 51–52.

Lei S. (2005) Aquaculture varieties: *Hyriopsis schlegelii* artificial breeding. *Journal of Beijing Fisheries*, No. 4, pp. 62–63.

Mikimoto Pearl Island (1998) *Pearl Museum*. Toba City, Japan.

Pawasarat C. (2007) Biwa on the edge. *Colored Stone*, Vol. 20, No. 3, pp. 26–30.

Wong M. (2006) Production of bead-nucleated freshwater pearls on upward trend. *Jewellery News Asia*, No. 261, p. 62.

Xie N., Li Y., Zheng H., Wang G., Li J., Oi N., Yuan W. (2006) Comparison of culture and pearl performances among *Hyriopsis schlegelii*, *Hyriopsis cumingii* and their reciprocal hybrids. *Journal of Shanghai Fisheries University*, Vol. 15, No. 3, pp. 264–269.

Xu X., Qiu Q., Sun X., Luo J., Hu G., Jiang Y. (2005) A comparative study of *Hyriopsis schlegelii* and *H. cumingii* mussels in pearl production. *Jiangxi Fishery Sciences and Technology*, No. 1, pp. 39–41.