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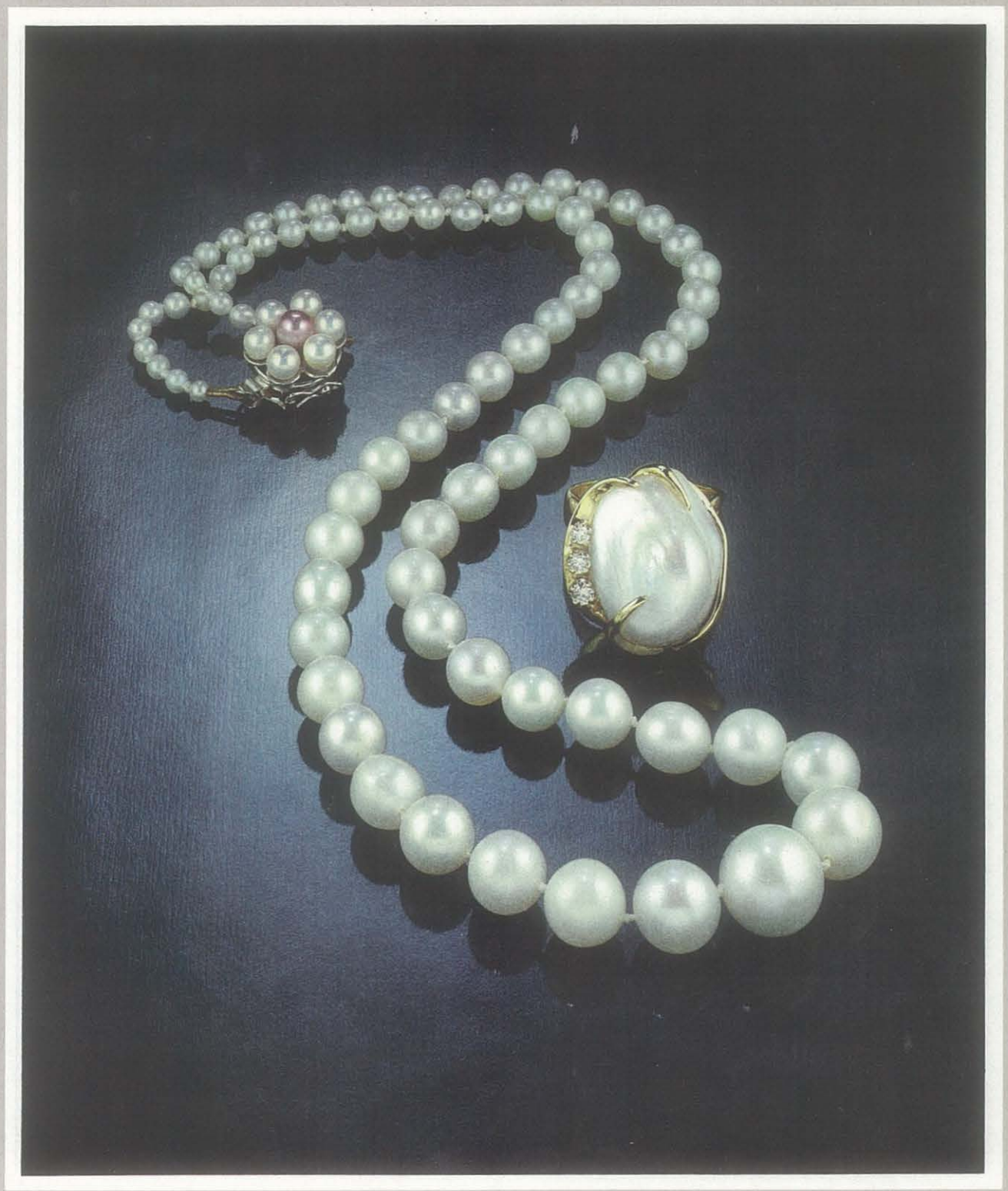

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FRESHWATER PEARLS OF NORTH AMERICA

By James L. Sweaney and John R. Latendresse

Natural pearls are among the rarest and most valued of fine gems. American freshwater pearls have a history thousands of years old and played a particularly prominent role in the jewelry of the late 19th and early 20th centuries. Today, though a fraction of its original size, the American freshwater pearl industry continues to produce fine material for the jeweler worldwide. The source of this pearl is the Unio mussel, "fished" by brailing boats and intrepid divers from the rivers and lakes of America. From the Unio in which it grows, the American freshwater pearl derives its distinctive shapes and colors. A new entry to the American pearl industry is the freshwater cultured pearl, illustrated in this article for the first time ever.

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Pearls are undoubtedly one of man's oldest treasures. As he sought food, primitive man would have found certain mollusks easy game. Inevitably, in time, he would have encountered pearls within these mollusks. Only the simplest of tools were needed to pierce these lustrous objects and fashion them into enchanting, enduring ornaments. As civilization developed, the pearl was often associated with purity, innocence, hope, and femininity. In contemporary times, the pearl has come to be known as the "Queen of Gems."

Historically, pearls have been enormously popular. During the Renaissance, when exploration opened the Orient and the New World to the traders of Europe, pearls were sought with such passion that the period has been called "the Pearl Age" (Kunz and Stephenson, 1908). No opportunity was ignored, and so pearls were fished wherever they could be found, from both freshwater and saltwater sources.

The next great pearl boom occurred in the late 19th and early 20th centuries, when pearl prices soared to fabled heights not seen before or since. In fact, natural pearls were so important during this period that many fine jewelers derived most of their income, reportedly as much as 80%, from the sale of pearls (Shire, 1982). Freshwater pearls played an important role in this market, because new discoveries of freshwater pearly mussels in the lakes and rivers of the United States contributed significantly to the supply of fine natural pearls. Although freshwater and other natural pearls have been overshadowed in recent years by the sheer volume of their cultured counterparts, they continue to be one of the classic gems, distinctive and highly prized for their beauty, wearability, uniqueness, and rarity.

In this article, we will discuss the freshwater pearls of North America, in particular those from the United States (figure 1). We will review how the freshwater mussel and its pearls have been harvested and used, describe

the natural history of these mussels and the pearls they produce, and look at the future of the freshwater pearl industry—both natural and cultured—in the United States.

A HISTORICAL PERSPECTIVE

There is good reason to believe that freshwater pearls were found very early in man's history. Indigenous to the lakes and rivers of North America, Europe, and Asia, the freshwater pearly mussel was an easily accessible food source. Opportunistic aborigines had only to wade into the shallows to be able to gather protein-rich food from often enormous beds of Unio mussels. Even in modern times, mussel beds have been found stretching several miles along a river, harboring hundreds of thousands of these creatures. Given the tendency of these mussels to form pearls, it is likely that men who lived off the mussels encountered freshwater pearls very early on.

In their monumental work, *The Book of the Pearl* (1908), Kunz and Stephenson describe early written references to pearls, the earliest of which appears to be the Chinese *Shu King*, in which freshwater pearls are described as having been fished from rivers in China and strung into necklaces around 2300 B.C. In America, some of the ancient mounds and shell middens of the Tennessee River Valley show evidence that the Indians used the mussel as food and the shell for utilitarian and decorative purposes as early as 4500 B.C. During the Woodland period, approximately 1000 B.C. to 800 A.D., the use of pearls appears to have been extensive, especially in culturally advanced tribes. The Hopewell mounds of Ohio, which contained large caches of freshwater pearls, date from about 200 B.C. to 200 A.D. (Dr. Bruce Smith, pers. comm.).

When the Spaniards began their exploration of the New World, they found and exploited good saltwater pearl fisheries in the Caribbean, especially around Venezuela, and along the Pacific coast of Panama and Mexico. Hernando de Soto's expedition into the southeastern portion of continental North America (1539–1542) was the first to report the discovery of American freshwater pearls. De Soto and his men encountered Indian tribes with what were described as "strings" and "festoons" of pearls. They were able to come away with some treasure, but on the whole the expedition was disappointing. Although some of what they brought back were actually fine pearls, much of what they saw were probably beads and other ornaments that the Indians had made out of the mother shell (Kunz and Stephenson, 1908). Other early finds occurred along the Atlantic seaboard and the lower portions of the Mississippi River, but these were generally minor in scope. Perhaps because their expectations were too high, or because the freshwater pearls were less accessible to the great sailing ships of the time, or because many of these pearls were different from the saltwater pearls the Spaniards were familiar with, these early explorers did not make much of their discoveries, and the North American freshwater pearls lapsed into obscurity for several centuries.

With the "rediscovery" of the freshwater pearl at Notch Brook in New Jersey in 1857, however, the heyday of the American pearl fisheries began. Significant pearl finds—on the Little Miami River of Ohio in 1878, the Pecatonica and other rivers of Wisconsin in 1889, the White River of Arkansas in 1895, the Clinch River of Tennessee in 1901, and others—made headlines that brought frenzied "pearl rushes" to these areas. During this period, many of the waterways of the eastern portion of the country were explored and developed for pearl or mussel fishing, but most of the pearl seekers wanted quick riches and so concentrated their efforts on the major finds (Kunz and Stephenson, 1908).

Freshwater pearls were very popular during this period, especially in the local areas where they were fished and in Europe. Jewelry of the Victorian period was sometimes set with numerous small "seed" pearls encircling a center gem or with rosettes of freshwater pearls arranged like the petals of a flower (see, for example, the pendant in the center of figure 1, a reproduction of a Victorian design). Jewelers of the Art Nouveau movement used American freshwater pearls extensively because the baroque, often grotesque natural shapes and unusual colors of these pearls worked well with the themes and sentiments of the period.

The mussel shells soon became an important resource themselves. J. F. Boepple, a button maker who immigrated to the United States from Germany in 1887, is credited with having fathered a new industry when he established a mother-of-pearl button factory in Muscatine, Iowa, in 1891. This new industry quickly expanded and became very important to the economy of the Midwest.

Figure 1. A sample of contemporary jewelry fashioned using American natural freshwater pearls. The pendant in the center is a reproduction of a piece from the Victorian era. Photo © 1984 Tino Hammid.

Besides buttons, numerous other mother-of-pearl products, such as handles for knives and razors, inlaid shell boxes, and other decorative objects, were turned out by these factories. By the turn of the century, Muscatine was the pearl-shell capital of the world. Button making brought prosperity to many areas, and steady employment to large numbers of factory hands as well as to the river folk and fishermen who gathered the mussel. The pearls were a valuable and important by-product, so pearl buyers from all over the world came to the button-making centers (Musgrove, 1962).

The mussel-shell and pearl industry ran at a strong pace until the 1920s, when a series of factors combined to topple it. The introduction of plastic buttons, which could be made more cheaply and to the precise dimensions required by modern sewing machines, began to erode the market for mother-of-pearl buttons. Many major natural pearl suppliers left the business at this time as increasing sales of cultured saltwater pearls from Japan, and decreasing production of natural pearls of all types, worked with negative publicity about the difficulty of separating cultured from natural pearls to undermine the market for natural pearls. Finally, the stock market crash of 1929 triggered the collapse of already weak natural pearl prices, and the Depression brought the shell-button industry to a virtual halt. To date, natural pearl prices have never re-

Figure 2. On "Decoration Day," the people who live and work along the Tennessee River gather at their family cemeteries and decorate the graves of their loved ones with freshwater mussel shells and other objects. The custom is said to have come to the U.S. from Ireland. Photo courtesy of the Tennessee River Folk Life Center, Nathan Bedford Forrest State Park, Eva, Tennessee.

gained the heights they reached in the early part of the 20th century. The shell-button industry remained marginally active until the last major factory, located at Savannah, Tennessee, closed in the 1950s.

The collapse of the button industry was offset in the late 1940s and early 1950s by the development of a new market for the shell: the saltwater pearl culturing industry of Japan. These growers, through trial and error, had found that the shells that produced American freshwater pearls were the ideal raw material for the shell bead they needed to nucleate their cultured pearls. After World War II, Japanese buyers came into the market heavily and a new boom for the mussel shell business began. Today, four or five suppliers export about 3,500 to 6,000 tons of freshwater mussel shell to Japan each year. In the midwest and southeast portions of the United States, mussel fishing is still a tradition for the people who live along the rivers and lakes. Indeed, it has become the custom in some areas to decorate the graves of loved ones with the mussel shell (figure 2).

In the 1950s and early 1960s, a number of important pearls were found as a result of the shell harvest, since many areas had not been worked seriously for 20 or 30 years. As recently as the early 1960s, annual raw production of freshwater pearls in the U.S. was about 20,000 troy ounces, (only 15% of which was useful for jewelry). The current yield is paltry—only 500 to 600 troy ounces annually—because water pollution and other types of habitat destruction have shortened the lifespan of the mussels and as a consequence diminished the size and quality of these natural freshwater pearls. Although the current market for American natural freshwater pearls, as for all pearls, is strong, the outlook for new production of all types of natural pearls, both in the U.S. and worldwide, is bleak, because the environmental problems that led to the current state of these fisheries are not likely to be reversed.

METHODS OF HARVEST

The pearly Unio mussels are easy prey to muskrats, otters, and other animals. The Indians of North America gathered them by simply wading into the river or lake, locating the mussels with their feet or hands, and pulling them out of the mud. This method is still used occasionally in areas where the mussel can be found in shallow water, and is referred to by local people as "toe digging." The Indians also developed a method of harvesting that was a precursor to one of the principal methods of commercial harvesting used in the 20th century, known as "brailing." Their method was to drag cedar branches behind their dugouts and canoes. The branches passing over a mussel bed would disturb those mussels that were open to feed, so that they would quickly close their shells, as often as not clamping onto the branches.

During the pearl rushes of the 19th and early 20th centuries, "toe digging" and long-handled rakes were the most common methods of harvest. As the button industry developed and the demand for large quantities of shell grew, the harvest be-

came more sophisticated, and "brailing" became the favored technique. The brail is a long bar or board, 6 to 15 feet (3–5 m) long, to which numerous "crowfeet" are attached via short ropes or cords. The "crowfoot" is a steel-wire device with several hooklike prongs that splay out like the toes on a bird's foot. Several "crowfeet" are fastened to each rope, and these ropes are attached every six inches or so along the brail. The brail is dragged behind a boat over the mussel bed, and the mussels clamp onto the "crowfoot" as it passes over them (figure 3). Brailing is mainly suited to working level areas with high concentrations of mussels, and since the brail can also disturb the habitat and damage the mussels not captured, it is now only in limited use.

Much of today's harvesting is done with conventional diving techniques. The diver dons a wetsuit, weight belt, and mask, and breathes with a regulator that is connected by an air hose to a compressor situated in his boat. Submerged in murky water from 20 to 60 feet (6–20 m) deep, the diver works in total darkness, finding his catch by touch. Since most of the shells produced today are used to make the nucleus for saltwater pearl culturing, the diver seeks only certain types and sizes of mussels. Those he leaves behind suffer minimal disturbance. Diving also allows production from areas that would not normally be accessible by other methods.

Experienced divers can make good money, but the work is risky and dangerous. First, the diver must often operate in total darkness, a condition that many people cannot tolerate. Also, any diving done in water over 20 feet deep is dangerous. Without controlled and accurate decompression, the diver runs the risk of getting the "bends," which can be crippling or even fatal. Many divers work alone, so accidents or equipment malfunction can also be a real problem. Since they breathe air pumped down from the surface and are not limited in the time they can spend on the bottom, the divers can easily work to the point of exhaustion, becoming too weak to help themselves when a problem arises. The diver must often work his way around commercial fishing lines, tree stumps, and other underwater hazards, and often dives near commercial shipping lanes or in areas open to recreational boating. It takes a special kind of person to cope with working in such a difficult and hostile environment.

Yet some of the areas where mussels are still found are economically depressed and the opportunity to earn some money can be a very strong incentive. Many who try diving have little or no training; some do not even know how to swim! Some earn a good living fishing the mussels, but most simply get by or supplement other earnings. The risks are too great, the work is too hard for most. Those who succeed earn every penny.

Figure 3. A modern-day brail, with a few captured freshwater pearly mussels. Photo courtesy of the Tennessee River Folk Life Center, Nathan Bedford Forrest State Park, Eva, Tennessee.

NATURAL HISTORY OF THE UNIO MUSSEL

Freshwater pearly mussels are a diverse and widespread group of bivalve mollusks classed under the family Unionidae. The name is derived from the Latin word *unio,* which means a large, fine pearl. Fossil records and other data indicate that this group of animals appears to have developed about 350 million years ago, during the late Devonian or early Mississippian period. The Unios probably evolved from marine animals, although exactly when and where is the subject of some dispute among scientists (Dr. D. H. Stansbery, pers. comm.).

Technically, Unios are neither mussels nor clams, but are a distinct and unique family of freshwater mollusks, characterized mainly by nacreous shells and a life cycle that has an intermediate larval form which parasitizes vertebrate animals, usually fish. The scientifically correct term is *naiad,* after the nymph of Greek mythology who presided over rivers and lakes. However, those who make their living from the Unios, and even scientists, usually call them "mussels" or "freshwater pearly mussels." In this article, we will use the traditional name *mussel.*

At one time, scientists estimated that the Unio family contained more than 500 species, which were spread throughout the lakes and rivers of Asia, Europe, and North America. Currently, the number of species is estimated to be around 250 to 300. Although much of this reduction is due to reclassification and clarification of the nomenclature, many Unio species have become scarce or extinct in recent times because of habitat reduction and alteration, water pollution and, to some extent, overharvesting. At least 20 species have vanished from North America during the 20th century, and a similar number are listed as endangered (Dr. H. van der Schaile, pers. comm.).

North America, especially within the Mississippi River drainage area, provides the perfect habitat for these animals because of the large areas of watershed with limestone substrata. This abundance of limestone creates the "sweet" (alkaline) water and the concentration of calcium that is most conducive to the growth of Unios, enabling North America to support a diverse and abundant population of these mussels. The distribution of these mussels is mainly in the eastern two-thirds of the United States (figure 4).

As mentioned, Unios have been found worldwide. The populations of the British Isles, mainly in Scotland and Ireland, are much reduced, although some very marginal pearl fishing still takes place. In Europe, the mussels have almost totally vanished. India and Pakistan have some Unio species, and some are probably found in Russia, especially Siberia, but the information on these occurrences is limited. China and Japan probably harbor the largest population of Unios outside North America. All the cultured freshwater pearls produced in these countries are grown in the three Unio species they have found suitable for culturing. Africa and South America are also known to support some of these mollusks.

Unios are generally hardy animals. Some species live in clear, fast-running mountain streams; others inhabit larger, slower moving rivers; still others prefer the even quieter waters of lakes and ponds. Their basic pattern of life is quite simple. Most live half-buried in the mud, sand, or gravel bottom of the body of water that they inhabit, feeding on waterborne bacteria, algae, and other plankton, and breathing waterborne oxygen by means of gills. Some types, especially those that live in mud or sand, can move about by means of a muscular foot. And several species, commonly called "floaters," are even able to inflate their bodies with gas so they can float and be carried along by current and wind! For the most part, though, Unios are sedentary, staying in one spot their entire life.

Unios normally populate a habitat rapidly, because one female can produce hundreds of thousands of larvae each year. These offspring are a valuable contribution to the food chain: where mussels are numerous, fish and other aquatic life forms are usually abundant. The larvae usually disperse by attaching themselves to fish. They may be further transported by birds and other animals that eat the host, so it is not unusual to find them in landlocked lakes and ponds.

While most Unios range from 3 to 6 inches (7.5–15 cm) across, some species are much smaller, with a maximum size of one inch or less. Others, like Megalonaias gigantea (the "washboard"), span a foot (30 cm) or more at maturity (figure 5). All species continue to grow as long as they live, but growth is most rapid the first few years. Most species live 15 to 50 years; in a

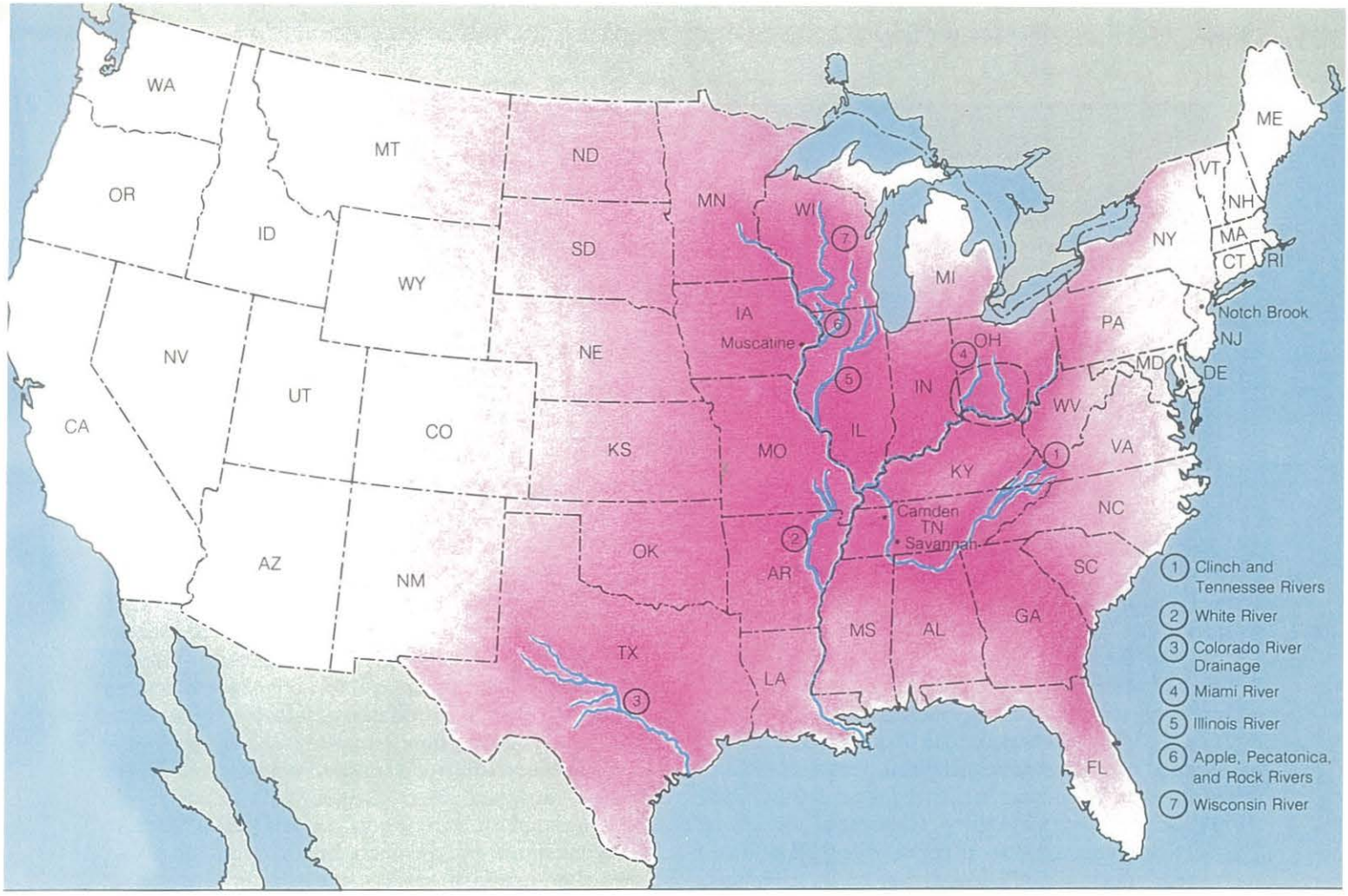


Figure 4. General range of Unios in the United States, approximate maximum distribution. Rivers of note are shown in blue; the Hopewell mound area is indicated by a dotted line.

nonpolluted habitat, some live as long as 100 years.

Because of their diversity, Unios can occupy many niches in the ecosystem, their main requirement being suitable water quality. Most importantly for man, Unios convert dissolved calcium into the lustrous aggregate materials that make up their shell and, under certain conditions, form pearls. All Unios produce shells with nacreous inner surfaces, and all continue to secrete nacre as long as they live, although the nacre flow slows with age. Some species, such as those used for freshwater pearl culturing in Japan and China, grow very thin shells, no more than 1 or 2 mm thick. Other species, such as those that provide the raw material for the mother-of-pearl beads used in saltwater pearl cultivation, form rather heavy shells, some portions of which are 15 to 30 mm thick. Generally, the thicker-shelled Unios are found in waters that contain a high concentration of dissolved calcium.

While most species produce white nacre, many other colors also occur, including pink, orange, lavender, and purple. The color of the shell and the pearl is a complex result of genetic and/or environmental factors, and is not totally understood. Some species that normally produce white nacre may also produce pink or orange nacre in certain bodies of water. Other species always produce one basic color of nacre, but the tone and general appearance of that color may vary considerably, depending on numerous factors.

Because most Unios are sedentary and live in habitats that tend to be quite rich in animal life, they are exposed to many natural circumstances that can cause pearls to form. For example, Unios are often hosts to various parasites, usually snails, other small mollusks, and various types of worms. In their search for food, these creatures get inside the protective shell and burrow into the

Figure 5. The Unio, or pearly mussel, in which natural freshwater pearls form. The species illustrated here, Megalonaias gigantea (the "washboard"), may grow to more than a foot; this shell measures approximately 5 in. (13 cm). Photo © 1984 Tino Hammid.

flesh of the mussel. The mussel is usually able to seal off and kill the intruder, and then gradually envelop the body in nacre, forming a pearl. Or a small fish can attack the mussel when it is opened to feed, tearing off bits of the mantle. A stray crumb of mantle tissue lodges in the shell, and a pearl begins to grow around it.

Self-nucleation is also possible. All of these mussels have a tooth-like structure on each valve near the hinge which allows them to grind their food. Because of the tremendous leverage involved, bits of this structure frequently break off and pearls form around them, between the "teeth." These pearls have a distinctive shape and texture that matches the "teeth" perfectly.

Unio pearls are often nucleated by debris, primarily bits of shell and possibly fish scales, carried into the mussel bed by water currents. In the early days, pearl seekers looked for mussel beds located just downstream from Indian mounds and shell heaps, where an abundance of minute shell particles weathered out, causing pearls to form much more frequently.

A common belief is that pearls are started or nucleated by a grain of sand. In the authors' opinion, based on years of personal observation and experimentation, the usual process of nucleation of natural pearls, at the very least in freshwater mussels, is the accidental introduction of natural *organic* substances, especially those of calcareous shell, into the body of the mollusk. While it is true that mineral substances can be used to culture blister pearls, and that pebbles can be encapsulated within a natural blister, these objects become heavily coated with conchiolin before the nacre will cover them. There is little if any attachment of nacre to such an object. In fact, the growers of Mabe-type cultured blister pearls use a plastic or soapstone hemisphere to start the blister, because these objects do not attach to the nacre and are easily removed, so that the inside of the nacre dome can be cleaned and colored. This view is substantiated by the fact that, even after many years of experimentation with various types of nuclei, including several types of manmade calcareous substances, the Japanese saltwater pearl growers still use the freshwater shell bead.

Once a pearl has been started, it grows as the mussel and its shell grow. As the years go by and the pearl becomes larger, it increasingly affects the mussel. Pearls that start out in the main body of the mussel tend to migrate downward as they gain weight, eventully settling against the lowest portion of the shell. As the mussel continues to grow, the nacre produced in that area accumulates on the pearl rather than the shell, so that the shell gradually becomes deformed. Historically, mussel fishermen have sought these "crippled" shells because they often contain a large pearl.

Pearls that form in areas around the hinge may become so large that the mussel can no longer close its shell. Once this occurs, the mussel has little chance of survival. It is not unusual for a single Unio to produce many small pearls—some have been found to contain more than 100. In general, the larger the pearl or the greater the number of pearls, the harder it is on the mollusk.

Why do some mollusks produce that magical stuff, nacre, and others simply calcareous substances? A simple question, yet the authors have

found no answer, even among malachologists. The pearly mussels, biologically not much more than a worm with a hard shell, have long been sought for their glowing pearls. The wonder is that such a lowly creature should create such a beautiful object.

AMERICAN NATURAL FRESHWATER PEARLS

The freshwater pearls of the Unios are often beautiful, distinctive, and unusual. If one is simply interested in smoothness and roundness in pearls, then look to the cultured pearl, because the truly round natural pearl is the exception rather than the rule. The freshwater pearls of North America exhibit an exceptionally broad range of colors, shapes, qualities, and sizes.

The physical and structural properties of these pearls are essentially the same as those of saltwater pearls. Natural pearls are composed mainly of nacre, which is primarily calcium carbonate, in the form of aragonite (82%–86%), conchiolin (10%–14%), and water (2%–4%), as described in Webster (1975). The presence of manganese as a trace element is evidenced by the X-ray fluorescence exhibited by natural freshwater pearls and shells. Other trace elements are present in the pigmentation seen in freshwater pearls and shells, but the role of these substances needs more scientific study.

Identification of natural freshwater pearls is most reliably accomplished in the laboratory using a combination of X-radiography, which discloses the internal structural characteristics that show natural or cultured origin, and X-ray fluorescence, which *usually* establishes freshwater or saltwater origin. In the field, distinctive characteristics of appearance are in many cases adequate to identify freshwater natural pearls. Important identifications should be confirmed by laboratory tests or by persons experienced in handling these goods. We will describe some of these distinctive characteristics below.

Color. Peach, apricot, and tangerine . . . rose, orchid, and lavender . . . bronze, silver, and gold . . . these and other names have long been used to describe the delicate colors and shadings of freshwater and other pearls. Lacking a scientific system for the communication of pearl colors, and well aware that the description of pearl color is complicated by the optical phenomena of luster, overtone, and orient, pearl dealers usually manage to communicate to one another through consistent use of these color names. Still, actual matching of colors must be done with the pearls themselves. The development of a reliable and repeatable system of color communication for pearls is an area that the authors are currently investigating, but the problem has no simple solution. Pearl colors can be so subtle that they challenge not only our language skills but our visual skills as well.

The phenomenon of rosé (or traditionally, rosea) is a good example of why the color description of pearls can be so difficult. In natural pearls, and to some extent, cultured pearls, rosé is both an overtone color and an optical phenomenon associated with a generally high level of luster. One could say that rosé describes a certain quality of nacre that is very lustrous and translucent and that has a typical color appearance. The color appearance of rosé is usually pinkish, but it can also appear reddish, violetish, or purplish.

The degree or intensity of rosé can vary greatly also. On some pearls, rosé appears as a slight to noticeable overtone on a light body color, and would be called white rosé or creme rosé, etc. Occasionally, one sees superior pearls of light body color, where the luster is so bright and the rosé tint so strong that the underlying body color is not really noticed. The color of such a pearl might be described as a *true* rosé.

On natural pearls, rosé is almost always natural. On cultured pearls, rosé is commonly accomplished with various types of dye. It is not unusual to enhance or develop rosé in both natural and cultured pearls by simple surface treatments that remove cloudy or opaque material or smooth the surface of the pearl. As a general rule, such treatments do not work well on pearls of inferior quality.

The color description of pearls is also complicated by the presence of conchiolin in the nacre. Although conchiolin is always present in nacre, it usually occurs in minor amounts which are colorless. Often, however, conchiolin picks up impurities that turn it dark brown or black. When this dark form occurs deep within the pearl around the nucleus, it may darken the overall color; when it concentrates in patches closer to the surface, it may appear as dark blotches of various colors. It also may be deposited as a layer or layers thick enough to affect the overall color of the pearl, but not heavy enough to appear dark, thereby adding a

golden, greenish, brownish, or grayish component to the body color. Many natural freshwater pearls called bronze, golden, and the like are conchiolin-rich, and many pink and lavender colors are modified by thin layers of conchiolin, often with a pleasing effect.

Lastly, certain colors are typical of pearls from particular locales and species. White is the most prevalent body color of freshwater pearls in America; it is usually a pure snowy white, touched with varying degrees of rosé and/or orient. At least two-thirds of the natural freshwater pearls produced in North America are white. Creme colors are not particularly common in American freshwater pearls, although they are typical of pearls of the Ohio River, especially those from the upper reaches of the system. In contrast, creme colors are frequently seen in the freshwater cultured and natural pearls of Japan and China.

The "black" colors occur in freshwater pearls, but the look we associate with South Sea pearls (both natural and cultured), of a deep pure black with attractive overtones, is rare in freshwater pearls. The "black" colors normally present on freshwater pearls are very dark pinks, lavenders, bronzes, grays, and the like.

Fancy colors in pearls are considered to be any desirable body colors not found in the light group or the black group. Although freshwater pearls of the Unios are noted for fancy pink, orange, purple, or golden hues, there are so many modifications and variations of these basic colors that the range seems almost endless. Even blue and green occur rarely. The colors usually have a soft, subdued pastel look, but some can be quite vivid. Figure 6 shows excellent examples of some of the various colors, including white and rosé, of American natural freshwater pearls.

Freshwater mussels and other mollusks sometimes produce pearls with more than one color. These may be bicolored, where the two sides of the pearl are two totally different colors, or multicolored—like an opal—where a number of totally different colors are seen on a single pearl.

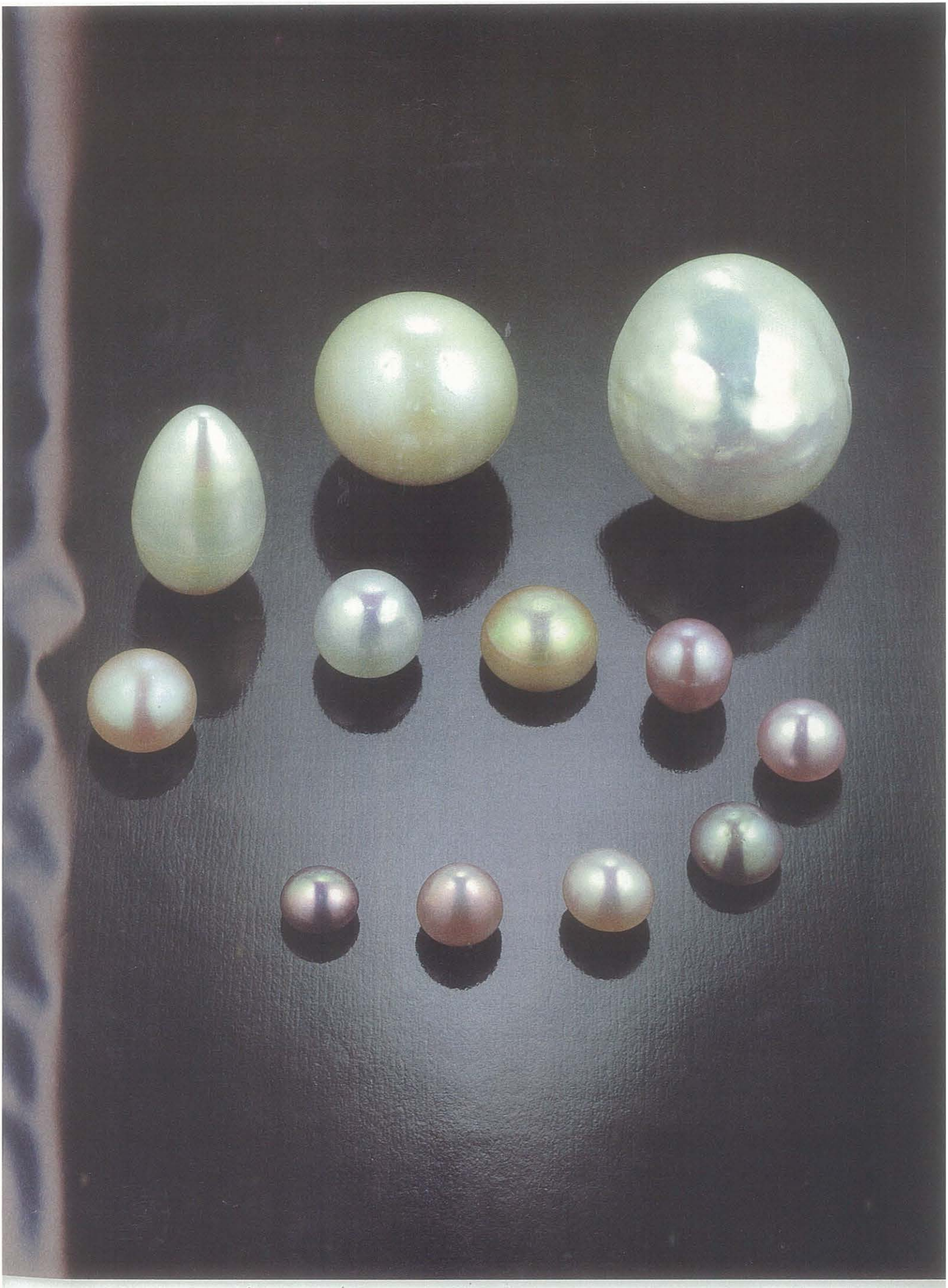
In the heyday of the natural freshwater pearl, specific mussels and certain locales were noted for their production of beautiful fancy colors. The Tennessee River and its tributaries were good producers of fancy colored pearls, because the habitat supported many different Unio species. In Texas, the Colorado River drainage, including the Concho River, the San Saba, and others, were noted for pink, purple, and lavender pearls. And several rivers in Wisconsin, including the Apple, the Pecatonica, the Rock, and the Wisconsin, produced pearls of various fancy colors, especially delicate and pure greens (again, see figure 6). Natural fancy colors are one indication (though not proof) that the pearls are of freshwater origin.

Shapes. Most natural pearls are and always have been baroque, and a good percentage of cultured pearls are baroque. In nature, the perfectly round pearl is very rare, accounting for less than 0.01% of American natural freshwater pearls, and a very small portion of other types of naturals. Even expensive strands of natural Oriental pearls usually contain many pearls that are off-round or slightly baroque. Other symmetrical shapes, such as the bouton, pear, and barrel, are also rare and unusual in natural pearls, because specific and limited factors must be present for a natural pearl to form symmetrically. The authors estimate that fewer than 5% of natural pearls are truly symmetrical.

In contrast, the shape of today's cultured pearls is usually a result of the grower's skill. Modern techniques of pearl culturing allow varying degrees of control over the form of the final product. For example, the shape of the myriad round saltwater cultured pearls produced in Japan is controlled mainly by three factors. First and most important, the round mother-of-pearl bead that is implanted as the nucleus accounts for about 70% to 90% of the volume of these cultured pearls, and thus largely determines the final shape. Next, the quality of that shell bead is carefully controlled so that no flaw in the nucleus will cause baroqueness in the cultured pearl produced. Lastly, the length of the growing period for the bulk of these cultured pearls has been reduced from several years to six to 10 months, thereby greatly reducing the chances that the cultured pearls will become baroque (Cohen, 1984).

The freshwater pearly mussels do form all the classic symmetrical shapes associated with natu-

Figure 6. Some of the many colors in which American freshwater pearls occur. Counterclockwise, from top right: rosebud, rosé, 25.4 × 20.8 mm (52.89 ct); round, light peach-pink, 17.2 mm (33.55 ct); pear, white rosé, 17.9 × 11.0 mm (15.54 ct); group of boutons 7.5 to 10 mm in diameter, showing various natural fancy colors. Photo © 1984 Tino Hammid.



ral pearls. Usually, these pearls are formed in areas near the adductor muscles and at the periphery of the shell, where the pearl can be turned or spun by the normal activity of the mussel, thus causing the nacre to be deposited smoothly and evenly. As evidence of this phenomenon, some symmetrical pearls show deposits of coarser nacre or chalky substances, and also grooves, that have been laid down concentrically onto the surface of the pearl, as if with a draftsman's compass. Symmetrical freshwater pearls are quite rare and desirable, with the round and the pear shape being the rarest, and the bouton and the barrel shape the most common. The pearls in the graduated necklace shown on the cover of this issue are all natural round freshwater pearls from the Tennessee River, and represent over 25 years of diligent collecting and sorting.

The Unios also produce pearls in an amazing array of baroque shapes and forms, often delightful, sometimes grotesque, but never boring. Some of these shapes are similar to the baroque pearls formed by other mollusk groups, but many are unique and typical of the freshwater pearly mussels. Certain of these shapes occur repeatedly, reflecting a set of conditions that is prevalent within the environment of the mussel.

Figure 7 shows several groupings of natural freshwater pearls which represent the most common baroque shapes found in American waters. Note that within each group, each pearl is unique but the overall shapes are similar. These groupings by shape are part of the system traditionally used by natural pearl dealers in America to sort and grade small natural freshwater pearls. Larger goods are usually graded and evaluated on an individual basis. Of these basic groups, "wings" and "petals" are the most common, and shapes no. 2 and no. 6 are the least common.

Other baroque shapes have been found with enough frequency to merit special names. Because of beauty, rarity, and demand, these classic baroque pearls may carry the same value as some of the symmetrical pearls of equivalent size and quality. One of these, the "turtleback," is roughly oval in outline with a domed cabochon-like top. Turtlebacks generally have a smooth surface with good luster and orient, so they are ideally suited for making important pieces of jewelry (the ring on the cover of this issue contains a fine turtleback pearl). Turtlebacks sometimes show a curious texture within the nacre that resembles stretch marks in human flesh. This texture reflects the fact that they usually grow near the outermost edge of the mussel shell, where the mantle has to stretch to cover the pearl. Mabes and other blister pearls which grow near the periphery of a mollusk shell sometimes show a similar texture. Turtlebacks normally start out as a free pearl within the mantle, but they may break through the mantle as they gain weight, settle against the shell, and become encapsulated as a blister pearl.

Another special shape is the "rosebud." This characteristically American freshwater pearl is typically high domed, with a flat back and roughly

Figure 7. Typical small baroque American natural freshwater pearls, of average to better quality, grouped in traditional shape categories. Left to right: shape no. 2, semi-round, sometimes referred to as "nuggets"; shape no. 3, oval but thick; shape no. 4, roughly triangular, known as "petals"; shape no. 5, longish but flat; shape no. 6, roundish or oval, but flat; and one size of "wing" pearls. Photo © 1984 Tino Hammid.

Figure 8. American natural freshwater pearls, nucleated by snails and periwinkles. Counter-clockwise, from top right: snail, white rosé, 39.0 × 30.0 mm (89.93 ct); snail, fancy bronze-lavender, 31.0 × 25.2 mm, (80.43 ct); pair of periwinkle pearls, matched, fancy pink and gold. Photo © 1984 Tino Hammid.

roundish outline. The top is always covered with bumps or ridges and, to be a true "rosebud," must be of very high luster and quality. Again, this type of pearl lends itself to fine jewelry. The bumpy or ridged surface is thought by the authors to be caused by multiple nucleation or by minute life forms or debris attaching to the surface of an otherwise smooth pearl. The face-up view of an exquisite and very large rosebud pearl is shown in figure 6, upper right.

The "snail" shape is also considered a classic. Pearls that are nucleated by snails or other shelled creatures usually take on the orientation of the calcium carbonate platelets of the shell at the nucleus, and can maintain the basic shape of the nucleus for many years. The large snail-shaped pearl in figure 8, upper right, was X-rayed and found to have a nucleus about 4 mm across. This pearl probably grew for at least 30 years before it was taken from the host mussel, and yet it retained the orientation of that tiny snail for the entire time. Figure 8 also shows an extremely fine and large lavender-colored snail pearl and a pair of wing-shaped pearls, which were probably nucleated by periwinkles.

Baroque pearls with totally unique shapes may be referred to as "exotics" or, if grotesque, as "monsters." Often, the form brings to mind a picture or image, and that pearl will be formally described according to that image, for example, "acorn," "bird's head," "strawberry," and the like. When such a pearl is large and of fine color and luster, the unique shape may add significantly to its beauty and value.

The nucleation of natural freshwater pearls by snails and other small mollusks also generates distinctive surface features. Many natural freshwater pearls show swirling, spiraling grooves or raised lines on the surface, which may be either deep and prominent or quite fine. These grooves or lines usually follow the overall shape of the pearl, more or less paralleling one another, rarely if ever

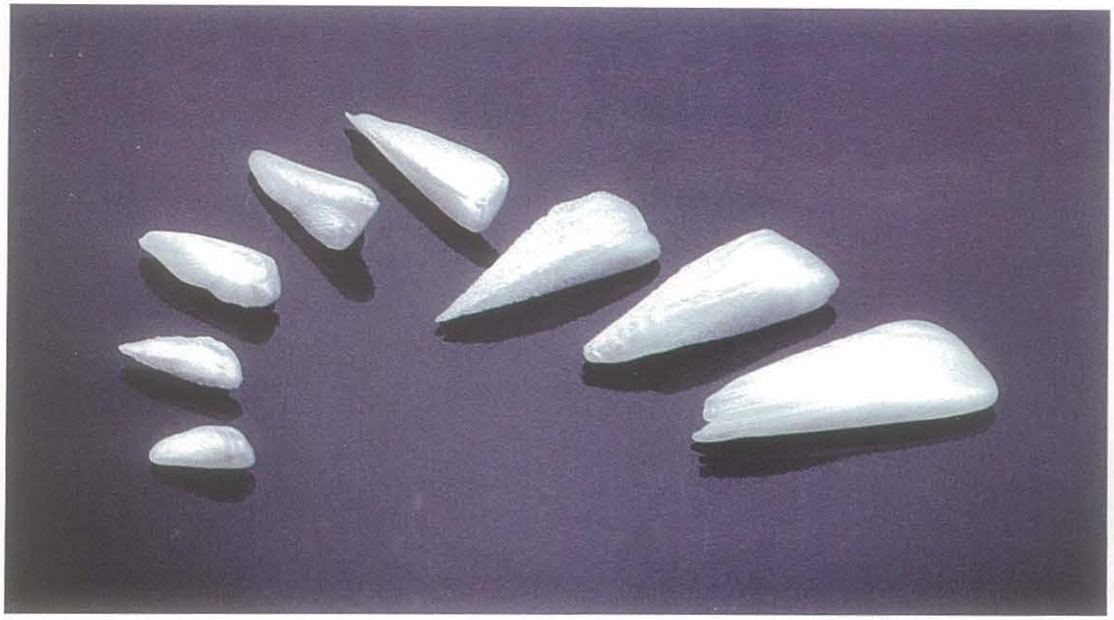


Figure 9. Size and age progression of natural "wing" pearls. Left to right; 6–7 × 2–3 mm, two to three years; 8–9 × 2–3 mm, three to four years; 10–11 × 3–4 mm, four to five years; 12–13 × 4–5 mm, five to seven years; 14–15 × 4–5 mm, six to seven years; 16–17 × 5–6 mm, seven to eight years. Ages are authors' best estimates. Photo © 1984 Tino Hammid.

crossing. A finely grooved surface can give the pearl a silky luster and, if the nacre is clear and translucent, can create light interference and dispersion, that is, orient. Because of these and other surface features, because of their baroque and irregular shapes, and because the nacre is often very pure and clear, American freshwater natural pearls show a lot of orient, often significantly more than pearls from other localities.

The rosebud, turtleback, snail, wing, and petal shapes can all be considered typical of American freshwater natural pearls. While it is possible for saltwater and other freshwater pearls to occur in similar shapes, it is unlikely because the same conditions and circumstances do not prevail in these environments.

Other Characteristics. The size of some freshwater pearls can be quite breathtaking. Many of the Unios are long-lived and large, inhabiting warm calcium-rich waters that promote the growth of very large pearls. Figure 9 shows a progression of wing pearls, small to large, with the authors' estimation of age. Unfortunately, most of the best habitats have been destroyed, disturbed, or contaminated, so the mussels growing today have relatively short lifespans and, consequently, produce very few large pearls.

American natural freshwater pearls, like other natural pearls, exhibit the full range of luster quality. The best of these pearls will compare favorably with the finest from any locality.

PEARL CULTURING IN AMERICA

Pearl culturing is both an art and a science. The pearl farmer needs the intuition to understand and work with nature and the pragmatic ability to apply new techniques and methods that will enhance his production. Pearl culturing is essentially farming in water, where the objective is high production at low cost. The risks are enormous. To set up a new pearl farm, large outlays of cash are needed for equipment, water leases, and the training of people to nucleate the shells. More capital is needed to obtain the livestock of the pearl farmer, the mollusks. Then the farm must be able to operate without income until the first crop can be harvested, which may be several years after it was "planted." Add to these problems the unpredictability of nature, which can wipe out a substantial investment overnight.

The success of the freshwater pearl growers in Japan and China led to the author's (Latendresse) endeavors to cultivate freshwater pearls in America. After years of research and experimentation in the 1960s and 1970s, the first pilot pearl farm was established in 1981 (Sweaney and Latendresse, 1982).

At the pilot project, a good-sized pearl farm located at Cedar Lake in western Tennessee, over 20,000 mussels were nucleated. At first, these shells showed good pearl growth, but several months into the project, a water-quality condition developed that had never before been encountered, even in the experience of the growers at Lake Biwa. This condition caused the mussels to stop producing nacre. The crop of nucleated mussels was moved to a site that had excellent water quality and a good population of wild mussels. Again, production proceeded very well until a drought in the summer of 1983 caused the water level to recede and the water qualilty to degenerate, with the re-

sult that the mother shells began to die off. Although the shells were quickly moved to another site that had proved itself in earlier experiments, a significant portion of this first large crop was lost.

The new site is well suited for culturing, since it already produces good natural pearls, and is accessible and workable. A good section of water has been leased and is being developed into a full-scale pearl farm. The shells from Cedar Lake have recovered and are doing reasonably well, considering their experience, and new mother shells are being nucleated at a laboratory nearby. Several other sites in Tennessee and other states are currently being tested with small groups of nucleated mother shells, and will be developed as farms if they prove feasible.

There is a cloud on the horizon that may dampen the future of these pearl-culturing efforts in some areas: acid rain. Through constant monitoring of water quality, our technicians have found that some of the local rains already have the chemical equivalent of weak sulphuric acid. Acid is very bad for the mussel, which needs "sweet" water that is neutral to alkaline in pH in order to be able to form its shell and pearls. At this point, acid rain is not recognized as a problem in the South, but indications are that it may soon become one, since many power-generating plants and industries in the area burn high-sulphur coal and oil.

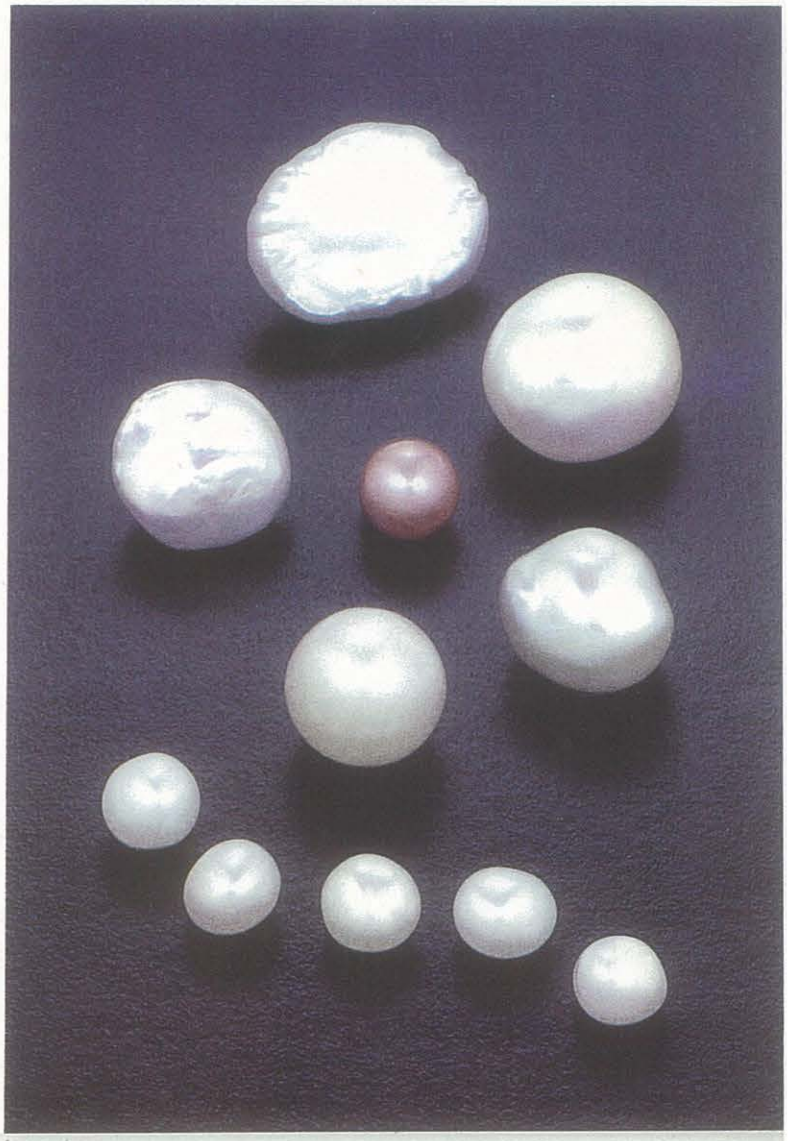
The pearl-culturing enterprise has had its share of ups and downs, but the prospects are still quite good. We expect a harvest within the next year or two, but given our previous setbacks, we know that it is too early to name a specific time. Culturing has been accomplished in the American mussel, and the pearls promise to be exquisite, well worth the time and effort. As evidence, refer to figure 10, the first published photograph of American cultured freshwater pearls (GIA Gem Trade Laboratory report no. 2416970, 1984).

CONCLUSION

The natural freshwater pearls of America present a paradox. Although some are, without a doubt, the most beautiful pearls of all, many people, including many jewelers, do not realize that such fine gems have come from the lakes and rivers of the United States. In part, this is probably due to the fact that natural pearls of all types are not as available as they once were, primarily because of environmental factors. Current production of freshwater natural pearls in America is 5%, or less, of what it was as recently as the 1950s and early 1960s; worldwide, production of natural pearls, from freshwater and saltwater, is also dramatically reduced.

And, while many people understand the difference in price between a fine natural ruby and its synthetic counterpart, the cost of a fine natural freshwater pearl is difficult for some to accept, especially when compared with the inexpensive cultured products on the market today. Yet the price ratio between natural freshwater pearls and

Figure 10. A sampling of freshwater pearls cultured in America by John Latendresse. The group includes one baroque, white rosé, 12 × 10 mm (2.2 ct); one baroque, white rosé, 9 × 8 mm (1.5 ct); one smooth baroque, white rosé, 10 × 9 mm (4.9 ct); one smooth baroque, white rosé, 8 × 7.5 mm (2.7 ct); one round, white, 7 mm (2.8 ct); one round, bronze-lavender, 5 mm (0.79 ct); and five semi-round pearls, white rosé, about 4 mm each (2.65 ct total weight). None of these pearls was treated or enhanced in any way. Photo © 1984 Tino Hammid.



cultured pearls is no greater than that between natural and synthetic rubies.

Tastes have changed. Whereas 60 years ago, when natural pearls dominated the market, pearls of all colors and shapes were accepted as the norm, and round white pearls were the exception; today, with cultured pearls in the forefront, almost the opposite is true. While the beauty and variety of American natural freshwater pearls can never be duplicated, some of that can be recaptured. The consumer will have many new choices and the jeweler, a new product, with the American freshwater cultured pearl.

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Gems & Gemology Editor John Koivula Wins Nikon Photomicrography Contest

Noted gem photomicrographer John Koivula was recently awarded first prize in the 1984 Small World International Annual Photography competition sponsored by Nikon International. Mr. Koivula, who is editor of the Gem News section of Gems & Gemology *and a frequent contributor to the journal, won the contest with his photomicrograph of inclusions of goethite and hematite in a slab of Brazilian agate that was sectioned and polished perpendicular to the formational layering. In addition to a cash award, John and his wife Kristie will be flown to New York for the award ceremony. All of the entries that placed in the contest will be on display throughout November at "Nikon House," Rockefeller Center, New York. The winning photomicrograph is reproduced here courtesy of Nikon Inc. Instrument Group, Garden City, New York. Magnified 30 ×.*