European Freshwater Pearls: Part 1—Russia

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Freshwater pearls from *Margaritifera margaritifera* (L., 1758), also called the 'European pearl mussel', are part of European cultural history. The mussels live in cool, clean, oxygenated waters, and formerly ranged from the north-western Iberian Peninsula to north-western Russia. During the last century, populations have largely diminished due to environmental influences, and the species is listed as endangered in the International Union for the Conservation of Nature (IUCN) Red List; harvesting them for pearls is prohibited. In north-western Russia, particularly from 18th and 19th centuries until 1917, they were commonly incorporated into embroideries, traditional headdresses, jewellery and various objects of religious significance. Interest in pearls waned after the Russian Revolution, and interviews conducted during the 2000s with people in former pearling centres showed an almost complete lack of awareness of pearls.

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Introduction

The freshwater mussel *Margaritifera margaritifera* (L., 1758) has been reported as a source of pearls since antiquity, and eventually became known as the 'European pearl mussel' in popular language. Significant pearl production has occurred in only a few countries, such as parts of Germany (especially Bavaria and Saxony) and Great Britain (especially Scotland). The mussel's population levels have fallen by more than 90% (with few exceptions) during the last century, mainly due to environmental reasons. The species has been listed on the IUCN Red List as endangered since 1996 (www.iucnredlist.org/details/12799/0).

Over the centuries, freshwater pearls from *Margaritifera margaritifera* became part of European cultural history, and this article is the first part of a series that will cover their past and present importance. The focus of this article is Russia, where freshwater pearls were used abundantly for both secular and ecclesiastical purposes, particularly from the 18th and 19th centuries up to the 1917 Revolution. Some secular examples include embroidered dresses, traditional headdresses for women called *kokoshniks* (e.g. Figure 1) and jewellery (e.g. Figure 2). However, visits by the author to north-western Russia in 2001, 2006 and 2008 have shown that local knowledge about pearls has nearly disappeared, and only a few such items were seen at museums in the former pearling centres of Kem in Karelia and Umba on the Kola Peninsula.

The purpose of this article is to describe the history, taxonomy and biology of the *Margaritifera margaritifera* mussel, and then to trace the origins of Russian freshwater pearls, followed by a brief

Figure 1: Russian freshwater pearls (2–4 mm in diameter) are featured in this late-19th-century kokoshnik *(traditional headdress). Courtesy of the Ethnographical Museum, St Petersburg, Russia. Photo by E. Strack.*

characterization of their properties. Much of the information in this article is based on what the author observed and was told during her visits to Russia. In addition, general information was taken from Strack (2006).

Historical Context

The pearl mussel was first described by Carl von Linné (or Carolus Linnaeus) as *Mya margaritifera* in the 10th edition of his *Systema Naturae* in 1758. He most probably took the word *Mya* from Pliny the Elder (Gaius Plinius Secundus, AD 24–79), who used it in his *Historia Naturalis* for a small freshwater mussel. In 1816, the Danish scientist Heinrich Christian Friedrich recognized the genus *Margaritifera*, which he named *Margaritana* in 1817. In the course of the 19th or early 20th century, the name was changed back to *Margaritifera*; the exact date and reason for this are unknown. *Margaritifera*, taken from *margarita*, the Latin word of Greek origin for *pearl*, indicates 'the pearl-bearing one'.

Pearls from *Margaritifera margaritifera* had been known and worked into jewellery long before von Linné described the mussel in 1758. One of the oldest written testimonies to European pearls is from Gaius Suetonius Tranquillus (AD 75–150), when he refers, in his history of Roman emperors, to the pearls that had made "the divine Julius undertake his conquest of Britain". Before him, both Pliny the Elder and Cornelius Tacitus (AD 55 and 116/120) had expressed their disappointment with the lack of beauty shown by British freshwater pearls (Strack, 2006).

From the Middle Ages until about 100–150 years ago, the European freshwater pearl undoubtedly was important as a valuable decorative object. Fine-quality individual pearls or necklaces were extremely rare, and most of them probably found their way to pearl markets in the Far East. The majority of European freshwater pearls were used for the decoration of objects of both secular and ecclesiastical use. Some of these items are kept today in churches, monasteries and museums where they serve as a unique witness to the existence of pearls in European cultural history.

Figure 2: These earrings containing Russian freshwater pearls (5–6 mm in diameter) are dated to the late 19th century. Courtesy of the Ethnographical Museum, St Petersburg, Russia. Photo by E. Strack.

Freshwater Pearl Mussels

Taxonomy

Freshwater mussels occur worldwide and, along with marine bivalve molluscs, belong to the class Bivalvia. They have two shells, or valves, that are connected by a hinge and a ligament. Their inner soft body has a slightly different, more delicate organization than marine molluscs, and the reproductive cycle of some species is distinctly more complicated (see below).

Pearl production occurs from those mussels within the suborder Schizodonta belonging to the superfamily Unionoidea. Such mussels have been called *najades* in scientific colloquial language. This name dates back to the 18th century, and alludes to the nymphs in Greek mythology that protected rivers and lakes. The superfamily Unionoidea is divided into two families, Unionidae and Margaritiferidae. Both families probably originated from a common freshwater lineage that developed from marine molluscs migrating into freshwater during the Mesozoic Era (Strack, 2006).

The Unionidae family has ~140 genera with more than 1,000 species that occur worldwide. Significant pearl production from Unionidae mussels is known from the eastern half of the United States, specifically the Mississippi River and its tributaries where huge quantities of pearls were fished during the so-called pearl rush in the second half of the 19th and early 20th centuries. Pearl production concentrated on 50–60 species.

The occurrence of the Margaritiferidae family is confined to the northern hemisphere, situated between approximately 40° and 70° north latitude, with the Arctic Circle representing the northern boundary. The Margaritiferidae family was classified in 1929, and until that year the genus *Margaritifera* was seen as belonging to the Unionidae family. Some old texts still attribute it to the 'Najade' family.

Pearls that were to become known on the world market as 'European freshwater pearls' come from only one species, *Margaritifera margaritifera*. Today's taxonomic classification of the genus is not clearly structured and shows overlaps; it is not described in further detail here. *Margaritifera margaritifera* is considered the youngest species, probably originating about 8 million years ago during the Late Miocene Epoch (Strack, 2006).

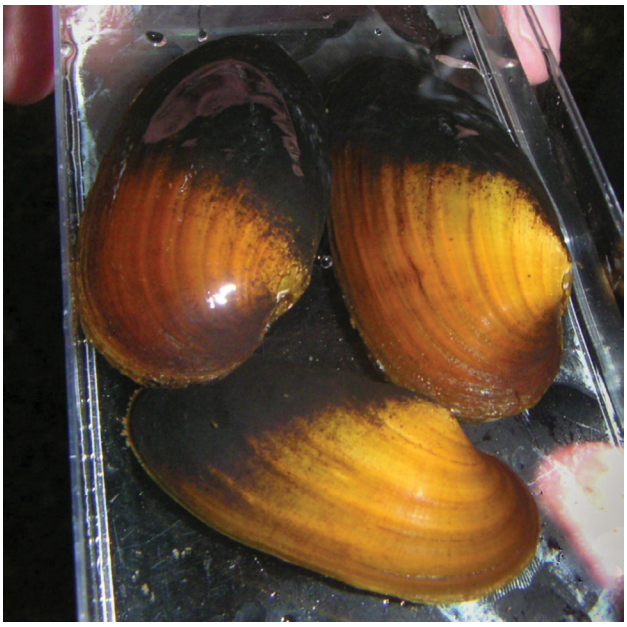


Figure 3: Each of these three Margaritifera margaritifera *mussels measures ~8.5 cm long. They typically bury about half of their shell into the ground (the light-coloured portions), while the other half protrudes into the water column and is positioned at an oblique angle toward the current. The mussels are usually found growing close to one another with their shells pointing in the same direction. Courtesy of R. Altmüller; photo by E. Strack.*

Biology

Margaritifera margaritifera (e.g. Figure 3) is native to an area comprising parts of the Iberian Peninsula (Portugal and Spain); southern, central and eastern France; Belgium; Luxembourg; northern and central Germany; and eastern Austria and the Czech Republic. It stretches in the north-west to Great Britain and in the north and north-east to Scandinavia and north-western Russia (Figure 4; see also Reis, 2003; Strack, 2006).

Margaritiferidae have the highest life expectancy of all known invertebrates, and may live up to 200+ years (R. Altmüller, pers. comm., 2007). This extraordinary life span is due to the extremely low metabolism that goes hand-in-hand with a slow growth rate of 1.0–1.5 mm per year, dependent on water temperature.

The pearl mussel needs clean, summer-cool waters with temperatures between 4° and 23°C with high oxygen and low nutrient and calcium contents. As the Ca content should not exceed 0.0045–0.0153 grams per litre, the species is regarded as a so-called calcium hater (Strack, 2006). This seems contradictory, since the mussel needs Ca to grow its relatively thick shells. It

apparently compensates for the low amount of available Ca with its slow growth rate.

The pearl mussel prefers a substrate of coarse sand or pebbles consisting of quartz, granite or gneiss. It responds to muddy or fine-grained sandy substrates by becoming smaller and thinner. It generally avoids both stagnant waters and strong currents, and prefers streams but also inhabits rivers and occasionally lakes (Strack, 2006). Mountainous sites are preferred and lowlands are the exception. The ideal water depth is 0.5–2 m, but up to 8 m has been recorded (Strack, 2006).

The shells are made up of two symmetric, oval-shaped convex halves (Figure 3). They can attain a maximum size of ~16 × 6 × 6 cm, while the average length is 10 cm. (Strack, 2006). Various localities may show slight morphological differences with regard to shape, size and thickness of the shells.

Margaritifera margaritifera is unique among other freshwater mussels of the Unionidae family, which have far less demanding life cycles and shorter life expectancies. In particular, this mussel has a parasitic glochidial (larval) stage that requires a host fish for its reproductive cycle. It uses only fish of the genus *Salmo*; in central Europe the salmonid is the brown trout (*Salmo trutta fario*) and in western and northern Europe it is the Atlantic salmon (*Salmo salar*). The reliance on salmonids goes back to the earliest stages of the pearl mussel's development, when these fish carried the mussel larvae from the Mediterranean area to northern Europe (Strack, 2006).

Margaritifera margaritifera reaches sexual maturity at 15 years and remains fertile for the next 50–70 years. The breeding season starts in early summer, when female mussels transport their eggs from the gonads to special breeding chambers within their gills called *marsupia*. Fertilization takes place within the marsupia after male mussels from further upstream have released their sperm into the water. Tiny glochidia (larvae) form within four to six weeks. They are kept in the marsupia until July–August when water temperatures rise, and then are released into the water. Each female mussel can hold about 4 million larvae during one breeding season, and can produce about 200 million glochidia during her long active life. Although this is considered one of the highest fertility rates, survival is difficult, and of one million glochidia only about five survive (Strack, 2006).

The glochidia are only 0.07 mm when they are released into the water, but their bivalve shell is already fully developed. It has a hook on the shell rim and a larval thread, which enables several bivalves to connect into small balls and hook themselves into the gills of a host fish by using their strong contractor muscles. New juvenile host fish are required each season, as the fish become immune once they have carried the glochidia. The host fish reacts to the glochidia by secreting a cover around them, and for the next six months the enclosed larvae transform into juvenile mussels. (The relationship between glochidia and host fish can be seen as a type of non-simultaneous symbiosis, in which the host fishes will later benefit from the filtering capacity of adult mussels in keeping the water clean.) In early summer of the following year, the mussels break through the cover secreted by the host fish and fall to the ground. At this time they measure 0.5 mm long and will dig themselves into the substrate where they will spend the next five years. Having attained a size of 1 cm, those that survive this period (about 5%) return above ground where they will spend the rest of their lives (Strack, 2006).

Transportation of glochidia by a host fish enables them to reach the upper regions of a river or stream, and an even wider distribution may occur if birds or other animals feed on the host fish. The complicated growth history of the larvae may also be designed to prevent them from moving downriver and eventually reaching the sea (as saltwater is toxic to freshwater mussels). It is only during the past 50 years that *Margaritifera margaritifera*'s life cycle has been fully understood, thus enabling an appreciation of the mortality factors that are faced by juvenile and adult mussels.

Russian Freshwater Pearls

Pearl Mussel Distribution

Originally, *Margaritifera margaritifera* occurred in a wide area of north-western Russia that stretched from Lithuania in the west to the slopes of the Ural Mountains in the east, and from the tributaries of the Don and Volga Rivers in the south to the White Sea in the north. The mussels formerly were especially abundant in rivers and streams flowing into the White Sea, where the Atlantic salmon served as a host fish (Korago,

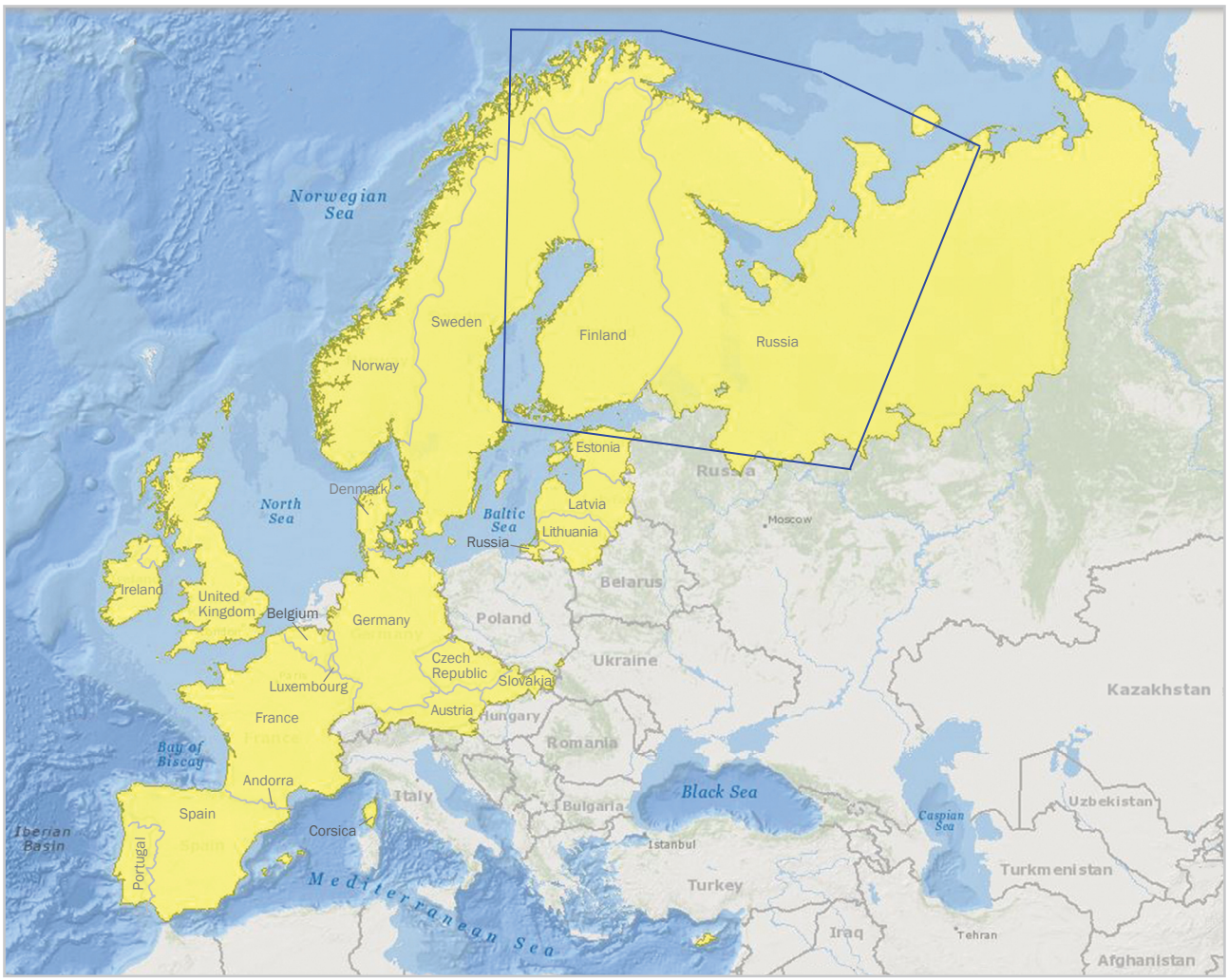


Figure 4: The former range of Margaritifera margaritifera *mussels (shown in yellow) extended from the Iberian Peninsula in south-eastern Europe to Finland and north-western Russia. After* http://maps.iucnredlist.org/map.html?id=12799. *The outlined area refers to the view shown in Figure 5.*

1981; Kaliuzhin, 2004). Today, large Russian populations of *Margaritifera margaritifera* remain only in the Keret River in Karelia and the Varzuga River on the Kola Peninsula (~6 and ~140 million mussels, respectively; see Figure 5; S. P. Kitaev, pers. comm., 2001; Makhrov et al., 2014; Popov and Ostrovsky, 2014). The Varzuga River hosts largest uninterrupted population in Europe, with mussels living along an approximately 220 km stretch of river within an undisturbed, post-glacial eco-system that provides adequate nourishment and space for breeding and survival (Ziuganov, 1994; Strack, 2006). Significant stocks have largely disappeared from most other rivers.

Pearl mussels also occurred in various rivers that spilled into Lake Ladoga and Lake Onega (particularly the terminus of the Kumsa, Oster and Vodlia Rivers; see Ivanter and Kuznetsov, 1995; S. P. Kitaev, pers. comm., 2001).

In some areas, pearls were also produced from *Anodonta*, the common pond mussel belonging to the Unionidae family. They seem to have come particularly regularly from a lake near the city of Werh-Newinsk, 100 km north of Yekaterinburg in the Ural Mountains (Strack, 2006, p. 206).

Pearl Usage

The use of freshwater pearls for decoration and adornment in north-western Russia goes back to the Middle Ages. Pearls became more generally used towards the end of the 18th century. One might even say that they came into fashion during that time, and this lasted until the end of the Russian empire under the Romanoff dynasty in 1917 (Korago, 1981). Traditional festive linen or silk dresses were embroidered with pearls, which also were used to embellish a kokoshnik, the tiara-like headdress worn in traditional costume (Figure

Figure 5: The map shows the main rivers and former pearling centres in Karelia and on the Kola Peninsula in north-western Russia. After Strack (2006).

6). Kokoshniks were not only embroidered with pearls, but were decorated in the forehead area with pearl strings in net-like, interwoven and tasselled patterns. Earrings were often made of fine pearl strings that were similarly arranged in a garland or flower pattern (e.g. Figure 2).

Pearling centres developed along the Dvina River and its tributaries near the city of Arkhangelsk, on the Keret and Kem Rivers in Karelia and on the Kola Peninsula (particularly near the Umba and Varzuga Rivers; Figure 5). The city of Kem, founded in 1783 and situated on the White Sea at the mouth of the Kem River, was particularly important, and the string of pearls that is shown on the city's coat of arms (Figure 7) bears witness to this. Another Karelian centre for working with pearls was the small city of Olonez, capital of a governorate with the same name, situated near Lake Ladoga. Olonez was an important and wealthy city in the past, but has fallen into obscurity since then and therefore was not included in the field research described below. Apart from the villages, where talented local women did the craft work, professional workshops for pearl embroideries also opened up in large cities.

Figure 6: A pearl-bearing kokoshnik is worn by Princess Olga Konstantinovna Orlova as part of a masquerade costume for a ball in 1903. The original photograph measures 50.5 × 36.5 cm and was taken by Elena Mrozovskaya; downloaded from Wikimedia Commons.

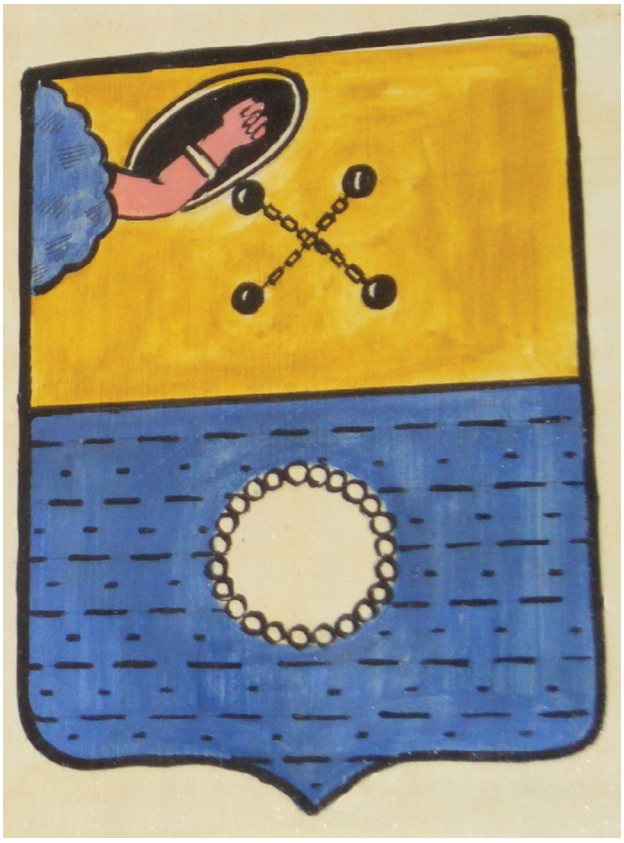


Figure 7: The coat of arms of the city of Kem, a 18th–19th century pearling centre at the mouth of the Kem River on the White Sea, includes a string of pearls in the form of a round necklace. The upper part depicts an arm emerging from a cloud that holds a shield which, together with the cannon balls underneath, alludes to the importance of Kem as a military base in the border region of the Olonez governorate. Photo by E. Strack.

In rural areas, the mussel shells themselves also were worked into buttons or small objects, and a number of small workshops existed along some of the northern rivers until the early Soviet era.

The Ethnographical Museum in St Petersburg houses one of the most exquisite collections of Russian pearl works. The museum not only displays good examples of the quality and status of preserv-ation of pearl-bearing objects prior to the Russian Revolution in 1917, but it also provides an image of traditional village life that has disappeared in modern times. Additional pearl holdings are pre-sent in the Armoury Chamber of the Kremlin in Moscow, which focuses on ecclesiastical treasures. The Russian Orthodox Church secured a consider-able portion of the pearl riches in north-Russian rivers where it often held fishing rights. Chasubles for priests and antependia (altar-front decorations) were embroidered with pearls since the 10th century, and pearls also were used for devotional works such as chalices, book covers, crosses (so-called *panagia*), mitres and icons. The goldsmiths and silversmiths who created these objects often made lavish use of both pearls and floral designs.

Since 1721, by a decree of Peter the Great, all pearl rights belonged to the czar. This was revised in 1731, although large pearls still had to go to the imperial crown. It is questionable whether this rule was strictly followed by people in the villages. During the 18th and 19th centuries, young lads and women in villages that did laundry in the streams often did pearl fishing, using their toes to look for the mussels.

The first two decades of the Soviet era (1922–1991) saw a continuous decline in both the populations of pearl mussels (mostly as a result of pollution by various industries) and pearl production. Even more significant was an increasing lack of interest in pearls that went hand-in-hand with the establishment of the new political system. By this time, those who had used and appreciated pearls in the past—such as the local nobility, well-to-do citizens or the *kulaks* (wealthy village families)—no longer existed. In the aftermath of the revolution, they had left the country, been killed or gone into hiding by integrating themselves into early Soviet society. Also, when religious practices were forbidden after the Russian Revolution, devotional objects that used pearls were no longer produced.

Almost certainly, pearls continued to be found during the first decades after the Russian Revolution, but they are difficult or impossible to trace today. Interest in pearls decreased further in the decades after World War II. In 1966, the Soviet Ministry of Fisheries forbade the harvesting of pearl mussels in a number of rivers, and in 1985 it was completely prohibited (Makhrov et al., 2014). In 1995, *Margaritifera margaritifera* was listed as endangered in the *Red Data Book of Karelia* (Ivanter and Kuznetsov, 1995). Meanwhile, all species of *Margaritifera* are listed as endangered in the *Red Data Book of the Russian Federation* (S. P. Kitaev, pers. comm., 2001).

Today Russian pearls are no longer significant within the country or on the world market, and since they are no longer harvested, they have practically been forgotten.

Field Research

To learn more about Russian freshwater pearls, the author travelled to Karelia and the Kola Peninsula in 2001, 2006 and 2008. Visits were made to the towns of Umba, Kuzomen and Varzuga on the White Sea coast of the Kola Peninsula; the village of Keret and the city of Kem in Karelia; as well as the cities of Arkhangelsk on the coast of the White Sea and Petrozavodsk, the capital of Karelia, situated at Lake Onega. Interviews were conducted with local authorities, scientists and village citizens (approximately 13 people in total). The citizen interviews concentrated on elderly people (between 70 and 80 years old) who had grown up in the 1930s and 1940s. None of those interviewed remembered ever seeing pearls or having searched for them (or knew people who did). All persons agreed that pearls were never spoken about, although there seemed to be some vague collective knowledge among the elderly people interviewed that pearls had been found locally in the past. Not one family in the villages was known to possess local pearls. A retired fisheries inspector in Keret village reported that in 1974 an expedition from Moscow found 415 pearls in the area, but he could not give details, as at the time he was not allowed to ask questions.

Government authorities at the Fisheries Office in Umba and at the Fisheries Cooperative in Varzuga were well informed of the importance of the pearl mussel's symbiosis with local salmon populations (see also Kaliuzhin, 2004). However, all those interviewed agreed that pearls were an item of the past (although they did not seem interested in following up on the matter). Albeit, the head of the salmon cooperative in Varzuga was aware that a considerable number of pearls probably exists among the ~140 million pearl mussels that are thought to inhabit the Varzuga River. It is estimated that about four or five pearls can be harvested from every 1,000 mussels (V. Ziuganov, pers. comm., 1999; Strack, 2006).

Varzuga village, situated about 30 km inland from the mouth of Varzuga River, is an important religious centre for the White Sea coast. A monastery was established there in the second half of the 15th century by monks from the Solovetsky Islands. The monastery no longer exists, but Varzuga still has the oldest wooden church on the Kola Peninsula (built in 1674) and remains a place of religious pilgrimage. The local priest, Mitrofan Badanin, who has been Bishop of the Severomorsk and Umba region of the Kola Peninsula since 2013, was a highly respected authority in Varzuga. A former high-ranking navy officer and a learned man, he stated that all old treasures and written records on the southern coast of the Kola Peninsula disappeared during the Soviet era when the churches were partially destroyed or used for other purposes. Only a few icons remain in the churches today, and these were made in recent times and decorated with inexpensive Chinese freshwater cultured pearls that seem to find their way to even the remotest corners of the world. Unfortunately, these recent icons have no artistic value.

Varzuga has no museum that traces the area's history, but due to its position as a centre for salmon fishing it is a busy village. Some families rent houses to the few visitors, mainly Russian scientists on summer excursions and a few Scandinavian tourists who come for the fishing. The author was told by her hosts in Varzuga that so far no foreigners have asked questions about pearls or pearl mussels.

Kuzomen village, situated at the mouth of Varzuga River on the White Sea, was once also a local salmon fishing centre (and consequently a source of pearls). The village is now nearly deserted, and is characterized by extreme poverty and desolation. It is connected with Umba by a bus that travels only once a week. An elderly lady, one of the perhaps 100 people still living in Kuzomen and a retired school teacher, indicated that there was no longer any knowledge of pearls in the village. The same opinion was encountered in Keret village, where the few elderly people still living there in partly broken-down houses hardly knew that pearls came from the area in the past. One of the better-kept wooden houses in Keret village belonged to the local fisheries inspector. He was in charge of a government programme for sustaining and restoring mussel populations in the Keret River, which was undertaken for environmental reasons and to secure the salmon population. Timber floating, hydro-engineering construction and industrial pollution have over the decades taken a toll on the salmon population, and thus of the pearl mussel's host fish (Makhrov et al., 2014). The restoration programme has so-far been successful, as the river still hosts about 6 million pearl mussels. Pearls do not seem to be on the governmental agenda.

Figure 8: This late-19th-century kokoshnik is embroidered with small imitation pearls (which also form the tassels) together with larger Russian freshwater pearls. The natural pearls range up to 7 mm, have off-round shapes and are strikingly white. Courtesy of the Museum of History, Culture and Life of Tersky Pomors, Umba, Russia; photo by E. Strack.

The busy town of Umba is situated in the western Tersky coast (i.e. the southern coast of Kola Peninsula) and is connected to Kirov-Apatity by a well-maintained system of streets. The city was once a pearling centre for the Umba River and continues to be a base for salmon fishing. The local fisheries office houses breeding facilities for both pearl mussels and salmon. The most extensive collection of artefacts and objects relating to Russian pearl fishing is found in Umba's Museum of History, Culture and Life of Tersky Pomors. On display are photographs of local pearl fishermen, as well as samples of the equipment (e.g. knives and collecting bags) that they used. Photographs include local village women in their festive dresses, and the museum also owns one kokoshnik that is abundantly decorated with pearls (Figure 8). They were incorporated into the flat top of the kokoshnik, as well as in the ear flaps and within tassel-like rows overhanging the forehead; these features are characteristic of kokoshniks from the Olonez area (Srebrodolski, 1985; Bespalaya et al., 2012).

A similar kokoshnik is owned by the Museum of the Coast in Kem. In addition, the collection includes village costumes and paintings/photographs that show wealthy village women wearing pearl-embroidered kokoshniks and pearl necklaces.

Materials and Methods

Due to the historical and present situation in Russia described above, only a few pearl-bearing items could be located that were available for characterization.

During the author's visit to the museum in Umba, the museum's director kindly allowed the kokoshnik (Figure 7) to be removed from its glass case for closer examination with a loupe and UV lamp equipped with long-wave (366 nm) and short-wave (254 nm) bulbs.

In June 1998, the author had the opportunity to examine a number of pearl objects at the Ethnographical Museum in St Petersburg: several pairs of earrings from around 1800 (e.g. Figure 2), a kokoshnik (Figure 1) and a red velvet belt from the 19th century, and various necklaces from the late 19th century. These pieces were examined with an optical microscope (up to 80× magnification) and the UV lamp mentioned above.

Also in 2008, the author examined a necklace that was taken out of Russia by a Russian family in the 1920s (Figure 9). The pearls may have been harvested in the years before World War I or in

Figure 9: This necklace of Russian freshwater pearls has been owned by a family of Russian origin since the 1920s. The pearls range from 5.0 × 4.5 mm to 8.2 × 7.0 mm and have baroque shapes, are white to light grey and light to dark 'cream', and show distinct growth characteristics. The clasp is a modern addition. Photo by E. Strack.

the 19th century. The necklace was available for a limited amount of time, and only visual observations were possible.

Three additional pearls from the 20th century (Figures 10–12) were examined in 1999. They were made available by Russian fisheries biologist Valeriy Ziuganov, who obtained them during his studies of the Varzuga River. The pearls were examined using a gemmological microscope and the UV lamp mentioned above, and radiographs were taken with a Kodak 2200 digital X-ray system (60–70 kV, 49 W).

Results

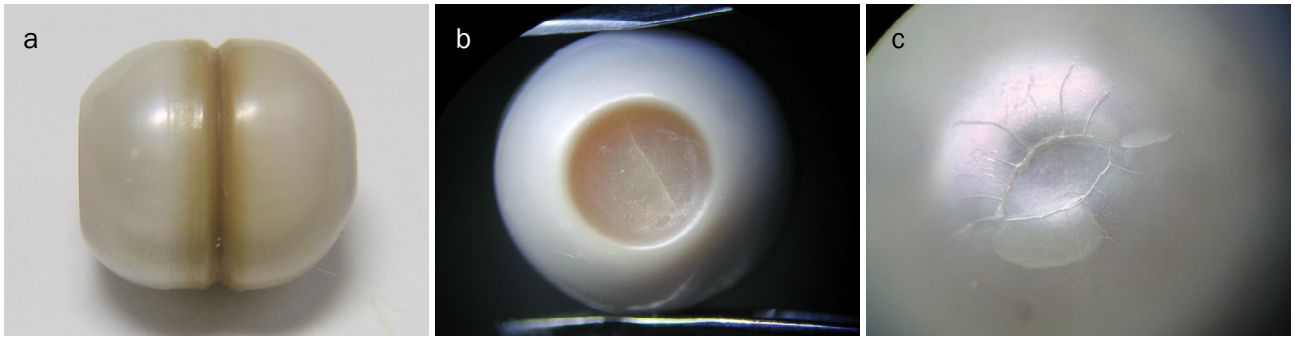
Pearls from the 18th and 19th Centuries

Kokoshnik from the Umba Museum. Examination with a loupe and a UV lamp revealed that the small 'pearls' in this kokoshnik were imitations, and only the larger ones (up to 7 mm) were natural freshwater pearls, present both individually and arranged into rosettes.

Samples from the Ethnographical Museum in St Petersburg. The earrings consisted of small pearl strings that were arranged to form drops and rosettes. The kokoshnik and the red velvet belt were decorated with strings of pearls in tulip and rose patterns. The necklaces consisted of multiple strings; the most notable were a four-strand necklace originally attached to a kokoshnik and worn under the chin, and a necklace consisting of 14 rows that were about 40 cm long.

The pearls in these objects averaged 1–4 mm, while the largest measured 7 mm and 9 mm and were present at the centre of the necklaces. Their colours ranged from white and light 'cream' to light grey. A few pearls were greyish brown, brownish orange and brownish purple. Several showed a distinct dividing line in the centre that separated white and brownish grey halves. There were no overtones observed. Lustre was generally dull, with the darker colours showing no lustre at all. Shapes included off-round, flat, barrel, button and baroque.

Figure 10: A barrel-shaped pearl from Varzuga River, measuring 7.08 × 6.77 × 6.72 mm (2.68 ct), is shown in these three views. This grey pearl has a brown dividing line in the middle (a), a brown spot at one end (b) and an indented area on the other end that is surrounded by cracks (c). Photos by E. Strack.



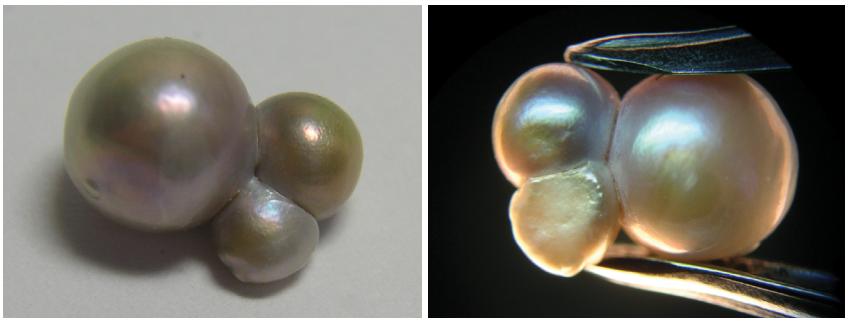


Figure 11: This intergrowth of three Varzuga River pearls measuring 3.18, 3.77 and 5.62 mm each is shown from the front (left photo) and back (right photo). It is greyish purple with 'bronze'-coloured areas and shows good lustre. The flat face on the back of the smallest pearl shows surface wrinkling that is characteristic for pearls of freshwater origin. Photos by E. Strack.

Most of the pearls had flat areas with a wrinkled growth pattern on their surfaces.

Microscopic examination of a few of the light grey pearls showed tiny fractures below the surface that may be interpreted as signs of dehydration of originally white pearls. All of the pearls showed an evenly distributed faint blue to whitish blue fluorescence to long-wave UV radiation that was distinctly weaker to short-wave UV.

Nearly all of the items from the Ethnographical Museum consisted entirely of natural freshwater pearls, and only a few small imitation pearls or small mother-of-pearl beads were noted.

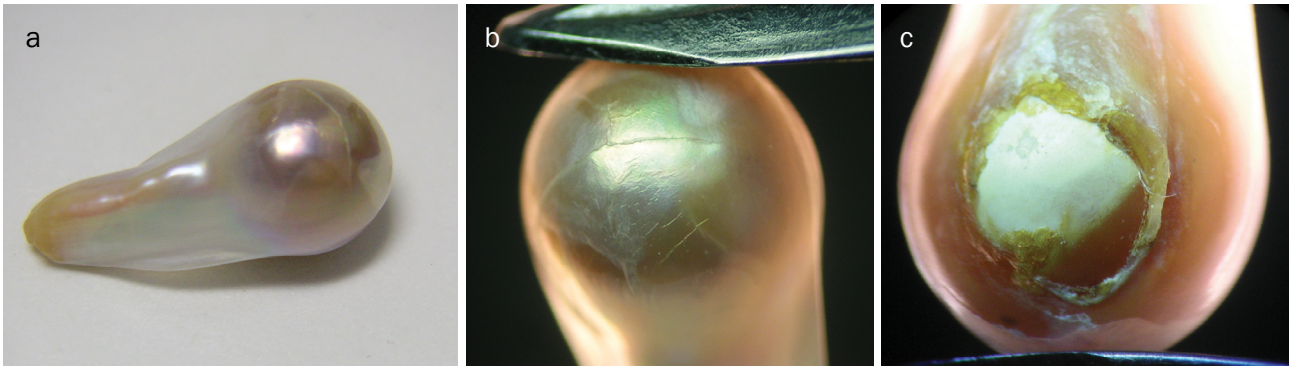
Pearls from the 19th/20th Century

Necklace Owned by a Russian Family. This necklace consisted of baroque pearls ranging from 5.0 × 4.5 mm to 8.2 × 7.0 mm. The colours were white to light grey and light to dark 'cream'. Most of the pearls showed distinct growth characteristics, including a characteristic wrinkling on their flat surfaces.

Loose Pearls. The three loose pearls obtained from Valeriy Ziuganov are described as follows:

- A barrel-shaped pearl measured 7.08 × 6.77 × 6.72 mm (2.68 ct), and was grey with a brown dividing line in the middle (Figure 10a, similar to that observed in some pearls from the Ethnographical Museum). One end of the pearl showed a brown spot (Figure 10b), while the other end was indented with associated cracks (Figure 10c). The lustre was dull.
- A sample consisting of three intergrown pearls with diameters of 3.18, 3.77 and 5.62 mm (1.83 ct) was greyish purple with 'bronze'-coloured areas (Figure 11). The lustre was good. Microscopic examination revealed surface wrinkling on flat areas that is characteristically observed with pearls of freshwater origin.
- A drop-shaped pearl that measured 10.96 × 4.82 × 4.40 mm (1.27 ct) showed a greyish purple coloration similar to that of the triple pearl described above, with a bluish pink overtone and light brown portions (Figure 12a). Surface cracks were present on one side of the pearl (Figure 12b), and an opening on the other side showed a white colour and a surface structure that appeared to consist of tiny rounded points that resembled nail heads. Lustre was good (Figure 12c).

Figure 12: These photos show a drop-shaped pearl from Varzuga River that measures 10.96 × 4.82 × 4.40 mm. It displays a greyish purple colour with a bluish pink overtone and light brown areas (a). (b) The 'bulb' of the pearl shows surface cracks on the front side (b) and a white opening on the underside with a structure made up of tiny rounded points that were visible at higher magnification (c). Photos by E. Strack.



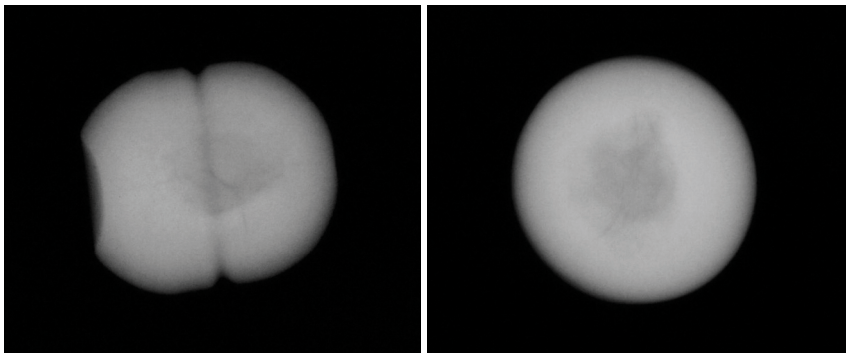


Figure 13: These radiographs of the barrel-shaped pearl in Figure 10 (~7.1 mm long and 6.7 mm in diameter) were taken at orientations parallel to and at right angles to its long axis. They reveal an irregular area of organic substance in the centre of the pearl, which appears dark in the radiographs.

All three pearls showed a weak blue UV fluorescence that was weaker in short-wave than in long-wave UV radiation. Radiographs of the pearls showed irregular and linear deposits of organic substance (Figures 13–15).

Conclusion

The European freshwater pearl mussel *Margaritifera margaritifera* has largely disappeared from its original distribution area in rivers and streams flowing into the White Sea in north-western Russia. Apart from a number of small populations in several rivers, only the Varzuga and Keret Rivers still hold large stocks of *Margaritifera margaritifera*. The species has been listed as endangered in the IUCN Red List since 1996, and pearl fishing has been prohibited in Russia since 1985, so there has been no significant recent production of these pearls. Moreover, in the decades since the Russian Revolution in 1917, there has been a general lack of local interest and knowledge of pearls.

A limited number of Russian freshwater pearl samples was available for study, including several 18th–19th century objects from museums in St Petersburg and Umba, a necklace from the 1920s and three loose pearls collected from the Varzuga River in the 1990s. The pearls ranged from ~1 to 11 mm and their colours were predominantly white, light 'cream' and light grey; some brownish hues also were present. Their lustre varied from dull to good, and shapes included off-round, flat, barrel, button and baroque. Most of the pearls showed a wrinkled growth pattern on flat surfaces. Varying numbers of imitation pearls (all of small size) were found in the objects studied from the museum collections. X-radiography of the three loose pearls revealed irregular and linear deposits of organic substance.

Figure 14: The radiograph of the triple pearl in Figure 11 shows a circle-shaped, thin linear deposit of organic material that is located just underneath the outer rim of the two larger pearls (~3.9 and 5.6 mm in diameter) that follows their outline. These circular features could initially be interpreted as beads, which obviously is not the case for these natural pearls. In a cultured pearl, the demarcation line of a round bead would not necessarily follow its outline.

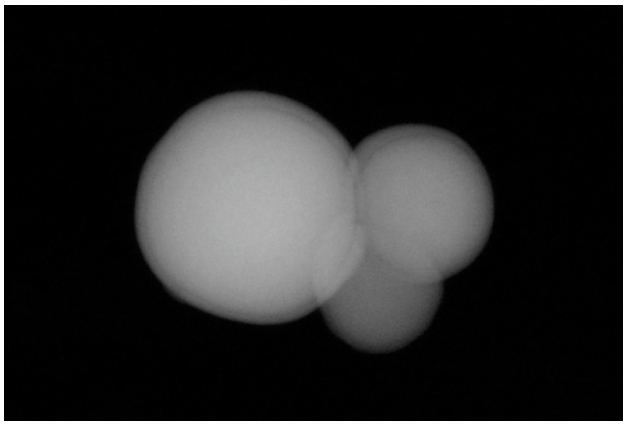
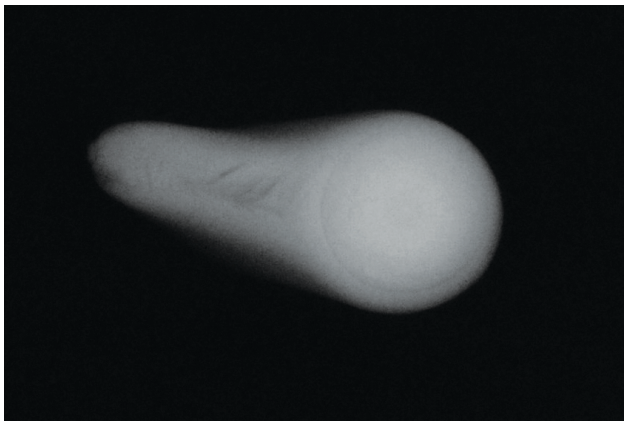


Figure 15: The radiograph of the drop-shaped pearl in Figure 12 (~11 mm long) shows a feature similar to that observed in the triple pearl. Within the 'bulb' is a circle-shaped, thin linear deposit of organic material slightly underneath the outer rim. At the centre of the bulb is a slightly darker core of organic substance. The 'tail' of the pearl has at its centre wavy brach-like extensions of organic material that are arranged parallel to one another along a common line.



Although Russian freshwater pearls are no longer known or encountered in local markets, they form an interesting part of European cultural history.

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