DISTRIBUTION OF THE FRESHWATER PEARL MUSSEL IN RUSSIA

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The review provides information about pearl harvesting (16th–20th cent.) and distribution of the freshwater pearl mussel *Margaritifera margaritifera* (L.) in North-West Russia; special focus is on the Kola Peninsula. In the Russian Federation at large, 157 rivers and streams are either known to have had pearl harvesting or/and reported to harbour pearl mussel (species affiliation of the mussels in 65 of them was confirmed by experts). The number of pearl mussel streams is strongly underestimated since both pearl harvesting and pearl mussel distribution have been insufficiently studied. State-of-the-art of pearl mussel populations is also poorly known, but it is safe to say there now (21st cent.) exist at least 24 populations. Freshwater pearl mussel abundance in Russia is higher than elsewhere in the world.

Key words: pearl mussel, nature protection, distribution, Kola Peninsula

INTRODUCTION

Freshwater pearl mussel *Margaritifera margaritifera* (L.) used to be quite widespread in rivers of NE North America and western Europe (reviews: Ziuganov et al., 1994; Geist, 2005). It is present is countries bordering Russia in the west. Large pearl mussel populations have survived in Norway and Finland (Oulasvirta, 2006, 2008; Larsen, this volume). In Estonia and Latvia, this mussel is rather scant (Timm, 1994; Rudzīte, 2004). In Lithuania, Byelorussia and Poland, the pearl mussel used to occur, but has apparently gone extinct (Dutkiewicz, 1960; Jankevičius, 1981; Kozlov, 1981).

Information about Russian pearls and the pearl mussel can be found in over 300 publications, but they have never been properly summarized. The ecology of Russian pearl mussel populations has been studied (Ziuganov et al., 1994). *Margaritifera margaritifera* was proven to be the only pearl mussel species living in North-west Russia (Sergeeva et al., 2008). However, distribution of the species in Russia is still largely understudied. Two papers (Vereshchagin, 1929; Yakunina, 1955) contain lists of rivers known for pearl harvesting, but the lists are incomplete. Furthermore, many of the rivers mentioned in these lists cannot be located in modern maps.

Intensive research into the pearl mussel distribution in Russia has only just begun. This work is underway in Arkhangelsk Region (review: Bespalaya et al., 2007a), western Leningrad Region (Ostrovskii and Popov, 2008), Karelia (Makhrov et al., submitted); a review of data on pearl mussel populations in southerner regions has been prepared (Makhrov, 2009).

Data on the pearl mussel occurrence in the Murmansk Region have not been summarized before (Pavlov et al., 2007). Such a summary is given in the present paper. In addition, we have synthesized published and archival information on the pearl mussel distribution in different regions of Russia.

PROBLEMS OF METHODOLOGY

Pearl harvesting had been practiced in Russia for several centuries, and pearls were widely used to decorate icon cases and costumes (let us mention only a few books: Khrebtov, 1897; Romanchenko, 1912; Yakunina, 1955; Donova, 1962; Oparin, 1976; Korago, 1981; Srebrodol'skiy, 1985; Vishnevskaya, 2007). However, the locations where the pearls were treated and worked into decorative items were often far away from the harvesting site (Vilkuna, 1980; Bernstam, 1983; Storå, 1989), wherefore it is hardly ever possible to locate the pearl rivers relying on information about the circulation of goods with pearls.

Some information about pearl harvesting was gathered by the few travellers, or found in archives. Often, the information about "pearl" rivers the researcher got hold of was second- or third-hand, which resulted in fallacies. Pearl fishers themselves tried to keep information about harvesting sites secret, passing it only to their sons. Top secret was information about small taiga rivers rich in pearls (Oparin, 1976).

More problems arise because changes in national borders and administrative borders between regions of Russia need to be taken into account. E.g., River Nyadema has been mentioned as a Russian river where pearls were harvested (Stukenberg, 1849; Bartenev, 1902; Vereshchagin, 1929; Yakunina, 1955). Since 1826 however, the watershed has been Norwegian territory, and the river now has the name Neiden (Chulkov, 1901).

To avoid such mistakes, we used modern maps to locate the rivers mentioned in old sources. Newspaper publications about pearl fishing were excluded from consideration because of low reliability of the information (in the future, it may become possible to verify the information through surveys of the rivers mentioned in the doubtful sources). A similar procedure was applied in other reviews (Bespalaya et al., 2007a; Makhrov, 2009; Makhrov et al., submitted).

Unfortunately, there have been hardly any studies of the pearl mussel distribution in Russia. The few scientific expeditions for pearl mussel study that were held mostly headed for the rivers with pearl harvesting. During general benthos surveys, the pearl mussel often evades the frame hydrobiologists use.

Thus, both information about pearl harvesting sites and data on pearl mussel distribution in Russia are rather limited. There is no doubt rivers with pearl mussel populations are much more numerous than it is stated in the literature. E.g., thorough surveys (Graevskiy and Baranov, 1949; Golubev and Esipov, 1973) helped find pearl mussel populations in six streams flowing to the relatively small Lake Vadozero.

PEARL MUSSEL DISTRIBUTION IN MURMANSK REGION

Pearl fishing was practiced in many rivers of the Kola Peninsula and adjacent part of the Karelian Coast, which now belong to the Murmansk Region, Russian Federation (Tab. 1). The pearl mussel is widespread in the western part of the region (Fig. 1). No findings of the species are known from rivers of the Kola Peninsula northern coast east of Tyuva (Tab. 1). No pearl mussel is to be found on the southern coast of the peninsula east of Varzuga (A. Zotin, pers. comm.).

Some information indicates pearls used to be harvested in the easternmost Kola Peninsula, in the Ponoi River (Tab. 1). As reported by Popov (1914) however, people from Varzuga failed to find pearls in the river early in the 20th century. The idea about pearl fishing in the river must have appeared because earlier sources claimed people of Ponoi "for this pearl fishing had the greatest habit" (Fomin, 1805; Molchanov, 1813).

Several rivers reported to have had pearl fishing could not be found in modern Murmansk Region maps and in the vocabulary (Voshchinin, 1939): streams emptying into Lake Permo (Kuznetsov, 1930) – the reference may be to Lake Permusozero in the Imandra Lake watershed; River and Lake Pil'ma (Kuznetsov, 1930; Makarov, 1934) – this may be a misprint, and the Nil'ma River in Karelia was meant; River Kol'cha (Zimmerman, 1853; Kuznetsov, 1930) – may be a distorted variant of Kolvitsa. Ukhanova (1966) mentioned Chernaya Umba (presumably River Chernaya in the Umba River watershed), Puzreka (apparently stands for Kuzreka), Povda (probably Kovda was meant).

On some occasions, rivers in different regions may have the same name, and it is unclear which one of them is the right one. E.g., a Valas River (Kuznetsov, 1930) can be found both in Murmansk Region and in Karelia. Also, both these regions have rivers named Shomba, consonant with Sombo, which was mentioned by Ukhanova (1966).

In the Umba River, pearl mussel glochidia were found on pink salmon gills (Grozdilova, 1974). In several fish hatcheries in Murmansk Region, glochidial infection was detected in Atlantic salmon parr (Bogdanova, 1967); the presumable infection agent was pearl mussel larvae.

Little is known about the human impact on pearl mussel populations in the Kola Peninsula. Several of the watercourses inhabited by the species (Paz, Tuloma, Niva, Zhemchuzhnyi Ruchei, Kovda) are affected by hydropower engineering. A number of populations in streams flowing to Lake Imandra had died out, and the Umba River population was heavily impaired by industrial pollution (Ziuganov et al., 1994). However, sulphur and nitrogen concentrations in shells of pearl mussels from other parts of the Kola Peninsula are low (Carell et al., 1995).

The pearl mussel was stocked into some rivers in SE Kola Peninsula: Chavan'ga, Chapoma, Strel'na, Yugina. The mussels survived, but nothing is known about further results of the stocking activities (Ziuganov et al., 1994).

Table 1. Water systems of the Kola Peninsula, where pearl harvesting had been carried out earlier or live mollusks were found (Bold type)

Water system	18th century	19th century	20th century	21st century
Paz river drainage basin		Reineke, 1830; Stukenberg, 1849	Fersman, 1923	**Polikarpova, Makarova, 2009**
Pechenga	Blagoveshchenskiy, 1902			
Western Litsa*				**Oulasvirta, 2006**
Ura*				
Tuloma drainage basin (6 streams)*		Reineke, 1830; von Middendorff, 1845; Stukenberg, 1849; Nemirovich-Danchenko V.I. 1877; Bartenev, 1902	**Collection of V. Soldatov (July 28, 1906), in Zoological Institute of Russian Academy of Science;** Fersman, 1923; Kupletskiy, 1925; Kuznetsov, 1930; Zorich, 1931	**M. Kaukoranta, pers. comm.**
Kola drainage basin (3 streams)	le Brun, 1718	Reineke, 1830; von Middendorff, 1845; Stukenberg, 1849; Slutchevskiy, 1897; Slezkinskiy, 1898; Bartenev, 1902	Kupletskiy, 1925; **Collection of V. Kapustin (June 12, 1926) in Zoological Institute of Russian Academy of Science;** Zorich, 1931; Valkov, 1934; **I.L. Shchurov, V.A. Shirokov, pers. comm.**	
Tyuva		von Middendorff, 1845		
Ponoi		Stukenberg, 1849; Bartenev, 1902; Oparin, 1976	Kupletskiy, 1925	
Varzuga drainage basin (9 streams)	le Brun, 1718; Blagoveshchenskiy, 1902; Ukchanova, 1966	Stukenberg, 1849; Zimmerman. 1853; **Rippas, 1899**; Bartenev, 1902; Kolpakova, 1937; Oparin, 1976	Popov, 1914; Regel, 1914; Fersman, 1923; Kupletskiy, 1925; Kuznetsov, 1930; Zorich, 1931 Valkov, 1934; **Saldau, 1939; Zhadin, 1939; Golubev, Esipov, 1973; Ziuganov et al., 1994, 1998; Kazakov et al., 1992; Prokhorov, 1995, 1996**	**Machordom et al., 2003; Bergengren et al., 2004**
Kuzreka			Kuznetsov, 1930	
Thurma			**A.A. Zotin, pers. comm.**	**Machordom et al., 2003**
Umba drainage basin (4 streams)*	Blagoveshchenskiy, 1902	Stukenberg, 1849; Zimmerman. 1853; Bartenev, 1902; Oparin, 1976	**Vise, 1912**; Regel, 1914; Kupletskiy, 1925; Kuznetsov, 1930; **Saldau, 1939; Zhadin, 1939; Grozdilova, 1974**	
Porja	Blagoveshchenskiy, 1902	Stukenberg, 1849	**I.G. Murza, O.L. Khristoforov, pers. comm.**	
Kolvitsa			**Anonymous, 1928**	
Niva and Imandra Lake drainage basins (15 streams)	Blagoveshchenskiy, 1902	Oparin, 1976	Kuznetsov, 1930; **Graevskiy, Baranov, 1949; Semyonov-Tjan-Shanskiy, 1960; Golubev, Esipov, 1973; Gilyasova, 2000**	
Luptche-Savino (Lupija)			Kuznetsov, 1930	
Kanda		von Middendorff, 1845; Zimmerman. 1853; Bartenev, 1902	Kozhin, Novikov, 1937	
Virma (Vuruma)			**Anonymous, 1928**	
Ostrechija			**Anonymous, 1928;** Kuznetsov, 1930; **Graevskiy, Baranov, 1949**	
Zhemchuzhnyi brook			**Makarov, 1934**	
Kovda		Stukenberg, 1849; Bartenev, 1902; Oparin, 1976	Kozhin, Novikov, 1937	

* There are data about pearl harvesting in Ura and Western Litsa during the 16th century (Andreev, 1920) and in Ura, Western Litsa, Tuloma and Umba during the 17th century (Anonymous, 1936; Ushakov, 1998)

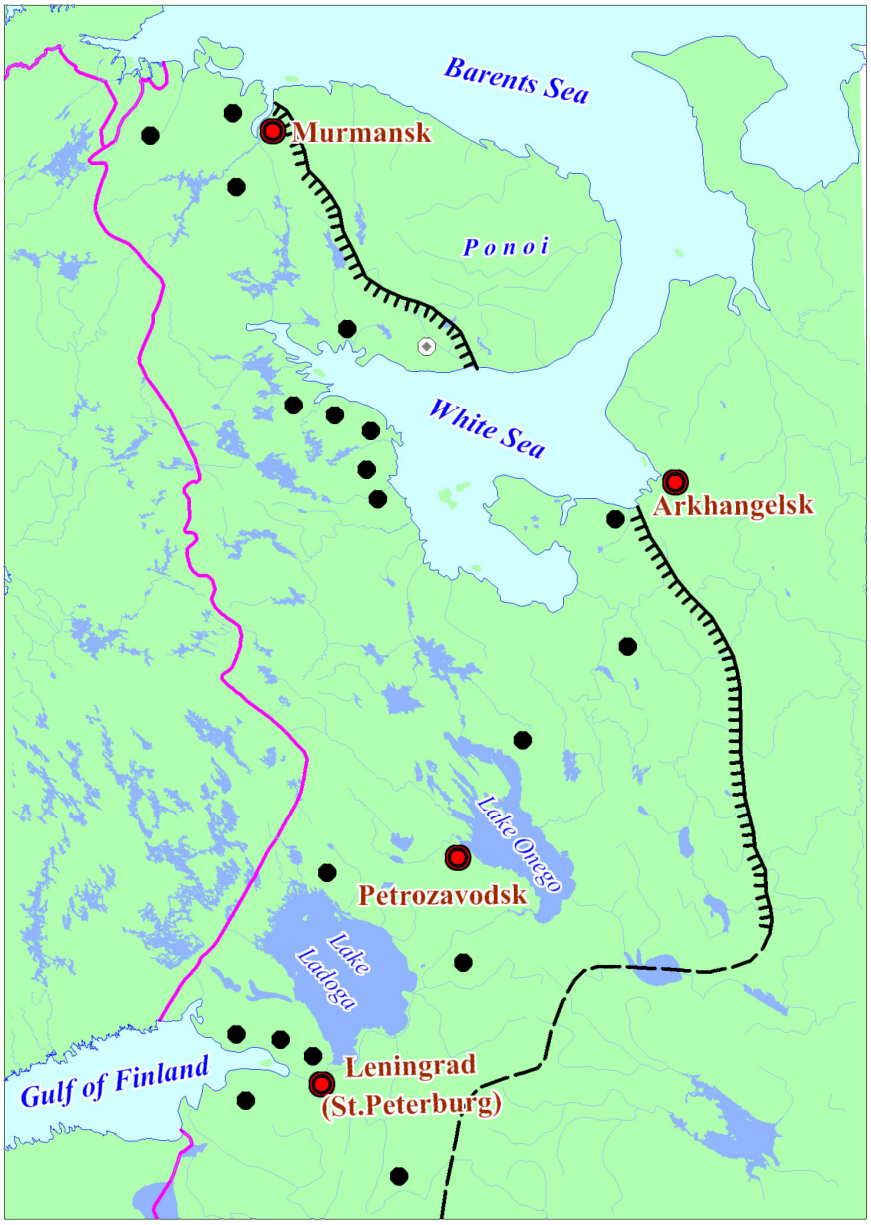

Fig. 1. Area of pearl harvesting (16th-20th centuries) in Russia. Dots mark rivers with surviving *Margaritifera margaritifera* populations (21st century)

PEARL MUSSEL DISTRIBUTION RANGE IN RUSSIA

In addition to rivers of the western Murmansk Region, the pearl mussel distribution range comprises the western part of the White Sea watershed, which administratively belongs to Republic of Karelia (overview: Makhrov et al., submitted). The mussel lives also in the southern part of the watershed, which belongs to the Arkhangelsk Region (Fig. 1). There are no reliable data on any pearl mussel findings east of the Solza River, including the Northern Dvina watershed (overview: Bespalaya et al., 2007a).

Pearl mussel used to be widespread also in the Russian part of the Baltic Sea watershed – in streams flowing to Lakes Onego and Ladoga, rivers on the Gulf of Finland coast (Anonymous, 1752; Maksimovich, 1788; Pallas, 1809; Anonymous, 1834; Kessler, 1868; Esipov, 1879; Semyonova et al.,

1992; Ostrovskiy and Popov, 2008; Makhrov, 2009; Makhrov et al., submitted; inventory of the RAS Zoological Institute's Collection, pers. comm. by I. Popov). Administratively, these areas belong to the Leningrad, Vologda, Pskov, Novgorod Regions and Republic of Karelia.

Pearl fishing has been reported also from the upstream of Zapadnaya Dvina – now belonging to Tver Region (Romanchenko, 1912). However, no findings of pearls or pearl mussel in the territory that is now Kaliningrad Region (former East Prussia) have ever been mentioned in the literature.

Table 2. Number of Russian water systems with pearl mussel populations and number of Russian streams with pearl mussel populations (in parentheses)

Region	Number of rivers where pearl harvesting was carried out/**Number of rivers where live pearl mussels were found**	Including:		
		Number of extinct populations	Number of living populations (21st century)	Number of populations with unknown status
Murmansk Region (Barents Sea drainage basin)	7 (14)/**4 (6)**	0 (0)	3 (3)	4 (11)
Murmansk Region (White Sea drainage basin)	13 (39)/**9 (25)**	0 (0)	2 (2)	11 (37)
Karelia (White Sea drainage basin)	18 (20)/**10 (11)**	3 (3)	5 (5)	10 (12)
Arkhangelsk Region	13 (18)/**2 (3)**	1 (1)	2 (3)	10 (14)
Lake Onego drainage basin	15 (19)/**3 (3)**	4 (6)	1 (1)	10 (12)
Lake Ladoga drainage basin	8 (36)/**3 (9)**	(1)	3 (5)	5 (30)
Gulf of Finland drainage basin	7 (10)/**6 (8)**	0	4 (5)	3 (5)
Western Dvina drainage basin	1 (1)/**0**	0	0	1 (1)
Total	82 (157)/**37 (65)**	8 (11)	20 (24)	54 (122)

Data on the number of watercourses where pearls used to be harvested in different parts of Russia are summarized in Table 2. The table does not include information about pearl fishing (Anonymous, 1780; Lovetzky, 1830; Stukenberg, 1849) or pearl mussel findings (Pallas, 1771; Gorodtsev, 1902; Gogulina, 1998) in the Volga River watershed – many of the accounts are fragmentary and need to be verified.

STATUS OF PEARL MUSSEL POPULATIONS IN RUSSIA

Before the 20th century, the main reason for a decline in pearl mussel stock was rapacious harvesting. E.g., late in the 19th century, all pearl mussels were collected from the Karelian river Pista, as reported by local people (Potakhin and Kapitonova, 2008). At that time, agriculture must have also affected the pearl mussel, but this impact was not studied then.

In the 20th century, pearl mussel extinction was triggered by timber floating and deforestation as well as by changes in the hydrology: impoundment, and water uptake for utility purposes (Makhrov et al., submitted). As mentioned above, some pearl mussel populations were affected by industrial pollution.

Today, one of the principal reasons for decline among the surviving pearl mussel populations is poor condition of the populations of glochidia hosts – Atlantic salmon and brown trout (Bespalaya et al., 2007b, Zyuganov, 2008; Ostrovskii and Popov, 2008; Makhrov, 2009; Makhrov et al., submitted).

Instead of these species, great numbers of the introduced pink salmon (*Oncorhynchus gorbuscha*) ascend rivers of the White Sea watershed. Glochidia attach to pink salmon gills (Grozdilova, 1974; pers. comm. by E. Ieshko), but die together with the fish before they can complete the development stage. The stream carries dead pink salmon into gaps between rocks, where adult pearl mussels live. Attacks on

freshwater pearl mussels by introduced muskrats (*Ondatra zibethica*) have been reported in the Varzuga river drainage basin (Bergengren et al., 2004).

In spite of the environmental problems mentioned above, the numbers of the freshwater pearl mussel in Russia are higher than elsewhere in the world. River Varzuga alone has a population of about 140 million mussels (Ziuganov et al., 1994; Bergengren et al., 2004), i.e. nearly as much as in all rivers of Norway taken together (Larsen, ibid.).

FURTHER RESEARCH

Detailed and large-scope research into current distribution of the pearl mussel in rivers and streams of Russia has to be set up, similar to the work done in our neighbor countries (Rudzīte, 2004; Oulasvirta, 2006, 2008; Larsen, 2009). It would be expedient to organize international studies of pearl mussel populations, first of all in transboundary river watersheds.

Simultaneously, study of the fish hosts of the mussel glochidia should be continued. The distribution of Atlantic salmon in Russia is quite well known (monographs: Kazakov, 1998; Kaliuzhin, 2003; Martynov, 2007), but Russian rivers with brown trout populations have not yet been listed (overview: Makhrov, 1999). It is also important to assess current condition of the fish populations in the rivers inhabited by the pearl mussel, and such studies have begun in Karelia (Makhrov et al., submitted).

To properly organize pearl mussel culture and reacclimatization, one needs to investigate its parasites, bacteria and viruses, analyze genetic diversity of *Margaritifera margaritifera*. Hardly any studies of this kind have been implemented, and only data on the genetic structure of several pearl mussel populations are available (Machordom et al., 2003; Artamonova and Bukhanova, unpublished).

Genetic data can also be used to investigate the pathways of the pearl mussel dispersal. Study of dispersal pathways in combination with analysis of environmental factors can help identify the factors restricting pearl mussel distribution in Russia.

It would also be interesting to study former pearl fishing activities as a social phenomenon of high significance for people in the north of Russia. Researchers from different countries would need to cooperate to learn more about pearl fishing in the territories that had drifted from one country to another. Furthermore, until the beginning of the 20th century, pearl fishers from Finland used to harvest pearls on the White Sea coast (Khrebtov, 1897; Nikol'skiy, 1927); and vice versa, Karelians went to Finland for pearls (Vilkuna, 1980; Storå, 1989). These practices may become a topic for international research.

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