

New Data on the Distribution of Lamprey *Petromyzon marinus* and *Lethenteron camtschaticum* (Petromyzontidae) in Barents and White Seas

M. A. Novikov^{a, *} and M. N. Kharlamova^b

^aPolar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk, 183038 Russia

^bMurmansk Arctic State University, Murmansk, 183038 Russia

*e-mail: mnovik@pinro.ru

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Abstract—Information about the sites of catches of the sea lamprey *Petromyzon marinus* in the western Barents Sea and Arctic lamprey *Lethenteron camtschaticum* in the Barents and White seas is presented based on the data of trawl surveys performed in 2004–2016. It is demonstrated that sea lamprey is occasionally encountered in the western Barents Sea; nine specimens have been recorded during the entire period of surveys. The northernmost point of a capture of sea lamprey is located near 76° N and the easternmost point is at 31°15' E. Arctic lamprey is not numerous in the Barents and White seas; a total of 66 and 17 specimens have been caught, respectively. Its local aggregations are found in the southeastern part of the Barents Sea and in Dvina Bay in the White Sea. Arctic lamprey penetrates to the north to 76° N and into the central part of the Barents Sea.

Keywords: sea lamprey *Petromyzon marinus*, Arctic lamprey *Lethenteron camtschaticum*, Barents Sea, White Sea, distribution, marine life stage

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INTRODUCTION

The marine life-history phase of noncommercial anadromous fish has been, as a rule, poorly studied, since they do not form any commercial aggregations in the open sea, and purposeful studies of species with low economic importance dispersed in the ocean are not usually performed. The information about sea ranges of such fish species is often based on occasional findings, expert estimates, some special studies and, therefore, only partially reflects the reality. This, to a greater extent, concerns the lampreys *Petromyzon marinus* and *Lethenteron camtschaticum*, data on whose distribution in the open sea are rather scarce (Viler, 1983; Pavlov et al., 1994; Dolgov, 2006, 2011; Silva et al., 2013; Orlov et al., 2014; Docker, 2015).

The sea lamprey *P. marinus* is an anadromous parasitic species with a vast range in the North Atlantic Ocean. In fresh waters of Europe, sea lamprey is, mainly, encountered in the mouths of rivers but can migrate upstream over long distances (Beamish, 1980; Hardisty, 1986). The peak of the spawning migration at high latitudes occurs in July–August (*Promyslovye biologicheskie resursy...*, 1977). The total duration of the freshwater life stage varies from 4 to 9 years, usually constituting 5 years (Maitland, 2003; Renaud, 2011). After metamorphosis, sea lamprey migrates to the sea, where it spends 2.0–2.5 years living a parasitic life

style and feeding on tissues of marine fishes (salmon, whitefish, sturgeon, cod, haddock, herring, shark, etc.) and mammals (Beamish, 1980; Maitland, 2003; Renaud, 2011; Silva et al., 2013). According to some data, the maximum total length (*TL*) of sea lamprey reaches 120 cm, the maximum weight is 2.3–2.5 kg, and the average length of adult specimens is approximately 60–75 cm (Maitland, 2003; Renaud, 2011).

In the East Atlantic Ocean, sea lamprey is found along the coast of Europe from the Adriatic Sea and the western part of the Mediterranean Sea to the North and Baltic seas. Sea lamprey occurs off the coasts of Morocco, Tunisia, Algeria, and Italy. The species is rare near the coast of Norway to the north of Trondheim but is occasionally recorded to Tromsø and eastern Finnmark, probably, to the Varangerfjord (Andriyashev, 1954; Ladiges and Vogt, 1979; Alekseev and Kuderskii, 2001; Renaud, 2011). The latest capture of sea lamprey was recorded near the coast of Kola Peninsula in November 1966: a female of *TL* 83.5 cm and a weight of 900 g was caught with a trawl-attached net in Kildin shoal in the area of Kola Bay in the Barents Sea (Grinyuk, 1970). Earlier, coastal waters of the Murman region near the outlet from Kola Bay, the area of Kildin Island, and, probably, the area of Kolguev Island were considered an eastern boundary of sea lamprey in the Barents Sea (*Promyslovye biologicheskie resursy...*, 1977). Modern data on the distribution

of *P. marinus* in the open part of the Barents Sea are scarce (Dolgov, 2006; Prozorkevich and Sunnanå, 2016). Reshetnikov (2007) states that the species is occasional in Arctic waters; the greater part of its distribution range is in Central and Southern Europe. Earlier, it was reported in Russian publications that the species is confined everywhere to coastal waters (*Promyslovye biologicheskie resursy...*, 1977, p. 107), but there are few data on catches of sea lamprey during trawl surveys in the Barents Sea at depths of 128–129 m (Dolgov, 2006). A case of capture of sea lamprey at a depth of 4099 m is also known: a specimen of sea lamprey was caught with a shrimp trawl in the Atlantic Ocean 400 km southward of the coast of New England, United States (Haedrich, 1977).

In the past, sea lamprey was a valuable commercial species in Western Europe, but the species has recently lost its commercial importance. In Russia, sea lamprey was not a commercial species for the same reason (*Promyslovye ryby SSSR*, 1949; *Promyslovye biologicheskie resursy...*, 1977). *P. marinus* has been listed in the Red Book of the Russian Federation as an endangered species. In the Russian territorial waters, solitary specimens occur in rivers flowing into the Gulf of Finland (Narva, Neva, and Luga rivers), in rivers of the Baltic coast in the territory of Kaliningrad oblast and in the Gulf of Finland, the Curonian Lagoon, and Vyborg Bay (Alekseev and Kuderskii, 2001; *Morskaya minoga*, 2001).

The Arctic lamprey *L. camtschaticum* is an anadromous parasitic species widely distributed in the Arctic and northern part of the Pacific Ocean (Renaud, 2011; Orlov et al., 2014; Docker, 2015). An anadromous form has a discontinuous range; it occurs in the White Sea and the southern part of the Barents Sea (from Varangerfjord, Kola and Motovsky bays eastward to the Pechora River) and in the Ob River basin. An anadromous form is, probably, absent eastward and once again appears in the basin of the Pacific Ocean from Anadyr and Yukon and further to the south in the basins of the Sea of Okhotsk and Sea of Japan (Andriyashev, 1954; Kuderskii, 1998; Makhrov et al., 2013; Docker, 2015). According to data of the Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (*Ekosistema...*, 2008), Arctic lamprey is encountered in the Kara Sea as well: four specimens *TL* 27–36 cm and a weight to 69 g were taken at a depth of 50 m southward of Vaigach Island in September 2007. In the opinion of Docker (2015), *L. camtschaticum* has the most northern distribution among lampreys reaching 72° N to the north of Alaska.

Arctic lamprey reaches *TL* 62.5 cm and a weight of 200 g; its lifespan is 6–7 years, four of which the species spends in rivers (Berg, 1948; Chereshev et al., 2001; Kucheryavii et al., 2007). According to published data, the species reaches *TL* 54 cm and a weight of 150 g in the White Sea (Altukhov et al., 1958). Arctic

lamprey is widely distributed in the regions adjacent to the largest rivers (Northern Dvina, Mezen, Onega rivers etc.). The species lives in the pelagic zone and in near-bottom layers; it may occur at a depth of more than 700 m; it is more frequently found in trawl catches in the upper 100-m layer (Orlov et al., 2014). Arctic lamprey attacks cod, navaga, halibut, smelt, salmon, herring, and other fish species (Chereshev et al., 2001; Makhrov et al., Orlov et al., 2014). Arctic lamprey is of valuable nutritional quality but a secondary fishery object in respect to its low abundance in the Far East basin (Chereshev et al., Orlov et al., 2014). In the past, catches of Arctic lamprey were rather high and it was of considerable commercial importance in the northern basin. Thus, in the Northern Dvina, 16 and 32 t of lamprey were taken in 1908 and 1909, respectively; in 1936–1939 the annual catch of lamprey in the USSR constituted 30–40 t (*Promyslovye ryby SSSR*, 1949; Altukhov et al., 1958).

The aim of this study is to analyze the distribution and some morphometric parameters of sea and Arctic lampreys caught in the Barents and White seas over the past decades based on the data of trawl surveys.

MATERIALS AND METHODS

The material for studies was obtained as a result of processing the data of surveys conducted using bottom and pelagic trawls onboard the research vessels of PINRO and the Institute of Marine Research (IMR, Bergen, Norway) and onboard the fishing vessels with participation of the researchers of PINRO in the Barents Sea and in adjacent western areas in the northern area of the Norwegian Sea and in the White Sea. The major bulk of the data were obtained in the course of the joint Russian (PINRO)–Norwegian (IMR) ecosystem survey annually conducted in August–September. In addition, data of other marine expeditions of PINRO were used: annual multispecies trawl-acoustic survey (TAS) (October–December); TAS of the spawning stock of the capelin *Mallotus villosus* (February–March); TAS of the immature portion of the commercial stock of the haddock *Melanogrammus aeglefinus* and saithe *Pollachius virens* in the southern part of the Barents Sea (May–June); multispecies TAS in the southeastern part of the Barents, Kara, and White seas (August–October). Thus, long-term data obtained during all seasons were analyzed. In 2004–2016, a total of 61884 trawl hauls in the Barents Sea and 424 trawl hauls in the White Sea were performed. The depth of trawl surveys varied from 1 to 848 m.

Catches were sorted by ichthyologists participating in the expedition; the length (*TL*) of lampreys was measured; if possible, specimens were weighted and their sex was determined (all live specimens were released into the sea. All data were additionally verified by checking the catch registration forms of trawl fishing. The data of trawl hauls were processed where the species *P. marinus* (sea lamprey) and *L. camtschat-*

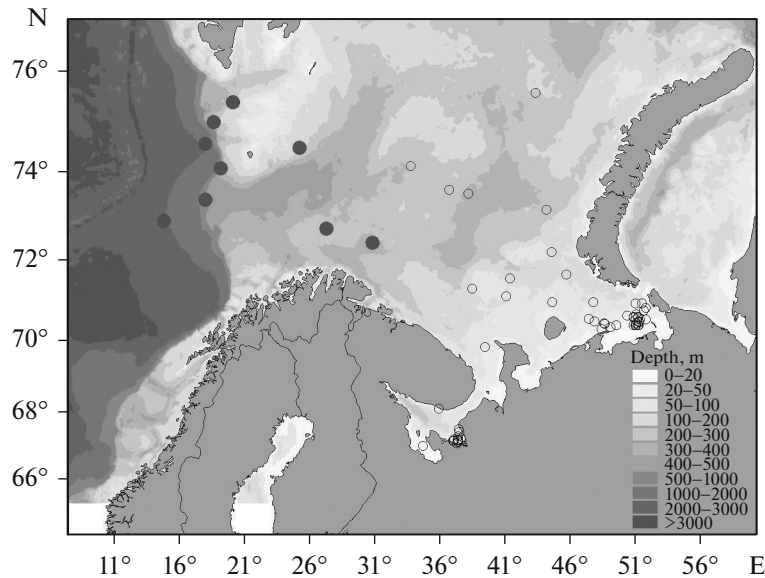


Fig. 1. Sites of catches of the sea lamprey *Petromyzon marinus* (●) and Arctic lamprey *Lethenteron camtschaticum* (○) in the Barents and White seas in 2004–2016.

icum, *L. japonica*, and *L. japonicum* (Pacific or Japanese, or Far Eastern lamprey) were recorded based on the field identification. The three latter names are synonyms (Bogutskaya and Naseka, 2004).

RESULTS AND DISCUSSION

Petromyzon marinus. In 2005–2015, a total of eight sea lampreys were captured as a result of trawl surveys in the region of the Barents Sea (Fig. 1, Table 1). In all cases, one specimen was taken per trawl haul. Lampreys were not detected to the north of 76° N and to the east of 31°15' E. The closest distances from the coast were 115 and 162 km (the area of the Scandinavian Peninsula). All specimens of lamprey were caught from the end of August to the beginning of December. The length of lampreys varied within 36–80 (70.2 ± 4.22)¹ cm, the weight ranged from 50 to 1500 (757 ± 117) g. At the beginning of November 2005, a specimen of TL 77 cm and a weight of 0.750 kg (Fig. 2) was detected on the Greenland halibut *Reinhardtius hippoglossoides* from the catch in the Medvezhinsky Trough at the boundary with the Norwegian Sea. The largest specimen in terms of weight (female 1500 kg) was captured at the boundary with the Norwegian Sea in October 2007. The other large specimens were caught in the Murmansk tongue (female TL 80 cm) in December 2005 and in the Storfjorden Trough (male TL 77 cm) in November 2008.

According to Beamish (1980), sea lamprey is usually found within a depth of 200 m in the western

Atlantic Ocean adjacent to North America; the boundary of its distribution extends northward to 53° N.

Based on the catches of 12 specimens, Dolgov (2006) has demonstrated that sea lamprey is distributed in a vast area in the Barents Sea: to 74°35' N in the north and 45°25' E in the east. Since the middle of the 1990s, lamprey was found in pelagic and (more seldom) in bottom trawls in North Kanin, Murman, and Goose banks and in areas of the Central Depression (Eastern Basin) and Perseus Elevation (Great Bank) and in some other parts of the Barents Sea. In all cases, specimens were recorded occasionally. Catches of sea lampreys using a pelagic trawl were recorded at depths of 15–50 m with a pelagic trawl and at depths of 128–159 m with a bottom trawl. Later, Dolgov (2011) critically reviewed the data on the distribution of sea lamprey in the Barents Sea: the northern boundary of its range was shifted southward to approximately 72° N, and the eastern boundary remained at 45° E. Our data indicate that sea lamprey has occurred more northward of the known sites of its catches in recent years; it has almost reached Spitsbergen. These data differ considerably from earlier published data on sea lamprey distribution in marine waters; on maps, the northern boundary of the range in the Barents Sea does not extend beyond 72° N; the area of its distribution presented on the basis of expert estimates extends along the coasts of the Scandinavian and Kola peninsulas as a uniform wide band, i.e., it is conditional (Pavlov et al., 1994; Dolgov, 2011; *FishBase...*, 2016). More particular information is presented on the map in the monograph by Docker (2015, p. 61), but it is based on outdated data of Hubbs and Potter (1971). In any case, practically all sites of catches of sea lamprey with

¹ Here and hereinafter: the mean \pm standard error.

Table 1. Size–weight characteristics of feeding specimens of the sea lamprey *Petromyzon marinus* in the Barents Sea with depths of catches

Month and year of capture	Sex	Length (TL), cm	Weight, kg	Depth, m
Dec. 2005	Female	80	0.870	330
Oct. 2007	Female	72	1.500	90
Sept. 2008	Male	77	0.786	248
Sept. 2008	Male	70	0.590	233
Sept. 2010	N/d	74	0.820	60
Aug. 2012	N/d	36	0.05	40
Nov. 2012	Female	78	0.725	420
Aug. 2015	N/d	68	0.670	40

N/d means the sex was not determined.

trawls (Fig. 1, Table 1) are located to the north and east of its earlier reported range (Docker, 2015). The data presented by Dolgov (2006) indicate the shift farther the eastern boundaries of the distribution of sea lamprey.

Lethenteron camtschaticum. During the entire period of surveys, 66 specimens of Arctic lamprey were captured at 42 trawl stations; 32 specimens of them were caught with a trawl in August 2016, mainly, in the southeastern part of the Barents Sea (the Pechora Sea) (Figs. 1, 3). The northernmost station of Arctic lamprey records in the Barents Sea was at 76° N as of sea lamprey, and the most western boundary was near 35° E. The maximum number of specimens captured during one 30-min trawling at a depth of 34 m in the Barents Sea was eight specimens that exceeded the maximum

density of their distribution recorded earlier in the northern part of the Pacific Ocean by 1.6 times (Orlov et al., 2014). All specimens of Arctic lamprey were caught in the Barents Sea in August–September. This is due to the fact that trawl surveys do not cover the southeastern part of the Barents Sea in other seasons.

Specimens of Arctic lamprey were found both in pelagic and bottom trawl catches at depths from 10 to 131 m, mainly (84% specimens) at depths to 38 m. The length of lampreys ($n = 65$) varied within 23–43 (32.52 ± 0.62) cm, the weight ranged from 15 to 146 (57.3 ± 2.1) g. A multimodal distribution of the size composition (Fig. 4) indicates the presence of several age classes in catches and makes it possible to draw a conclusion about the duration of the marine life-history stage, which, probably, lasts 2–3 years.



Fig. 2. Sea lamprey *Petromyzon marinus* (TL 77 cm) from the area of Medvezhinsky Trough in the Barents Sea, November 2005. Photo by P.N. Klepikovskii.

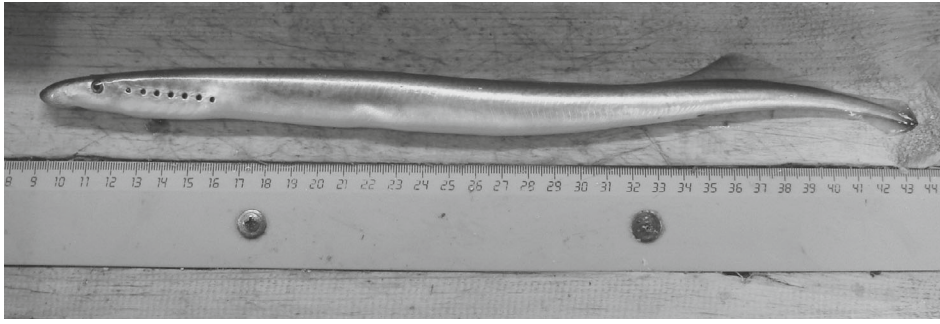


Fig. 3. Arctic lamprey *Lethenteron camtschaticum* (TL 34.5 cm) from the southeastern part of the Barents Sea, August 2016. Photo by R.N. Klepikovskii.

Arctic lamprey was found in trawl catches in the White Sea in 2012–2016. A total of 17 specimens were caught at 17 stations at depths of 11–52 m during the entire period of surveys. Almost all catches were localized in the Dvina Bay; only one specimen was found in the Onega Bay, and one specimen near the Tersky Coast of the Kola Peninsula. Lampreys in the White Sea were a larger TL 29–48 (37.2 ± 1.27) cm compared to lampreys in the Barents Sea.

According to our data, the boundaries of the range of Arctic lamprey in the Barents Sea are located more to the north and west than was reported in previous works (Wienerroither et al., 2011; Docker, 2015; Froese and Pauly, 2016). The depth of catches of Arctic lampreys in our study corresponds to the published data on the North Pacific (Orlov et al., 2014). The average length and weight of specimens from the Barents Sea are smaller than in the North Pacific, 41.4 cm and 128 g (Orlov et al., 2014). It should be emphasized that lampreys of the size corresponding to the commercial size (TL 28–41 cm) in the middle of the past century prevailed in catches of 2004–2016 (*Promyslo-*

vye ryby SSSR, 1949). The average length of the described specimens from bays in the White Sea is considerably larger than of anadromous lampreys from the Northern Dvina and Vyg rivers, TL 29–31 cm (Berg, 1948), and agrees with the data on the Northern Dvina River (Kozmin, 2011).

Arctic lamprey performs spawning migrations to the rivers on the northern coast of the Kola Peninsula (Andriyashev, 1954; Makhrov et al., 2013; Docker, 2015). In September 2016, two specimens, probably smolts, were caught in the Titovka (TL 15.4 cm) and Shovna (TL 17.6 cm) rivers. The Shovna River enters the Tuloma river, which flows into the Kola Bay. The Titovka River enters Motovsky Bay of the Barents Sea. Such catches make it possible to conclude what sites are the starting points for beginning of the marine feeding phase of the species and to judge the biological characteristics of juvenile specimens that start the feeding phase. The size of these smolts is in the range of the size indicated for Arctic lamprey specimens from the Sea of Okhotsk, TL 13.1–22.0 cm (Kucheryavyi et al., 2007; Nazarov et al., 2011).

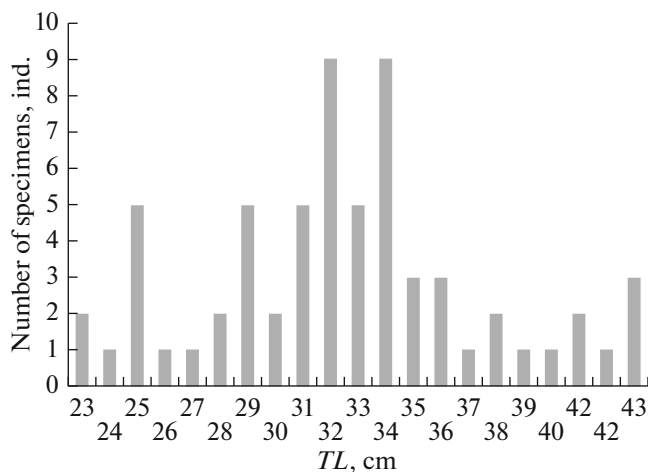


Fig. 4. Distribution of specimens of the Arctic lamprey *Lethenteron camtschaticum* from the Barents Sea in respect to the body length (TL).

CONCLUSIONS

The studies have demonstrated that sea lamprey has occurred occasionally in the Barents Sea during the past 13 years. Its range extends northward to approximately 76° N and eastward to 31°15' E. According to data of almost 62000 trawl hauls, sea lamprey was not found in the White Sea and in the Russian part of the Barents Sea. The species has not been found in the coastal zone; it is mainly recorded at high latitudes at the boundary between the Barents and Norwegian seas, in the region of Spitsbergen where it moves with Greenland halibut. The data on the distribution of sea lamprey in the open sea supplement all known data on the range of the species in the northeastern Atlantic Ocean, especially the northern boundary of its distribution.

Arctic lamprey is more numerous than sea lamprey. In the north, it reaches the same latitude as sea lamprey and its range extends to 35° E in the west. The

presented data on its distribution in the open sea broaden the information about the range of the species in the West Arctic region. In recent years, specimens of Arctic lamprey are periodically found in trawl catches in the southeastern part of the Barents Sea where they, most likely, form aggregations. Arctic lamprey also forms aggregations in Dvina Bay in the White Sea. These aggregations are both of feeding and pre-spawning types. Such aggregations in the White Sea at the end of summer—beginning of autumn were described earlier (Kozmin, 2011). The size—weight structure of a marine part of the Arctic lamprey population in the Eastern Barents Sea indicates its relative well-being; over the past 60–70 years, their size did not decrease. In the modern period, there is a tendency of Arctic lamprey distribution to the west and north of the Barents Sea.

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