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Species Composition, Abundance, Distribution Features and Size Characteristics of Fish of the Genus *Liparis* (Cottiformes: Liparidae) in the East-Siberian and Laptev Seas

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Abstract—Information on the distribution and occurrence of three species of the genus *Liparis*, *Liparis bathyarcticus* Parr, 1931, *L.* cf. *fabricii* Krøyer, 1847 and *L. tunicatus* Reinhardt, 1836 on the shelf of the Laptev and East Siberian seas, depending on the temperature, salinity and sediment types is presented according to the data of trawl surveys in 2014 and 2017. *L.* cf. *fabricii* is the most common species in the surveyed water area with the frequency of occurrence of 22.4% in the Laptev Sea and 24.7% in the East Siberian Sea. The total relative abundance and biomass of all species of the genus *Liparis* in the East Siberian Sea (377.7 ind./km^2 and 9.14 kg/km^2) were slightly higher than in the Laptev Sea (326 ind./km^2 and 8.32 kg/km^2). The maximum length of *L. tunicatus* in the East Siberian Sea (172 mm) exceeds the previously known one (160 mm). The average length and weight of fish of all three species of *Liparis* in the East Siberian Sea are greater than in the Laptev Sea.

Keywords: *Liparis bathyarcticus*, *Liparis* cf. *fabricii*, *Liparis tunicatus*, distribution, ecology, Laptev Sea, East Siberian Sea

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Representatives of the genus *Liparis* are one of the significant structural elements of the Arctic ichthyofauna (Karamushko, 2013), although their diversity in the Arctic seas of Russia is limited by a few species (Table 1). Four of them, *L. bathyarcticus* Parr, 1931, *L. fabricii* Krøyer, 1847, *L. laptevi* Popov, 1933 and *L. tunicatus* Reinhardt, 1836, are currently reported for the East Siberian and Laptev seas (Andriyashev, 1954; Chernova, 1991, 2018; Orlov et al., 2020a, 2020b). General information about these fish can be found in a number of summary works (Andriyashev, 1954; Able and McAllister, 1980; Chernova, 1991, 2013a, 2013b; Parin et al., 2014). At the same time, it should be borne in mind that the ideas about species and their nomenclature have undergone noticeable changes. Previously, two species of *Liparis* were identified in the Arctic seas: all specimens with a light peritoneum were attributed to *L. liparis* (Linnaeus, 1766), and specimens with a black peritoneum were attributed to *L. koefoedi* Parr, 1931 (Andriyashev, 1954). Later, the widespread species *L. liparis* (described from European boreal waters) was subdivided with the identification of the cold-loving *L. tunicatus* in the Arctic in the revision by Canadian authors (Able and McAllister, 1980; Able, 1990), The authors considered the gelatinous seasnail *L. koefoedi* from the waters of the Svalbard archipelago to be identical to the previously described *L. fabricii* from the same waters. *L. laptev* Popov 1933 with a pigmented peritoneum from the Laptev Sea was also included into the synonymy of the latter (Able, 1990). Nebulous snailfish from waters of the Svalbard Archipelago with a light peritoneum and described as a subspecies of *L. liparis bathyarcticus* was included in the revision into the synonymy of the Far Eastern variegated snailfish *L. gibbus* Bean 1881 based on the presence of a long gill opening and teeth shape (that differs them from short-gilled *L. liparis* and *L. tunicatus*). As a result, the authors of the revision indicate three species of the genus *Liparis* in the Siberian Arctic, *L. tunicatus, L. gibbus* and *L. fabricii*. Later, the differences were found between *L. bathyarcticus* and *L. gibbus* according to the characters of the olfactory system, which have diagnostic significance in the group of Liparidae: *L. bathyarcticus* is characterized by a reduced diameter of the posterior nostrils (they are half the depth of the anterior nostrils, have the appearance of a small pore); and in the lectotype *L. gibbus* (USNM 24047, eastern part of the Bering Sea, St. Paul's Island, Pribylov Islands) the posterior nostrils are similar in diameter to the anterior ones, there is a valve-like outgrowth on the edge (Chernova, 2008; Chernova, 2008, 2018). At present, *L. bathyarcticus* and

Table 1. Species composition of fish of the genus *Liparis* in the Arctic seas of Russia (Andriyashev, 1954; Chernova, 1991, 2018; Datsky, 2015; Mecklenburg et al., 2018; Randall et al., 2019; Orlov et al., 2020a, 2020b)

No.	Species	Sea					
		Barents	White	Kara	Laptev	East Siberian	Chukchi
1	*L. bathyarcticus* Parr 1931—nebulous snailfish	+	+	+	+	+	+
2	*L.* cf. *fabricii* Krøyer 1847—gelatinous snailfish	+	+	+	+	+	+
3	*L. gibbus* Bean 1881—variegated snailfish	–	–	–	–	–	+
4	*L. laptevi* Popov, 1933—Laptev's snailfish	–	–	+	+	+	–
5	*L. liparis* (Linnaeus, 1766)—striped seasnail	+	–	–	–	–	–
6	*L. montagui* (Donovan, 1804)—Montagu's seasnail	+	–	–	–	–	–
7	*L. ochotensis* Schmidt, 1904—Okhotsk snailfish	–	–	–	–	–	+
8	*L. tunicatus* Reinhardt 1836—kelp snailfish	+	+	+	+	+	+
	Total	5	3	4	4	4	5

L. gibbus are considered as independent species (Parin et al., 2014; Mecklenburg et al., 2018).

Specimens with the black pigmentation of the peritoneum and simple (in mature individuals) teeth are traditionally identified as *L. fabricii*. In this sense, it is a species complex including *L. fabricii* s. str. (the peritoneum has silver guanine pigmentation on a black background), *L. koefoedi* (the peritoneum is inky black, the head is compressed laterally, its width is 63-70% of the head length), *L. laptevi* (the peritoneum with sparse melanophores on a light non-silver background; the head is wide, 80% of the head length; the dorsal fin is low located over the body and noticeably expands only in the caudal part of the body) (Chernova, 2008; Chernova, 2018).

Over the past two decades, the environment of the Arctic ichthyofauna has undergone significant changes. Global temperature rise has a significant impact on the Arctic, which has already led to a 50% reduction in the area of ice cover from 2002 to 2017 (Kwok, 2018). First of all, the changes affected shallow shelf seas, including the Laptev and East Siberian Seas, which made it possible to conduct studies in areas previously inaccessible to bottom trawling (Chernova, 2015; Glebov et al., 2016a, 2016b; Orlov et al., 2020a, 2020b; Syomin and Zimina, 2020). This study presents the results of analysis of catches taken during large-scale trawl surveys in the above seas in 2014 and 2017. Favorable conditions for navigation allowed us to investigate a significant water area, which made it possible to assess both the diversity of fish in general and the quantitative characteristics of certain taxonomic groups which are an integral part of cold-water ecosystems. The results of the studies on eelpouts of the genus *Lycodes* were published earlier (Smirnova et al., 2019).

The aim of this study is to analyze the distribution, ecology, size composition and weight of fish of the genus *Liparis* based on the results of bottom trawl surveys in the East Siberian and Laptev seas.

MATERIALS AND METHODS

The material was collected during the cruise of the R/V *Dalnie Zelentsy* (Murmansk Marine Biological Institute) in the area of the Laptev and East Siberian seas in September–October 2014 and August-September 2017 (Fig. 1). The boundaries of the seas are indicated in accordance with the generally accepted demarcation of the waters of the World Ocean (*Atlas* ..., 1980).

The bottom relief of the shelf of the East Siberian and Laptev seas in the study area is a hilly plain without deep depressions and high elevations, with prevailing depths of 20–50 m. In the northern part of the seas on the continental slope, the depths increase sharply and on the abyssal plain reach >1000 m in the Laptev Sea and >900 m in the East Siberian Sea (Zalogin and Kosarev, 1999). The overwhelming majority of trawling operations was carried out to a depth of 200 m and only a few of them, in the uppermost part of the continental slope. The range of depths surveyed was 10-436 m in the Laptev Sea and 9.3–277.0 m in the East Siberian Sea.

At stations with depths of <20, catches were made by a conventional bottom trawl (design 2837-00-000) with a fine-meshed (12 mm) insert. The duration of trawl hauls was 30 minutes; the towing speed of the trawl was 2.5 knots. Pelagic surveys were performed by a commercial midwater trawl configured to perform catches in the pelagic zone at a speed of 3.5–4.0 knots and a towing duration of 15 minutes. At stations with depths of <20 m, a Sigsbee trawl was used with an opening perimeter of 100 × 30 cm (0.3 m^2) and a mesh size of 7 mm; the towing duration was 10 min. During the entire expedition period, a total of 312 trawl hauls with bottom and pelagic trawls (284) and Sigsbee trawl

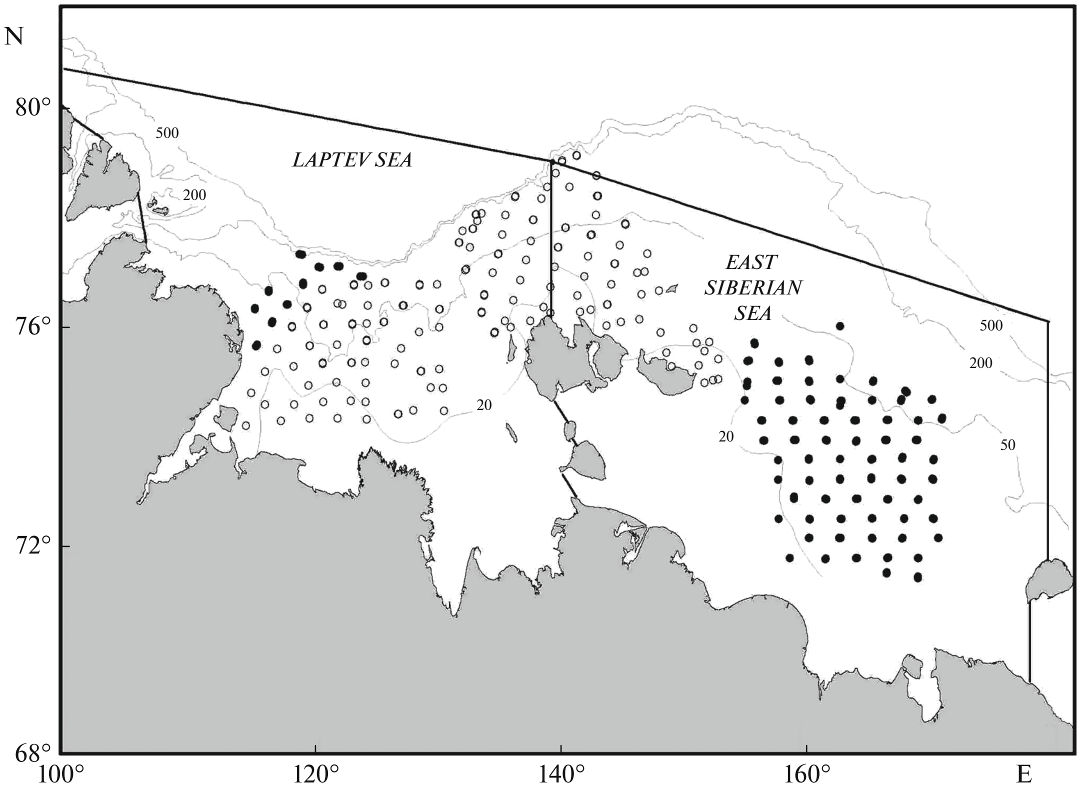

Fig. 1. A schematic map of trawl stations surveyed in the East Siberian and Laptev seas in September–October 2014 (○) and August–September 2017 (●). Here and in Figs. 2, 3: (—)—isobaths, (—)—boundaries of seas (according to *Atlas*..., 1980).

(28) were performed at 199 stations from the continental slope in the north to coastal areas in the south. Fish of the genus *Liparis* were recorded in 35.9% of catches; a total of 393 specimens were caught.

The water temperature and salinity were measured at each station using an automatic SBE 19 plus CTD probe (Sea-bird Electronics, United States). Sediment samples were taken with a Van-Veen grab sampler. The type of sediments was classified according to the most frequently used characteristics (Klenova, 1960). The dependence of the distribution of *Liparis* on the types of sediments was analyzed only for the Laptev Sea area.

The total length of fish (*TL*) was measured to an accuracy of 1 mm, weight, to 0.1 g of accuracy. The density of *Liparis* distribution in terms of weight (relative biomass) was calculated using quantitative data on the composition of catches and the area of the catch according to the formula (Aksyutina, 1968): $M' = M/1.852\,t0.001H$, where M is the actual mass of fish in the catch for 1 h trawling, kg; v is trawling speed, knots; t is the duration of trawling, h; H is the horizontal mouth opening of the trawl, m; 1.852 is the number of kilometers in a nautical mile; 0.001 is the coefficient of conversion of meters to kilometers. The relative number of fish was calculated using a similar formula. The catchability coefficient was not used in the calculations, since it is unknown for the types of trawls used and the fish species studied.

Russian and Latin names of fish are given according to the modern nomenclature (Parin et al., 2014; Fricke et al., 2021), with the exception of the Russian name *L. bathyarcticus*, nebulous snailfish (according to: Chernova, 2013a), since the later proposed name Arctic for it (Parin et al., 2014) was used before for the species *L. tunicatus*. In order to avoid confusion, for the latter, the name kelp snailfish, proposed in the nomenclature and faunal list, widely used in scientific usage, has been retained (Parin et al., 2014). In view of the fact that the group of gelatinous snailfishes requires taxonomic clarification and field identification of the species of this complex was difficult during trawl surveys, gelatinous snailfish is presented in this paper as *L.* cf. f*abricii*. It should be noted that *L. laptevi* is included in the list of species composition of the genus *Liparis* in the East Siberian and Laptev seas according to the results of the trawl survey in 2019. (Orlov et al., 2020a, 2020b).

RESULTS AND DISCUSSION

Species composition. Of 30 valid genera of the family Liparidae, only four genera are directly recorded in the Arctic (Chernova et al., 2004; Mecklenburg et al.,

Table 2. Frequency of occurrence (FO), average density of distribution, length (*TL*) and weight of fish of the genus *Liparis* in catches in the East Siberian and Laptev seas in 2014 and 2017

Species	*n*, ind	FO, %	Density		*TL*, mm	Weight, g
			ind. /km^2	kg/km^2		
			Laptev Sea			
L. bathyarcticus	81	20.1	121.3	4.95	37–270 / 108.3 ± 7.6	1.0–327.05 / 4.4 ± 7.6
L. cf. *fabricii*	86	22.4	71.9	0.70	40–156 / 84.5 ± 2.6	0.7–53.0 / 10.5 ± 1.1
L. tunicatus	39	11.2	132.8	2.67	34–134 / 55.3 ± 3.5	1.1–31.0 / 3.7 ± 1.0
			East Siberian Sea			
L. bathyarcticus	80	16.3	88.2	6.29	55–285 / 146.3 ± 7.2	2.8–358.0 / 76.5 ± 9.2
L. cf. *fabricii*	87	24.7	65.5	1.30	56–165 / 103.6 ± 2.5	1.8–89.0 / 19.0 ± 1.5
L. tunicatus	51	11.8	224.0	1.55	54–172 / 88.6 ± 3.4	2.2–83.0 / 12.3 ± 1.9

n is the total number of fish in catches; the variation ranges of a parameter are above the line, the mean and its error is under the line.

2018), among which the genus *Liparis* composed of 8 species occurs in the Arctic seas of Russia from the White Sea to the Chukchi Sea (Table 1). The maximum number of species was recorded in the Barents and Chukchi seas, the minimum number, in the White Sea.

During the study period, three species were recorded in the catches: nebulous snailfish *L. bathyarcticus*, gelatinous snailfish *L.* cf. *fabricii* and kelp snailfish *L. tunicatus*. All of them are typical for the Arctic seas, including the Laptev and East Siberian seas (Andriyashev, 1954; Chernova, 1991, 2013a, 2013b). The Laptev's snailfish was not found in our catches.

Frequency of occurrence and spatial distribution. During the study period, gelatinous snailfish was the most common species of the genus *Liparis* in the Laptev and East Siberian seas which was reported earlier (Andriyashev, 1954; Chernova, 1991; Orlov et al., 2020a, 2020b). Specimens of this species were found in 22.4% of catches in the Laptev Sea, in 24.7% in the East Siberian Sea (Table 2). Gelatinous snailfish was found in the northern part of the surveyed water area, including the area north of the New Siberian Islands archipelago. Given the literature data (Chernova, 1991; Chernova and Neyelov, 1995), it can be noted that the species distribution is mostly confined to the outer part of the shelf of the studied seas (Fig. 2).

The lowest frequency of occurrence was found for kelp snailfish (11.2% in the Laptev Sea and 11.8% in the East Siberian Sea). Unlike gelatinous snailfish, it was not found in the north along the edge of the shelf, and to the north of the New Siberian Islands it was found exclusively in the coastal area (Fig. 2c). Such distribution may be due to the predominant occurrence of the species in the area of coastal shallow waters, most of which was not covered by our trawl surveys.

The spatial distribution of nebilous snailfish in the east of the Laptev Sea and north of the New Siberian Islands is extensive and similar to the distribution of gelatinous snailfish, and in the middle part of the East Siberian Sea its catches were the smallest compared to other species (Fig. 2a). The frequency of its occurrence in the Laptev Sea was 20.1%, in the East Siberian Sea, 16.3% (Table 2).

In general, the frequency of occurrence of all three species of *Liparis* in the studied seas was 35.9%.

Relative abundance and biomass. The average abundance of *L. bathyarcticus* was 121.3 ind./km^2 in the Laptev Sea and 88.2 ind./km^2 in the East Siberian Sea (Table 2). Its highest biomass was recorded in the vast water area from the New Siberian Islands to the continental slope (Fig. 3a). The average biomass of *L. bathyarcticus* (6.29 kg/km^2) which was the highest among three species of *Liparis* was recorded in the East Siberian Sea; in the Laptev Sea, it was 4.95 kg/km^2.

The abundance of gelatinous snailfish slightly differs between two seas compared to other species (Table 2). The distribution of biomass of *L.* cf. *fabricii* is less uniform and differs almost twice: 0.7 kg/km^2 in the Laptev Sea vs. 1.3 in the East Siberian Sea (Fig. 3b).

Although the frequency of occurrence of kelp snailfish in the studied water area was minimal, its relative

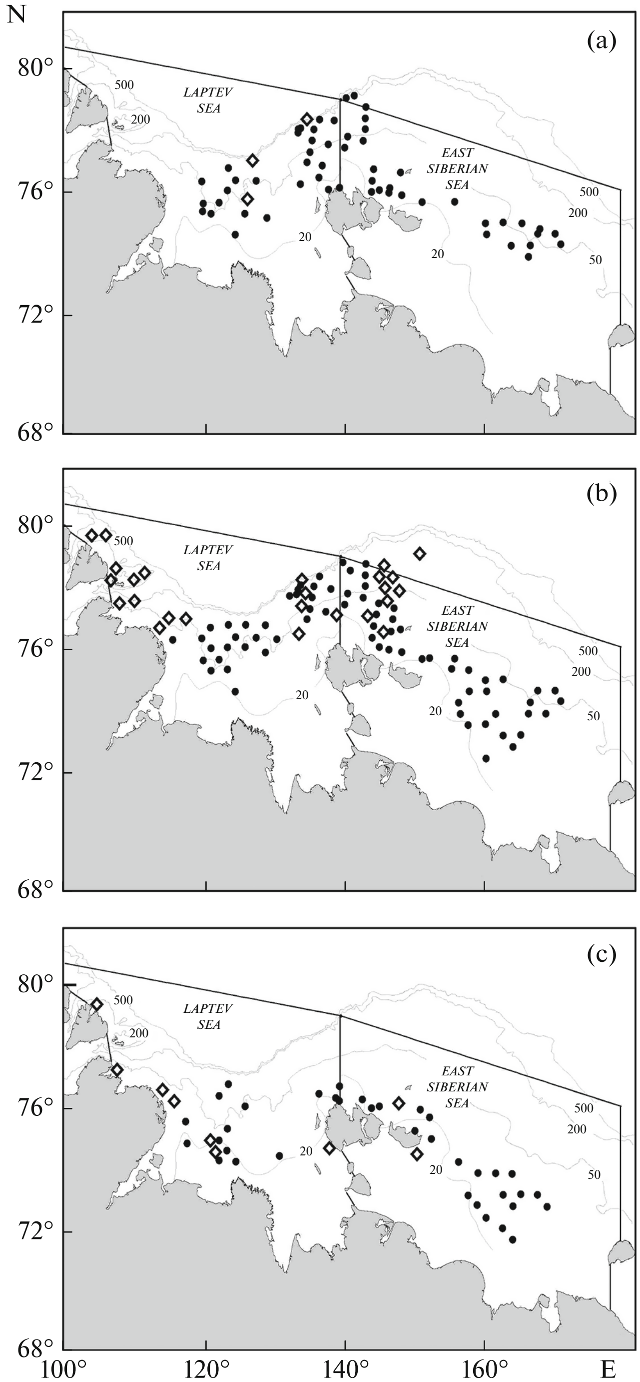

Fig. 2. Capture sites of *Liparis bathyarcticus* (a), *L.* cf. *fabricii* (b) and *L. tunicatus* (c) in the Laptev and East Siberian seas in 2014 and 2017: (●)—our data, (◇)—literature data according to Chernova, 1991; Chernova and Neyelov, 1995.

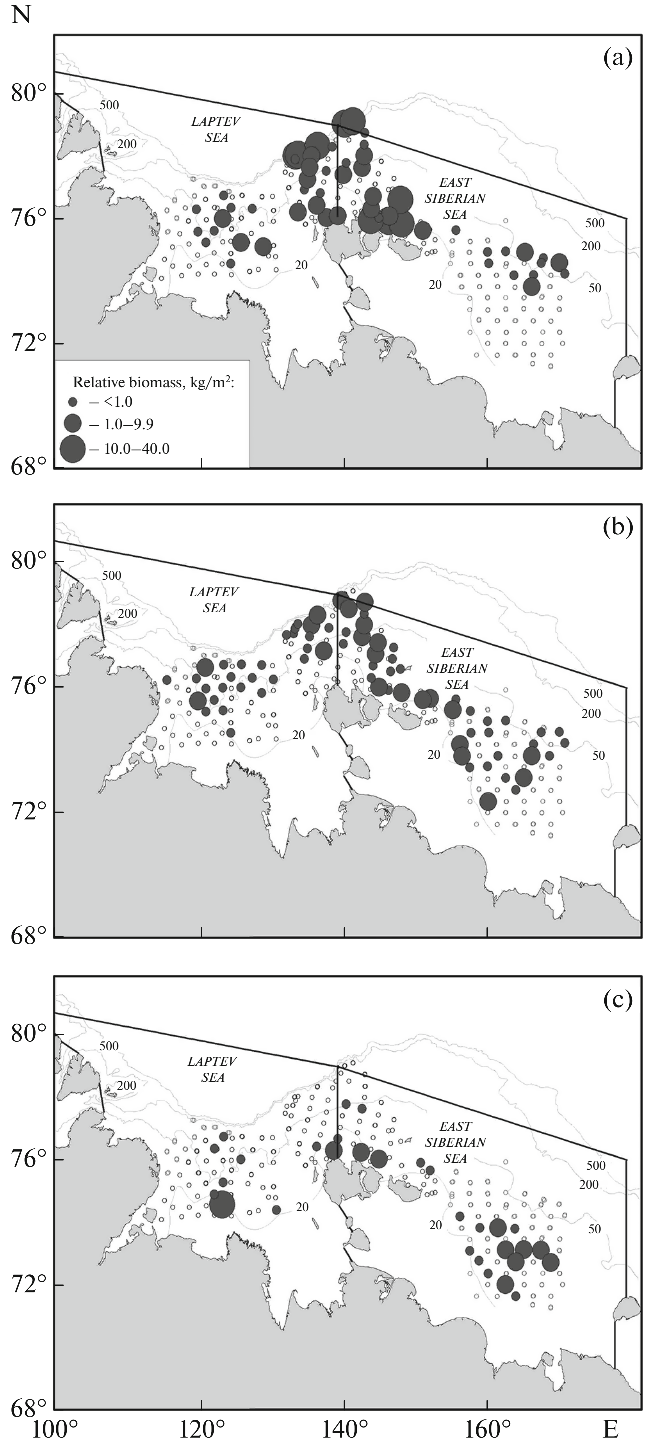

Fig. 3. Distribution of *Liparis bathyarcticus* (a), *L.* cf. *fabricii* (b) and *L. tunicatus* (c) in the Laptev and East Siberian seas in 2014 and 2017, (○) stations without catches of *Liparis* specimens.

abundance was higher than that of other species, averaging 132.8 ind./km^2 in the Laptev Sea and 224.0 ind./km^2 in the East Siberian Sea (Table 2). The highest relative biomass of kelp snailfish was recorded in the western part of the East Siberian Sea, off the coast of the New Siberian Islands and in a limited area in the south of the Laptev Sea (Fig. 3c), and the average values for the seas as a whole were 1.55 and 2.67 kg/km^2, respectively.

In general, the total values of the relative abundance and biomass of all *Liparis* species in the East Siberian Sea were slightly higher than in the Laptev Sea, amounting to 377.7 ind./km^2 and 9.14 kg/km^2, respectively, in the first sea and 326 ind./km^2 and 8.32 kg/km^2 in the second sea.

Bathymetric distribution. Three species of *Liparis* were recorded in the survey area in a similar and relatively wide range of depths but their bathymetric distribution was slightly different.

Nebulous snailfish was found in the Laptev Sea at depths of 15–307 m, in the East Siberian Sea, at depths of 22–277 m, but the largest number of specimens was recorded in the depth range of 10–50 m (Figs. 4a, 4b). In the Laptev Sea, the number and biomass of specimens change in different directions with increasing depth: the quantitative proportion of specimens (%) decreases, and the biomass increases, which is due to the features of the bathymetric distribution of fish of different sizes (large specimens occur at greater depths than juveniles). The abundance and biomass of this species in the East Siberian Sea decrease with depth. Nebulous snailfish (like *L. gibbus*) within its vast range was found at depths from 0 m near Greenland (Møller et al., 2010) to 647 m in Svalbard waters (Neyelov and Chernova, 2005). It should be noted that the juveniles of two species, *L. bathyarcticus* and *L. tunicatus* are easily confused (Møller et al., 2010, our data), and small specimens caught in shallow waters most probably belong to kelp snailfish, which inhabits mainly coastal waters.

Liparis cf. *fabricii* in the Laptev Sea was found at depths of 28–307 m, in the East Siberian Sea, at depths of 18–101 m (Figs. 4c, 4d). The main proportion of fish, both in terms of the abundance and weight, was recorded at depths of <100 m, and in the East Siberian Sea, most of the specimens were caught in a shallower area, 10–50 m. In addition, in the Laptev Sea, gelatinous snailfish was found at three relatively deep-water stations in the upper part of the continental slope (191–307 m), where this species had already been recorded at a depth of 231–233 m (Chernova and Neyelov, 1995).

Previously, it was considered that this species is characteristic of deep troughs to a greater extent than of shallow waters (Andriashev, 1954), but later it was reported that it is widespread in shallow waters (Chernova, 1991). In Greenland waters, gelatinous snailfish was recorded at depths of 5–1460 m (Møller et al., 2010). It was caught in coastal waters of the Severnaya Zemlya archipelago by divers at depths of 7–20 m (Chernova et al., 2021). Reports on the finding of gelatinous snailfish at a depth of 1880 m (Kirillov et al., 2016) are doubtful, since it is suggested that it was caught in the pelagic zone above the indicated depth (Able, 1990; Mecklenburg et al., 2018). A wide bathymetric range may indicate the combined character of the taxon *Liparis* cf. *fabricii*.

Liparis tunicatus is the most shallow-water species of the genus in the Arctic seas. It is found almost from the surface, 0 m (Møller et al., 2010) and shallow waters, 7–13 m (Chernova et al., 2021) to a depth of 620 m (Coad and Reist, 2004), but it rarely occurs deeper than 150 m (Parin et al., 2014). In the Laptev Sea and the East Siberian Sea, it was recorded in the depth ranges of 10–94 and 12–54 m, respectively. Most of the fish, both in the number and weight, were recorded at depths of <50 m (Figs. 4e, 4f).

Habitat temperature range. In the East Siberian and Laptev seas, a significant temperature change with increasing depth is observed only in the summer, when the upper layer can be heated up to 10°C (Zalogin and Kosarev, 1999; *Ecologicheskii Atlas* ..., 2017). The temperature of the water masses in the Laptev Sea drops sharply with increasing depth and has negative values (up to –1.5°C) already from the horizon of < 25 m. On the continental slope, negative temperature values can be traced to a depth of ~100 m and >300 m, and the intermediate layer is characterized by positive temperatures in the range of 0.6–0.8°C due to the effect of warm Atlantic waters. Temperature stratification in the East Siberian Sea is less pronounced (Zalogin and Kosarev, 1999).

All species of the genus *Liparis* found in the study seas belong to the Arctic ones (Andriyashev, 1954; Parin et al., 2014) and are well adapted to negative temperatures. *L.* cf. *fabricii* has the largest thermal range (6.4°C) within the distribution range, occurring at a temperature of –1.9...+4.5°C (Chernova, 2018; Mecklenburg et al., 2018). During the study period, gelatinous snailfish was found in the Laptev Sea at a temperature of –1.8...+0.45 (range 2.25)°C, in the East Siberian Sea, at –1.7...+2.8 (4.50)°C. Most specimens in the seas (97 and 84%, respectively) were caught in waters with negative temperatures (Fig. 5).

Kelp snailfish within the range was recorded at temperatures of –1.8...+3.8°C (Jørgensen et al., 2005; Mecklenburg et al., 2018), the thermal range of the species is 5.6°C. In the Laptev Sea, the species was caught at almost the same temperatures: –1.77...+3.74 (5.51)°C, and unlike gelatinous snailfish, kelp snailfish prefers positive temperatures (Fig. 5e, 5f). In the East Siberian Sea, kelp snailfish was caught in waters with a temperature of –1.60...+4.20°C at a slightly higher maximum value, 0.4°C higher than was previously known for the species. The thermal range (5.80°C) is also higher than the previous value. Thus, the upper limit of the positive temperature for kelp snailfish has increased and is currently 4.20°C. At first sight, this may appear to be an insignificant fact, but only until the issue of the species survival in the conditions of the observed warming of the Arctic is raised.

Nebulous snailfish within the range occurs at a temperature from –1.78 (Ponomarenko, 1995) to 3.7°C (Mecklenburg et al., 2018) with a thermal range of 5.48°C. In the Laptev Sea, *L. bathyarcticus* was

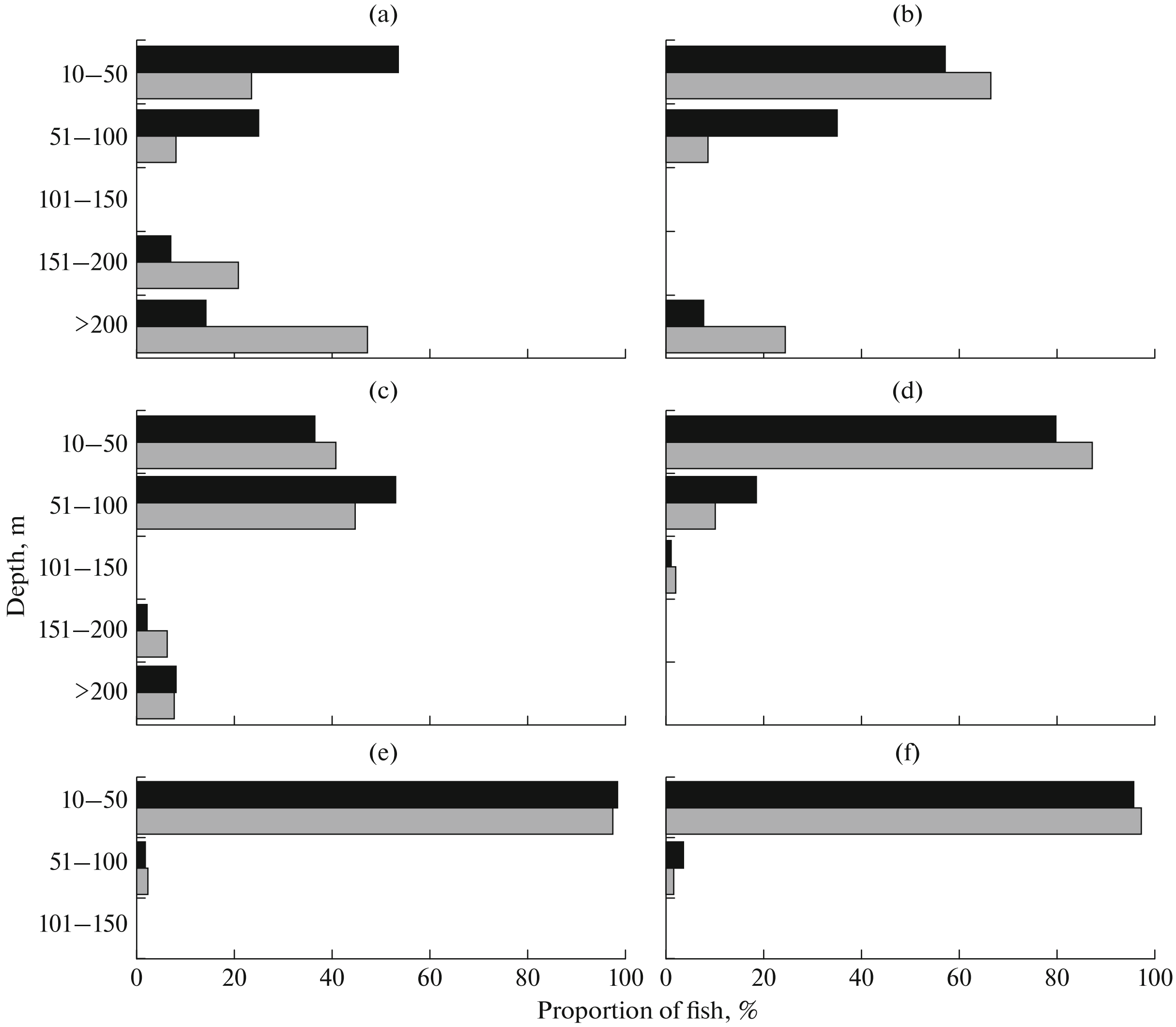

Fig. 4. Bathymetric distribution of *Liparis bathyarcticus* (a, b), *L.* cf. *fabricii* (c, d) and *L. tunicatus* (e, f) in the Laptev (a, c, e) and East Siberian (b, d, f) in 2014 and 2017: (■) abundance, (▩) biomass.

recorded at a temperature of –1.77...+2.73 (4.50)°C, in the East Siberian Sea, from –1.70 to +1.92 (3.62)°C. Most of the fish in these seas (81 and 88%, respectively) were caught in waters with negative temperatures (Figs. 5a, 5b).

Salinity range of occurrence. Water salinity in the Laptev Sea increases from the southeast to the northwest and north. A significant role in the formation of the salinity regime of the sea is played by the inflow of continental fresh waters, the annual volume of which ranges from 541 (Bauch et al., 2009) to 720 km^3 (Zalogin and Kosarev, 1999). In shallow southern and southeastern areas, salinity varies within 1–5%, in the northwest it increases to 34%, and on average, it varies within 20–30% (Zalogin and Kosarev, 1999). The water salinity in the East Siberian Sea increases from the southwest to the northeast and from the coast to the continental slope. The surface salinity is 18–22‰ in the coastal zone and 24–26‰ in the north at the melting ice edge. Desalination in shallow areas up to depths of 20–25 m affects the entire water column. In deeper water areas in the north and east of the sea, salinity at the horizons of 5–10 m (sometimes 10–15 m) increases sharply and then increases slightly with depth (Zalogin and Kosarev, 1999). Apparently, *Liparis* species living under such conditions must have certain features of euryhalinity.

Among the considered species, gelatinous snailfish is the most euryhaline one; it is found within the range at salinity from 24.40 (Esipov, 1952) to 35.03‰ (Neyelov and Chernova, 2005). During the study period in the Laptev Sea, the species was found in a relatively narrow range of oceanic salinity, 32.52–34.76‰ (mostly above 33.0‰). In the East Siberian Sea, the salinity range for *L.* cf. *fabricii* was noticeably

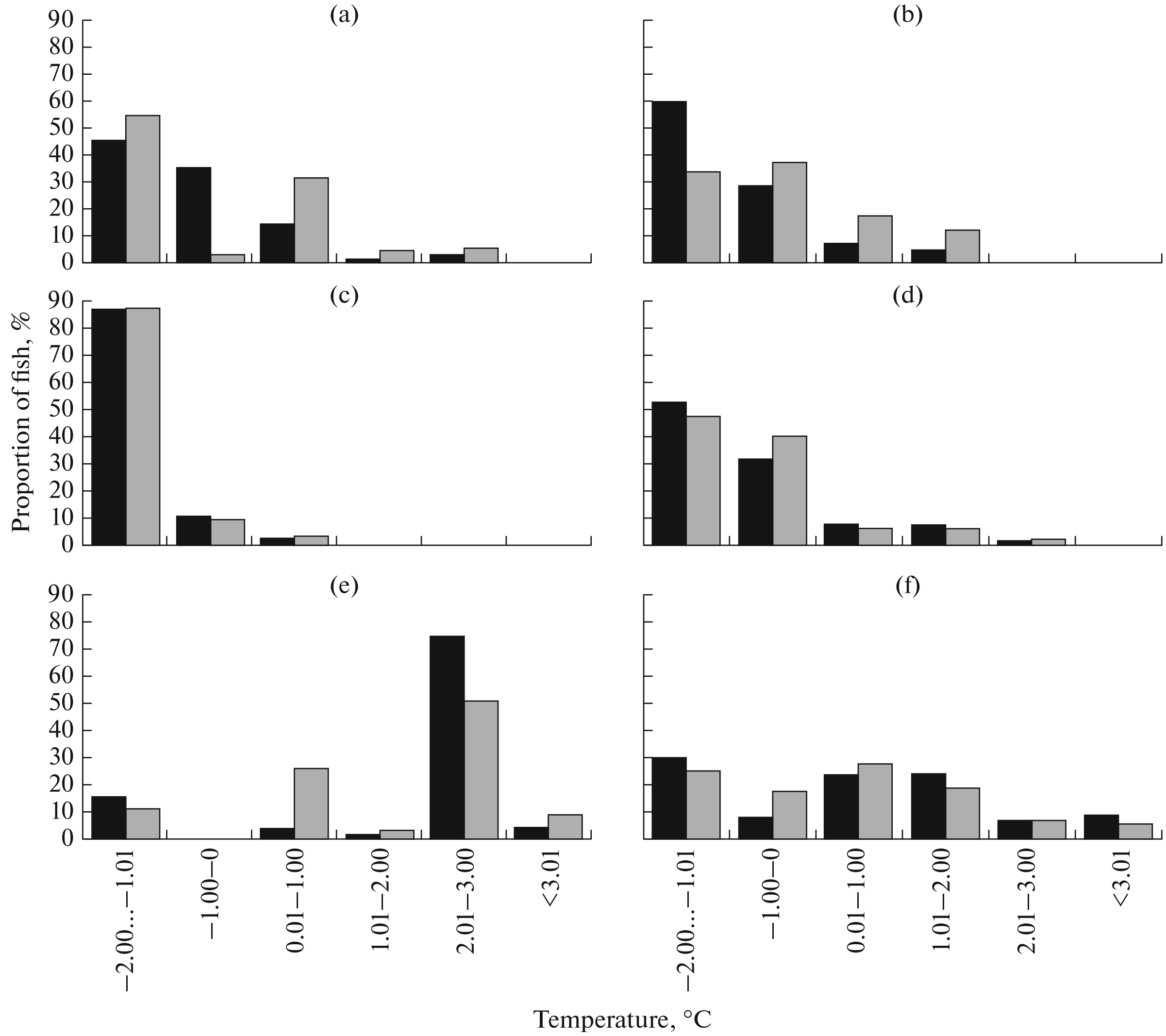

Fig. 5. Distribution of *Liparis bathyarcticus* (a, b), *L.* cf. *fabricii* (c, d) and *L. tunicatus* (e, f) at different water temperature in the Laptev (a, c, e) and East Siberian (b, d, f) seas in 2014 and 2017; designations see in Fig. 4.

wider, 26.70–34.29‰, and most specimens were recorded at a salinity of 29–33‰ (Fig. 6).

The water salinity at which nebulous snailfish was found within the range varies from 28.67 (Mecklenburg et al., 2018) to 34.86‰ (Chernova and Neyelov, 1995). According to our data, this range turned out to be wider. In the Laptev Sea, it is 25.25–34.80‰ (and up to 90% of specimens were found at salinity >33‰), in the East Siberian Sea, it is 27.50–34.84‰ with a more uniform distribution of specimens in the salinity gradient (Figs. 6a, 6b).

The kelp snailfish *L. tunicatus* is reported in waters with the salinity of 32.4–33.5‰ (Mecklenburg et al., 2018). According to our data, the species is more euryhaline, since in the Laptev Sea it is found in the salinity range of 27.30–34.76‰ (about 80% of specimens at >29‰), and in the East Siberian Sea, 26.70–32.50‰ (more than half of the fish at <29.0‰) (Figs. 6e, 6f). Thus, the salinity range in the habitat of kelp snailfish is significantly wider compared to the previously available data.

Distribution by bottom sediment types. In the Laptev Sea, bottom sediments in shallow waters consist of sand and silt with inclusions of pebbles and boulders, and in deeper water areas the bottom is covered with silt (Sukhovey, 1986; Bolshiyanov et al., 2007). Almost all types of sediments contain gray viscous clay.

The information obtained in the course of our study on the nature of bottom sediments in the sites where *Liparis* species were captured showed that they live in areas with sediments of four main types (Fig. 7). Nebulous snailfish were caught mainly in areas with a silty bottom and only occasionally in sites where bottom sediments were composed of sandy silt or silty sand. In the areas of catches of gelatinous snailfish, sediments were of the same types, but their ratio was

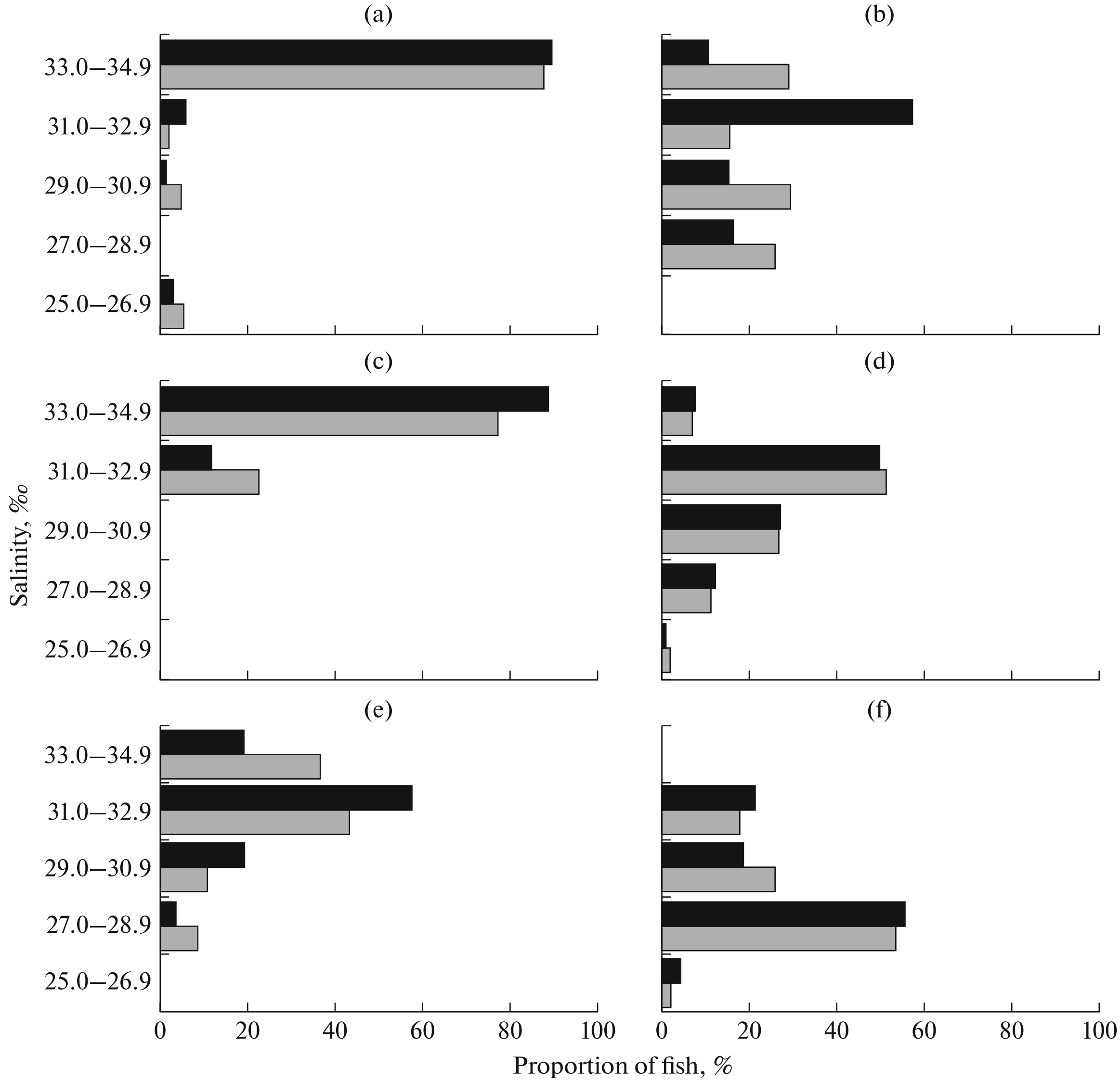

Fig. 6. Distribution of *Liparis bathyarcticus* (a, b), *L.* cf. *fabricii* (c, d) and *L. tunicatus* (e, f) at different water salinity in the Laptev (a, c, e) and East Siberian (b, d, f) seas in 2014 and 2017; designations see in Fig. 4.

different. This species was most common at stations with sandy silt sediments. Kelp snailfish lives in areas with sandy or silted sediments to varying degrees (silty sand, sandy silt) and was not found in sites with a silty bottom.

Size composition and body weight. In the study area, nebulous snailfish is the largest species, which can reach *TL* 287 mm (Jan Mayen Island) (Chernova, 1991, like *L. gibbus*). In the East Siberian Sea, a specimen of almost the same length was caught, 285 mm (2014, depth of 315 m). In general, specimens of *TL* 37–285 mm and weight of 1.0–358.0 g were recorded in the surveyed water area, and fish in the East Siberian Sea were significantly larger (Table 2). The relationship between the linear dimensions (*TL*) and the body weight of nebulous snailfish approximated by a power function, showed that the fish in the Laptev Sea reach the same body weight at a shorter length (Fig. 8a, 8b), but the average length and body weight of fish were higher in the East Siberian Sea (Table 2). Nebulous snailfish can possibly reach larger sizes. The assumption is based on the catch of a specimen of *TL* 385 mm in Providence Bay and identified as *L. gibbus* (Barsukov, 1958). But, as is known (Chernova, 2008; Chernova, 2008, 2018), after the revision of the species traits of variegated snailfish, the status of *L. bathyarcticus*, which was previously registered as *L. gibbus*, was restored. Nebulous snailfish can be found in the Anadyr Bay (ZIN 34378) and in general, in the north of the Bering Sea (Mecklenburg et al., 2016, 2018).

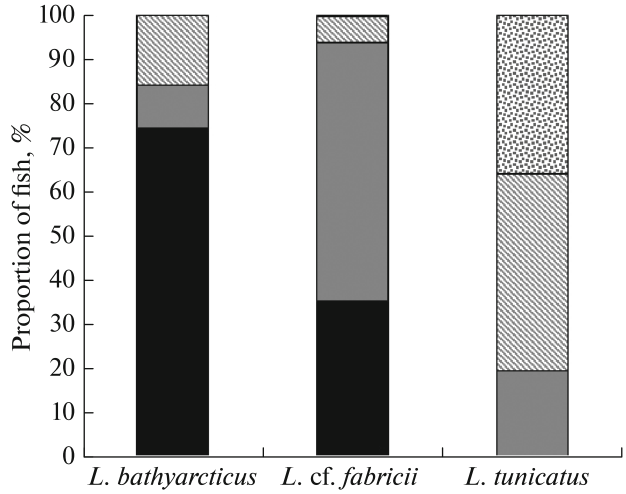

Fig. 7. Occurrence (proportion by biomass) of specimens of three species of the genus *Liparis* on sediments of different types in the Laptev Sea in 2014 and 2017: (▨) sand, (▧) silty sand, (■) sandy silt, (■) silt.

The size of variegated snailfish within its modern range usually does not exceed 273 mm (Mecklenburg et al., 2018), therefore, a large specimen caught in Providence Bay could also be nebulous snailfish.

The currently known maximum length of gelatinous snailfish, of 210 mm was recorded in the Barents Sea (Wienerroither et al., 2011). The sizes of fish from our catches in the Laptev and East Siberian seas are significantly smaller. The length of specimens in the Laptev Sea varied between 40 and156 mm, and the weight between 0.7 and 53.0 g, in the East Siberian Sea, within 56–165 mm and 1.8–89.0 g, respectively (Table 2). As in nebulous snailfish, the maximum and average values of the length and body weight of *L.* cf. *fabricii* were higher in the East Siberian Sea. At the same time, the weight of gelatinous snailfish with the same length, in both the Laptev Sea and the East Siberian Sea, was almost similar (Figs. 8c, 8d).

The maximum length of kelp snailfish is 160 mm (Chernova, 1991). There are other data on the maximum size (190–200 mm), but the species identification of these specimens was probably erroneous (Mecklenburg et al., 2018). In our catches, the length of *L. tunicatus* reached 172 mm, which exceeds the previously recorded length. The length of kelp snailfish varied between 34–134 mm in the Laptev Sea and 54–172 mm in the East Siberian Sea, and the weight was 1.1–31.0 and 2.2–83.0 g, respectively. The average length and weight of specimens of *L. tunicatus* as of other two species are higher in the East Siberian Sea (Table 2). The weight of kelp snailfish in the Laptev Sea with the same length is much smaller than in the East Siberian Sea (Figs. 8d, 8e), but since in our catches in the Laptev Sea, the species is represented by a small number of specimens, among which the proportion of small (*TL* 34–50 mm) was 50%, the data obtained should be considered preliminary.

CONCLUSIONS

(1) Three species of the genus *Liparis*, *L. bathyarcticus*, *L.* cf. *fabricii* and *L. tunicatus*, were caught during the trawl surveys in the Laptev and East Siberian seas in 2014 and 2017. The gelatinous snailfish is the most common in the study area; the frequency of its occurrence was 22.4% in the Laptev Sea and 24.7% in the East Siberian Sea.

(2) The total relative abundance and biomass of three species of the genus *Liparis* in the East Siberian Sea (377.7 ind./km^2 and 9.14 kg/km^2, respectively) were slightly higher than in the Laptev Sea (326 ind./km^2 and 8.32 kg/km^2).

(3) The boundaries of the habitat temperature range for two species have been specified: the lower one for *L. bathyarcticus* (–1.77 vs. –1.6°C, previously known) and the upper one for *L. tunicatus* (4.2 vs. 3.8°C).

(4) The lower and upper limits of the salinity range have been specified for two species: *L. bathyarcticus* (25.25–34.84 vs. 28.67–34.46‰) and *L. tunicatus* (26.70–34.76 vs. 32.4–33.5‰).

(5) *L. bathyarcticus* in the Laptev Sea lives mainly in areas with a silty bottom, *L.* cf. *fabricii*, in areas with silty and sandy-silty sediments, *L. tunicatus*, with silty sand and sand.

(6) The maximum length of *L. tunicatus* in the East Siberian Sea is 172 mm, which exceeds the previously known value (160 mm). The average length and weight of fish of each of three species of the genus *Liparis* are larger in the East Siberian Sea than in the Laptev Sea.

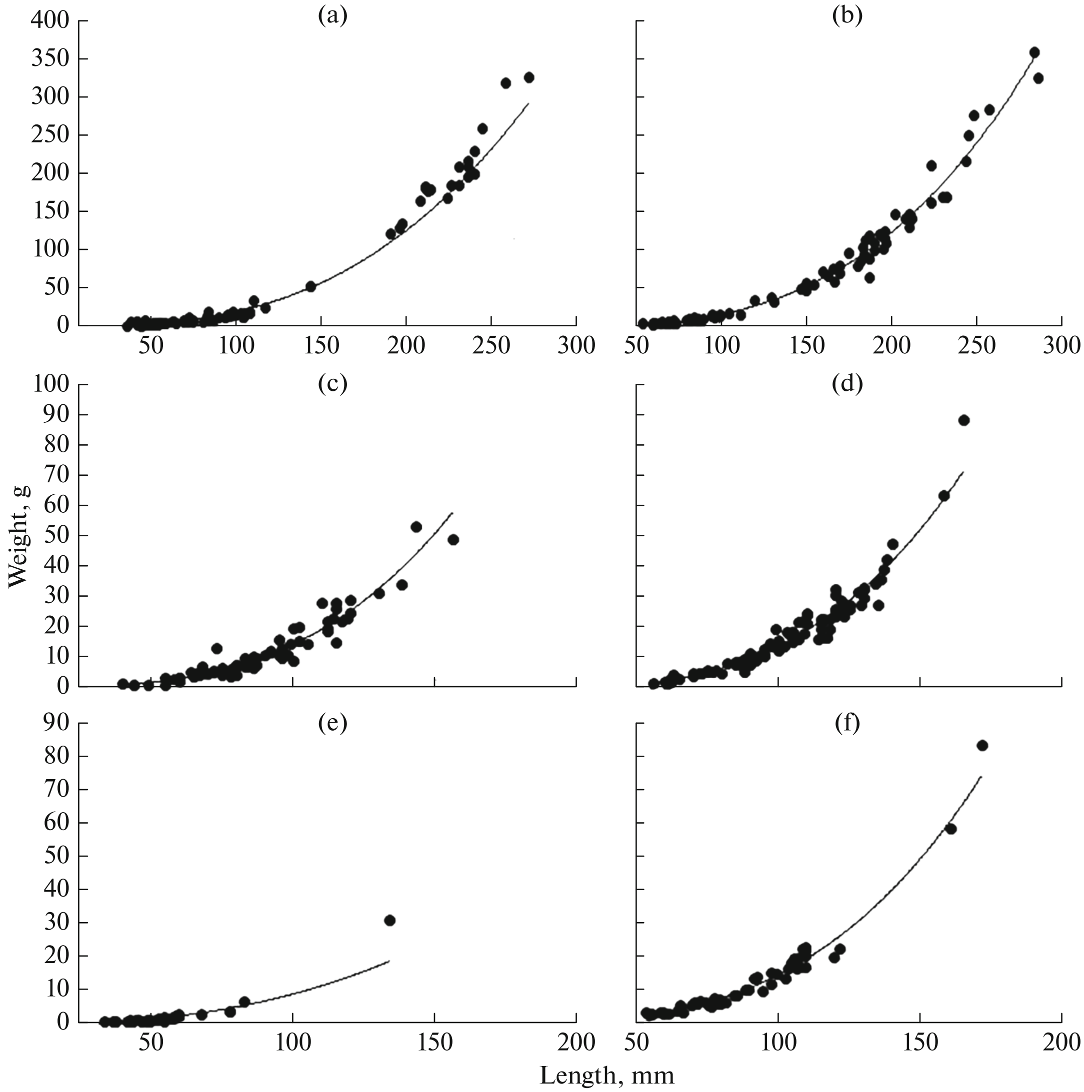

Fig. 8. Relationship between length (*TL*) and body weight of *Liparis bathyarcticus* (a, b), *L.* cf. *fabricii* (c, d) and *L. tunicatus* (e, f) in the Laptev (a, c, e) and East Siberian (b, d, f) seas in 2014 and 2017: (a) $W = 5 \times 10^{-6} TL^{2.79}$, $R^2 = 0.95$; (b) $W = 10^{-5} TL^{3.02}$, $R^2 = 0.99$; (c) $W = 10^{-5} TL^{3.02}$, $R^2 = 0.91$; (d) $W = 5 \times 10^{-6} TL^{3.23}$, $R^2 = 0.96$; (e) $W = 9 \times 10^{-5} TL^{2.5}$, $R^2 = 0.89$; (f) $W = 10^{-5} TL^{3.07}$, $R^2 = 0.96$.

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