

SOME BIOLOGICAL FEATURES OF RARE AND POORLY-STUDIED SCULPINS (COTTIDAE, HEMITRIPTERIDAE, PSYCHROLUTIDAE) IN THE PACIFIC WATERS OFF THE NORTHERN KURIL ISLANDS AND SOUTHEASTERN KAMCHATKA, RUSSIAN FEDERATION

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ABSTRACT. – Eight rare or poorly-studied sculpins: the longfin Irish lord (*Hemilepidotus zapus*), spatulate sculpin (*Icelus spatula*), scaly-belly sculpin (*I. perminovi*), sponge sculpin (*Thyriscus anoplus*), roughskin sculpin (*Rastrinus scutiger*), scaled sculpin (*Archistes biseriatus*) of the family Cottidae, bigmouth sculpin (*Ulca bolini*) of the family Hemitripterae, and smoothcheek sculpin (*Eurymen gyrinus*) of the family Psychrolutidae were captured from the Pacific waters off the Northern Kuril Islands and Southeastern Kamchatka Peninsula (47°50'N to 52°00'N, depth range from 100 to 850 m) from surveys conducted between 1993 and 2002. Features of spatial and vertical distribution, size and age composition, male and female proportions and feeding habits of the longfin Irish lord, spatulate sculpin, scaly-belly sculpin, sponge sculpin and roughskin sculpin are discussed and some biological and/or distribution data of the scaled sculpin, bigmouth sculpin and smoothcheek sculpin are reviewed.

KEY WORDS. – Distribution, biological features, sculpins, Northern Kuril Islands, Southeastern Kamchatka.

INTRODUCTION

The family Cottidae is one of the most common taxa in the Pacific waters off Kamchatka and the North Kuril Islands. There are about 80 species in this family and together with the closely-related families of Hemitripterae and Psychrolutidae, they compose nearly one-fifth of the entire ichthyofauna in terms of diversity (Boretz, 1997, 2000; Orlov, 1998a; Fedorov, 2000; Sheiko & Fedorov, 2000) in the area. The vertical distribution range of these sculpins extends from the tidal zone to the abyssal depths. Many of the species are of relatively high abundances and biomass (Tokranov, 1988a; Tokranov & Orlov, 2000), which makes them targets of inshore fisheries. Sculpins play important role in bottom ichthyocenoses as predators, potential food competitors or food items of commercially important species. However, there have been limited data on the occurrence, spatial and vertical distribution and biology of many of the sculpins in the North Pacific in general and in the Pacific waters off Kamchatka and the North Kurils in particular (Gilbert & Burke, 1912; Soldatov & Lindberg, 1930; Taranetz, 1936, 1937; Andriashev, 1939, 1954; Schmidt, 1950; Clemens & Wilby, 1961; Shuntov, 1965; Fedorov, 1973a; Hart, 1973; Peden,

1979; Yabe et al., 1983; Masuda et al., 1984; Nelson, 1984; Matarese & Vinter, 1985; Lea, 1986; Dudnik & Dolganov, 1992; Amaoka et al., 1995; Orlov, 1998a, 1998b, 2000a, 2000b, 2003; Tokranov, 1998a, 1998b, 1999; Poltev & Mukhametov, 1999; Yabe & Soma, 2000; Chereshevnev et al., 2001; Tokranov & Orlov, 2001, 2002; Mecklenburg et al., 2002; Fedorov et al., 2003).

This paper provides data on the occurrence and spatial-bathymetric distribution of eight rare or poorly-studied sculpins found in the Pacific waters of the North Kurils and Southeast Kamchatka. The eight species include the longfin Irish lord (*Hemilepidotus zapus*), spatulate sculpin (*Icelus spatula*), scaly-belly sculpin (*I. perminovi*), sponge sculpin (*Thyriscus anoplus*), roughskin sculpin (*Rastrinus scutiger*), scaled sculpin (*Archistes biseriatus*) of the family Cottidae, bigmouth sculpin (*Ulca bolini*) of the family Hemitripterae and smoothcheek sculpin (*Eurymen gyrinus*) of the family Psychrolutidae. All the species were characterized in terms of their size, age and sex compositions and food habits, except for the scaled sculpin, bigmouth sculpin and smoothcheek sculpin as there were insufficient data collected.

Table 1. The numbers of individual fish used for the study of the biology of rare or poorly-studied sculpins from the Pacific side of the North Kuril Islands and Southeast Kamchatka.

Species	Number of Fish			
	Length-Frequencies	Weight, Sex and Age Examinations	Feeding	Fecundity
Longfin Irish lord	1,208	156	244	54
Spatulate sculpin	161	80	80	15
Scaly-belly sculpin	876	120	105	-
Sponge sculpin	165	75	63	36
Roughskin sculpin	47	-	10	-
Scaled sculpin	2	-	-	-
Bigmouth sculpin	53	-	-	-
Smoothcheek sculpin	3	-	-	-

MATERIALS AND METHODS

This paper is based on the materials collected within the framework of a scientific program conducted for inadequately-studied or insufficiently-utilized species found on the continental slope of the Far Eastern seas. Material presented in this paper includes the results of analyses of catches from over 10,000 bottom trawls made between April and December (1993 - 2002) in the Pacific Ocean near the North Kurils and Southeast Kamchatka (between 47°50'N and 52°00'N at depths of 100 - 850 m).

The Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), as well as those of Kamchatka (KamchatNIRO) and Sakhalin (SakhNIRO) conducted over 50 joint research cruises where distribution and biology data of sculpins were collected. Collection was made by the Japanese trawlers (TOMI-MARU 53, TOMI-MARU 82 and TORA-MARU 58) specially equipped for ground hauls at parts of the continental slope having a rough relief. The bottom trawls have both a vertical (5 - 7 m) and a horizontal (25 m) opening and trawling was conducted at all hours, the mean speed being 3.6 knots. The temperature at the depth of the haul was measured during most of the hauls. As the duration of hauls during the cruises varied between half an hour and 10 hours, all catches were subsequently recalculated into standard 1 hour hauls. The distribution of individual species by depth and temperatures at the haul depth was analyzed according to the relative number of their occurrence (calculated by average one hour haul catches).

The size composition was analyzed based on measurements of the length of sculpin specimens (the volume of material for each species is presented in Table 1). The ages of longfin Irish lord, sponge sculpin, spatulate sculpin and scaly-belly sculpin were determined from otoliths using the "break and burn" technique where the otolith was broken in the centre and then burnt with a flame. The yearly rings on the otolith were enhanced by the flame and were more visible after the procedure. The food composition of these four species and that of the roughskin sculpin was determined by the quantity-weight method according to Borutskyi (1974) from the material collected in 1995 - 2002. The fecundity of the longfin Irish lord, sponge sculpin and spatulate sculpin was studied using the ovaries of females at the III - IV maturity stages (rape and pre-spawning). Each ovary was weighed and the

number of eggs in each ovary was counted (about 20 - 25% of the total weight) for individual fecundity computations.

RESULTS AND DISCUSSION

Occurrence and spatial-bathymetric distribution. – The endemic Pacific genus *Hemilepidotus* (family Cottidae) includes six species (Peden, 1979), the brown Irish lord (*H. spinosus*), longfin Irish lord (*H. zapus*), red Irish lord (*H. hemilepidotus*), yellow Irish lord (*H. jordani*), banded Irish lord (*H. gilberti*) and butterfly sculpin (*H. papilio*). The butterfly sculpin is considered by Russian taxonomists to be in a separate genus, *Melletes*. The brown Irish lord inhabits the Pacific coast only from Southeast Alaska to California. The range of the latter four species is much wider and includes the Far Eastern seas of Russia. Until now, all the confirmed records of the adult or immature individuals of the longfin Irish lord (Fig. 1), which has a pelagic larval stage, were known to come exclusively from the coastal waters of the Aleutians.

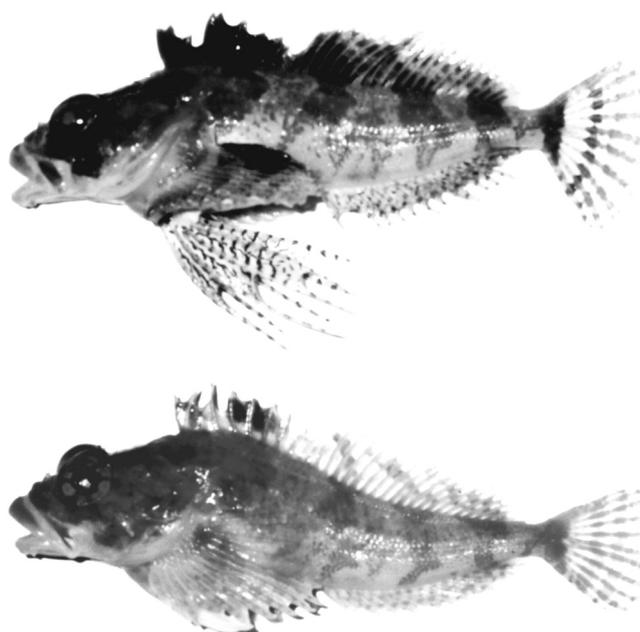


Fig. 1. Longfin Irish lord (*Hemilepidotus zapus*), lateral view. Above = male, 167 mm TL; below = female, 171 mm TL.

While conducting the species identification of the fish collected within the framework of the abovementioned program, Boris Sheiko from the Zoological Institute of the Russian Academy of Science (St. Petersburg) discovered a cottid species new to the Russian fauna in 1998: the longfin Irish lord (*H. zapus*). Subsequent field observations showed that it was rather common in trawl catches in several parts of the area surveyed. It was caught along with two other species, the banded Irish lord, *H. gilberti* and yellow Irish lord, *H. jordani* (Tokranov & Orlov, 2001).

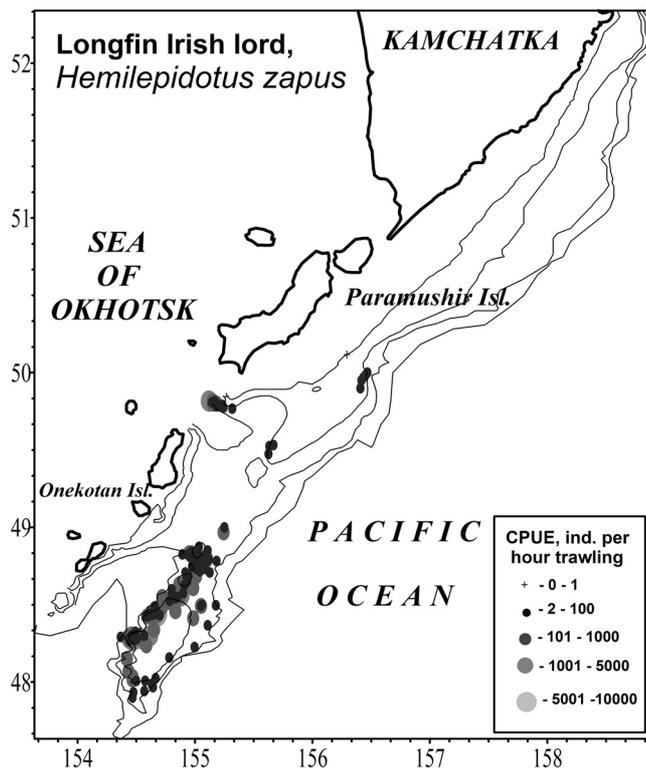


Fig. 2. Distribution and relative abundance categorized by CPUE (specimens per hour trawling) of the longfin Irish lord (*Hemilepidotus zapus*) in the Pacific waters off the Northern Kuril Islands, April - December, 1999 - 2001. Thin lines = isobaths of 100, 200, 500 and 1,000 m; CPUE, ind. per hour trawling = catch per unit effort, individuals per hour trawling.

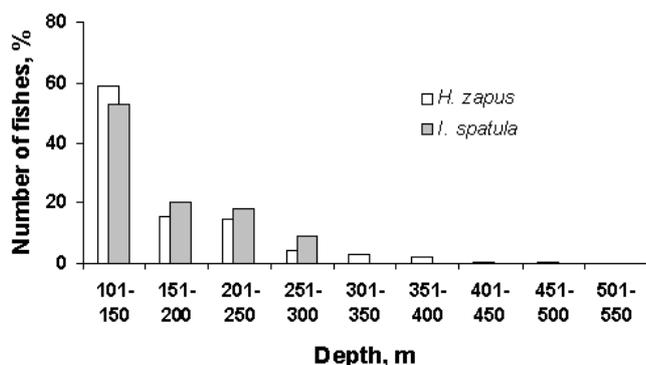


Fig. 3. Bathymetric distribution of the longfin Irish lord (*Hemilepidotus zapus*) and spatulate sculpin (*Icelus spatula*) from the Pacific waters off the Northern Kuril Islands, April - December, 1995 - 2001.

The results of studies made in 1999 - 2001 showed that the longfin Irish lord occurs between 47°50'N and 50°10'N (Fig. 2). The maximum catch made of this species (5,000 - 7,000 individuals or 500 - 700 kg per one hour haul) were exclusively from the Western slope of the elevation of the Northern link in the outer Kuril chain ridge (48°10'N to 48°30'N). It is notable that this species inhabits parts of the shelf and continental slope with a rough substrate or one covered with sponges. We should point out that throughout the entire period of observations, there were only several cases of the longfin Irish lord and banded Irish lord (which the former is most closely-related to taxonomically) in the same sampling session. This species occurred constantly in North of 50°10'N in the Pacific waters of the Shumshu and Paramushir Islands and the Southeast Kamchatka.

According to Fedorov (2000) and Sheiko & Fedorov (2000), the longfin Irish lord is an outer-shelf species inhabiting depths of 61 - 189 m. As seen from trawl catches, this species occurs at depths of 100 - 530 m, with bottom temperatures of 0.2 - 3.6°C. The fish occurs predominantly at depths of 100 - 250 m (temperature: 0.5 - 2.0°C) where about 90% of individuals were taken during the observation period (Fig. 3).

The spatulate sculpin (Fig. 4) was first described from Avacha Bay (Gilbert & Burke, 1912). However, it was later found as a frequent fish species in the Okhotsk, Bering and Arctic seas (Schmidt, 1950; Andriashev, 1954; Fedorov, 1973b). Contemporary ideas suggest that the spatulate sculpin occurs also in the Pacific side off the Kuril Islands and Kamchatka (Nelson, 1984; Fedorov, 2000; Sheiko & Fedorov, 2000). However, studies on this species have been limited to habitat depths and temperatures and general biology (Andriashev, 1954). Some data on the spatial and vertical distribution, size and age composition and food habits are available only for the Pacific side of the North Kuril Islands (Tokranov & Orlov, 2002; Orlov, 2003).

As the 1995 - 2002 trawling results show, the spatulate sculpin occurs only between 47°50'N to 50°20'N (Fig. 5). Maximum catches of this species (100 - 150 individuals per one hour haul) were recorded at a limited portion of the Western slope of an elevation in the Northern link of the outer ridge in the Kuril Chain (48°10'N to 48°30'N).

The spatulate sculpin is a part of the outer shelf ichthyofauna and it has been recorded at depths of 12 - 365 m (Fedorov, 2000; Sheiko & Fedorov, 2000). As seen from trawl catches, this species occurs at a depth range of 100 - 300 m,

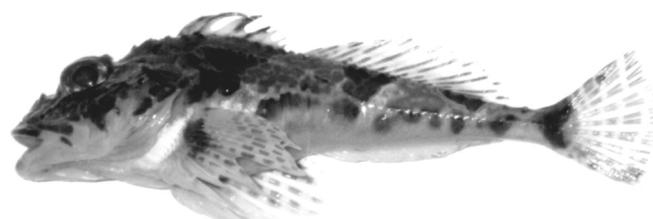


Fig. 4. Spatulate sculpin (*Icelus spatula*), 129 mm TL, female, lateral view.

the bottom temperatures being 0.0 - 3.6°C. The fish concentrate predominantly at depths of less than 200 m where 73% of individuals were found during the period of observations (Fig. 3). There were no tows conducted at depths of less than 100 m.

The scaly-belly sculpin (Fig. 6) was described from the Sea of Okhotsk by Taranetz (1936). The range of this species extends from the Pacific coast of Hokkaido, Japan to the North Sea of Okhotsk, including the Kuril Islands and East Kamchatkan waters (Schmidt, 1950; Yabe et al., 1983; Masuda et al., 1984; Nelson, 1984; Amaoka et al., 1995; Orlov, 1998a; Fedorov, 2000; Sheiko & Fedorov, 2000).

In surveys from 1993 to 2002, the scaly-belly sculpin occurred discretely throughout the survey area at depths of 200 - 800 m (bottom temperatures were 1.6 - 3.7°C). There were also several records at depths of 820 - 840 m. The fish inhabited

parts of the continental slope with rough substrates or those covered with sponges (Fig. 7). Maximum catches of this species (300 - 400 individuals per one hour haul) were recorded at the Southernmost part of the area surveyed (47°50'N - 48°30'N) on the Eastern slope of the underwater upland (Orlov, 2003).

The scaly-belly sculpin is a mesobenthic species occurring at depths of 175 - 900 m (Sheiko & Fedorov, 2000). The analysis of trawl catches showed that this species occurs at

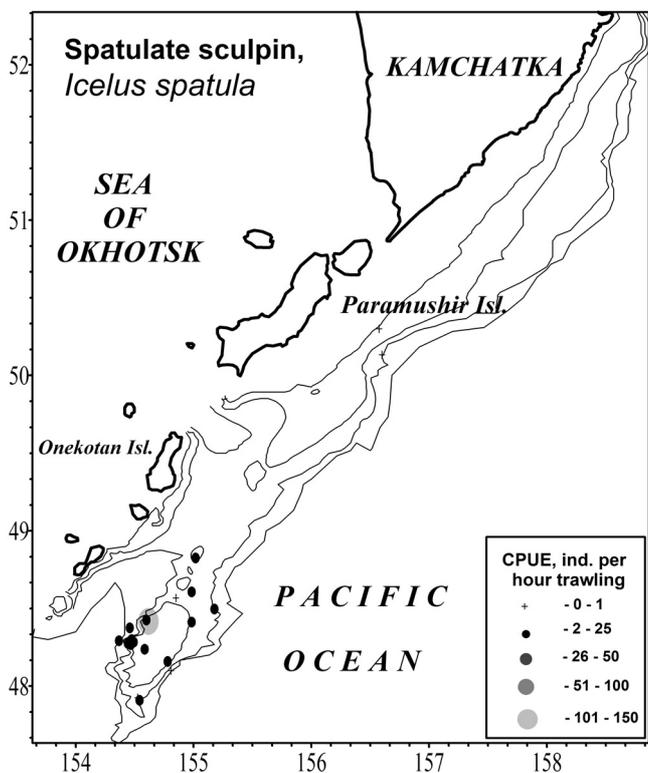


Fig. 5. Distribution and relative abundance categorized by CPUE (specimens per hour trawling) of the spatulate sculpin (*Icelus spatula*) in the Pacific waters off the Northern Kuril Islands, April - December, 1995 - 2001. Thin lines = isobaths of 100, 200, 500 and 1,000 m; CPUE, ind. per hour trawling = catch per unit effort, individuals per hour trawling.

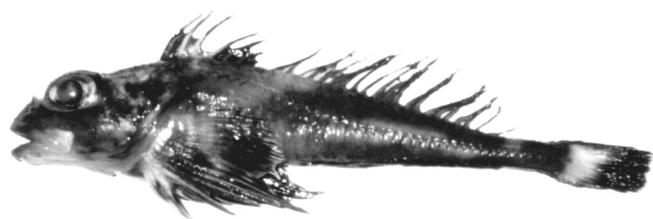


Fig. 6. Scaly-belly sculpin (*Icelus perminovi*), 135 mm TL, female, lateral view.

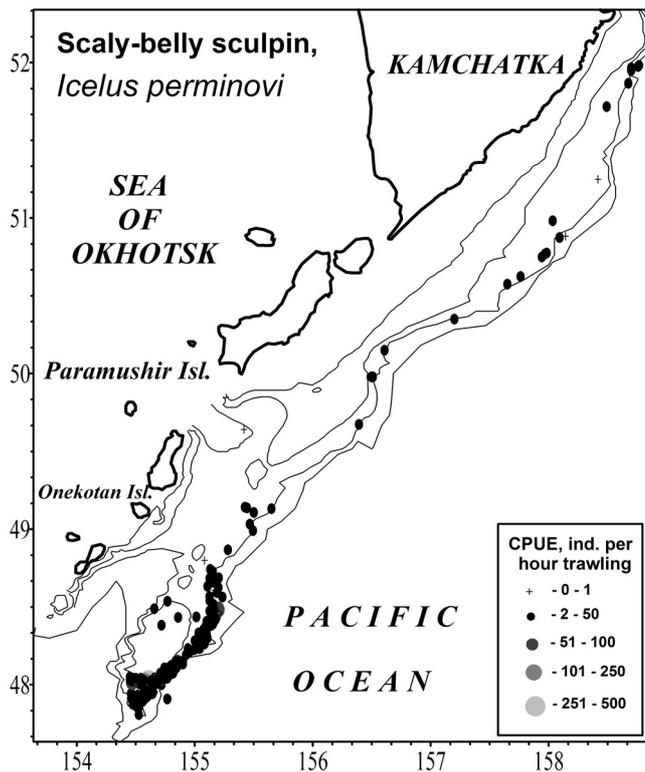


Fig. 7. Distribution and relative abundance categorized by CPUE (specimens per hour trawling) of the scaly-belly sculpin (*Icelus perminovi*) in the Pacific waters off the Northern Kuril Islands and Southeastern Kamchatka, April - December, 1993 - 2002. Thin lines = isobaths of 100, 200, 500 and 1,000 m; CPUE, ind. per hour trawling = catch per unit effort, individuals per hour trawling.

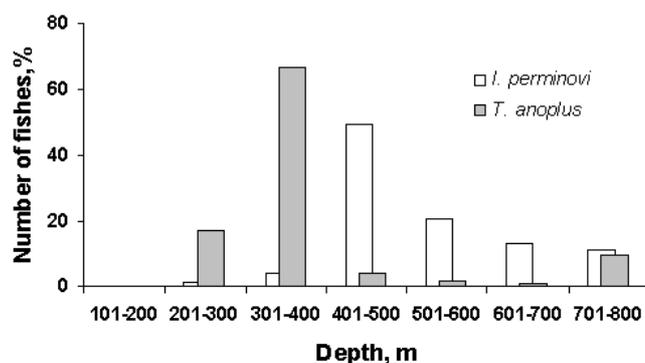


Fig. 8. Bathymetric distribution of the scaly-belly sculpin (*Icelus perminovi*) and sponge sculpin (*Thyriscus anoplus*) from the Pacific waters off Northern Kuril Islands and Southeastern Kamchatka, April - December, 1993 - 2002.

a wide range of depths (200 - 840 m), concentrating at depths of 400 - 600 m (Fig. 8), which is probably the zone of its bathymetric optimum in this region of the North Pacific.

The sponge sculpin (Fig. 9) was originally described in the early 20th century from the only specimen caught near the Attu Island (Aleutians) in the Bering Sea (Gilbert & Burke, 1912). This cottid species was subsequently recorded sporadically near the Commander Islands and on the Pacific side of the North Kuril Islands and East Kamchatka (Fedorov, 1973a, 1973b, 2000; Sheiko & Fedorov, 2000) when the North Pacific ichthyofauna was being studied. The sponge sculpin was characterized as a mesobenthic fish whose main habitat was in the near-bottom waters of the lower shelf and upper slope at depths of 104 - 800 m.

The trawl surveys made in 1995 - 2002 showed that the sponge sculpin was commonly found in the area surveyed



Fig. 9. Sponge sculpin (*Thyriscus anoplus*), 126 mm TL, female, lateral view.

but not abundantly. This species occurs only in specific biotopes of the upper bathyal of this region (portions of bottom with rough and rocky ground relief covered with sponges). The sponge sculpin occurs between 47°50'N and the Fourth Kuril Strait (49°50'N). The only case of its capture outside this range was at the Southern extremity of Kamchatka. The major habitat area for this species is the slope of the Northern link upland in the outer ridge of the Kuril Chain (47°50'N to 48°40'N) (Orlov, 2003) where catches of over 50 - 100 individuals per one hour haul have been recorded (Fig. 10).

The analysis of trawl catches shows that this species occurs at depths of 130 to 800 m, concentrating at depths of 300 - 400 m (bottom temperatures were 1.8 - 3.6°C) where over 66% of individuals were found during the period of observations (Fig. 8). Only 0.2% of the entire number of sponge sculpin captured was observed at less than 200 m.



Fig. 11. Roughskin sculpin (*Rastrinus scutiger*), 119 mm TL, female, lateral view.

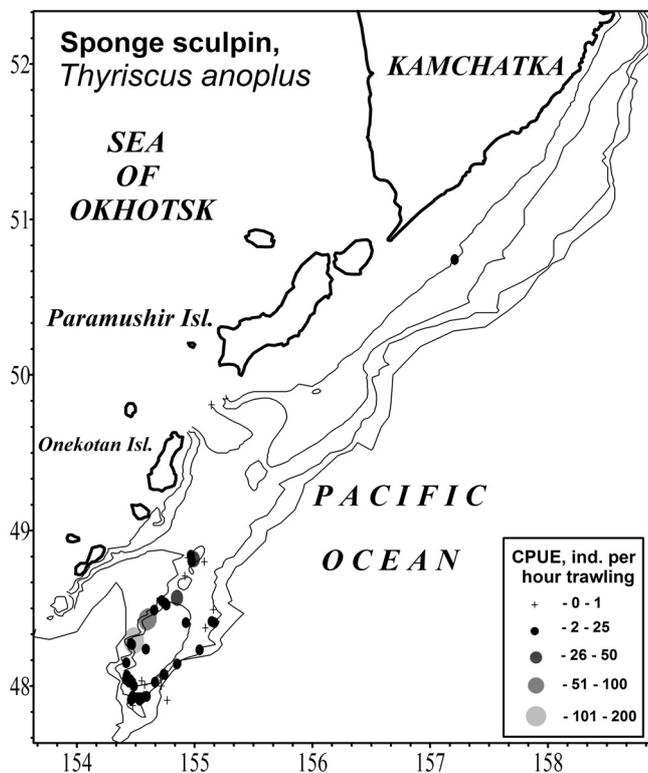


Fig. 10. Distribution and relative abundance categorized by CPUE (specimens per hour trawling) of the sponge sculpin (*Thyriscus anoplus*) in the Pacific waters off the Northern Kuril Islands, April - December, 1995 - 2002. Thin lines = isobaths of 100, 200, 500 and 1,000 m; CPUE, ind. per hour trawling = catch per unit effort, individuals per hour trawling.

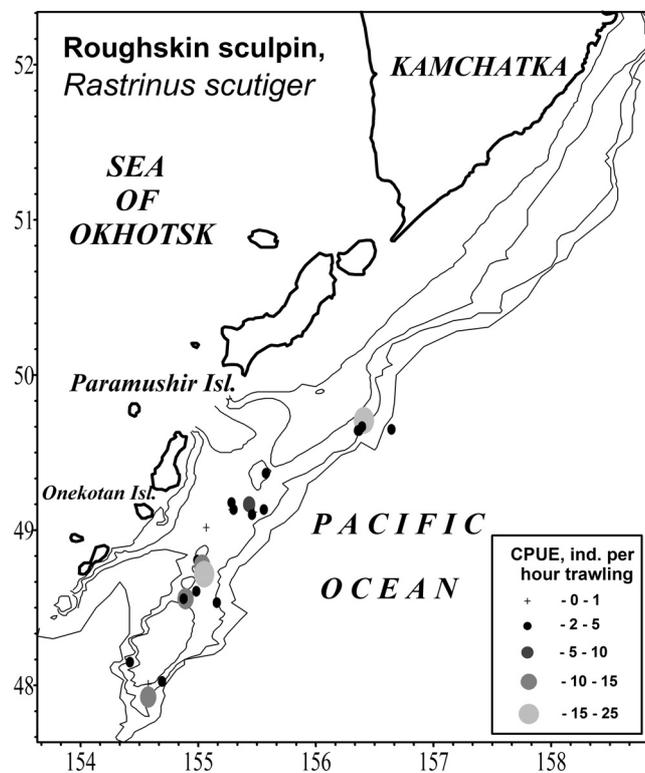


Fig. 12. Distribution and relative abundance categorized by CPUE (specimens per hour trawling) of the roughskin sculpin (*Rastrinus scutiger*) in the Pacific waters off the Northern Kuril Islands, April - December, 1995 - 2002. Thin lines = isobaths of 100, 200, 500 and 1,000 m; CPUE, ind. per hour trawling = catch per unit effort, individuals per hour trawling.

The roughskin sculpin (Fig. 11) was described in the late 19th century from a fish that came from the vicinity of the Attu Island (Aleutians) in the Bering Sea (Bean, 1890). This species was also subsequently found in the Southeast and Western part of the Bering Sea, as well as off the Commander and Kuril Islands (Nelson, 1984; Sheiko & Fedorov, 2000).

During our surveys in 1995 - 2002, the roughskin sculpin occurred only in catches in the South of Pacific waters off the North Kuril Islands (50°00'N) (Fig. 12). Catch ranges varied between 1 - 2 and 17 - 23 individuals in a one hour haul with the peak values reached both in the Central and Southernmost parts of this region (Orlov, 2003).

Similar to the sponge sculpin, the roughskin sculpin is a mesobenthic species occurring within the depth range of 100 - 512 m (Sheiko & Fedorov, 2000; Tokranov & Orlov, 2002). According to our observations, the roughskin sculpin occurs

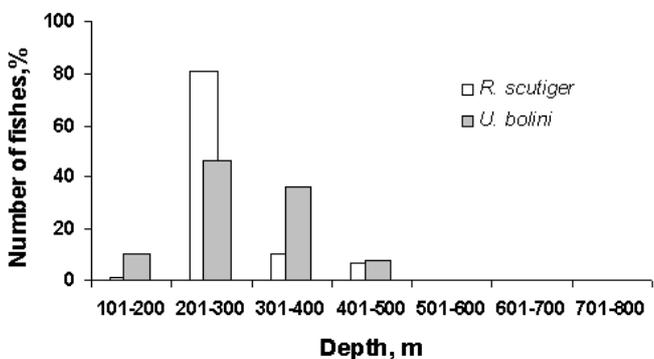


Fig. 13. Bathymetric distribution of the roughskin sculpin (*Rastrinus scutigera*) and bigmouth sculpin (*Ulca bolini*) from the Pacific waters off the Northern Kuril Islands and Southeastern Kamchatka, April - December, 1993 - 2002.

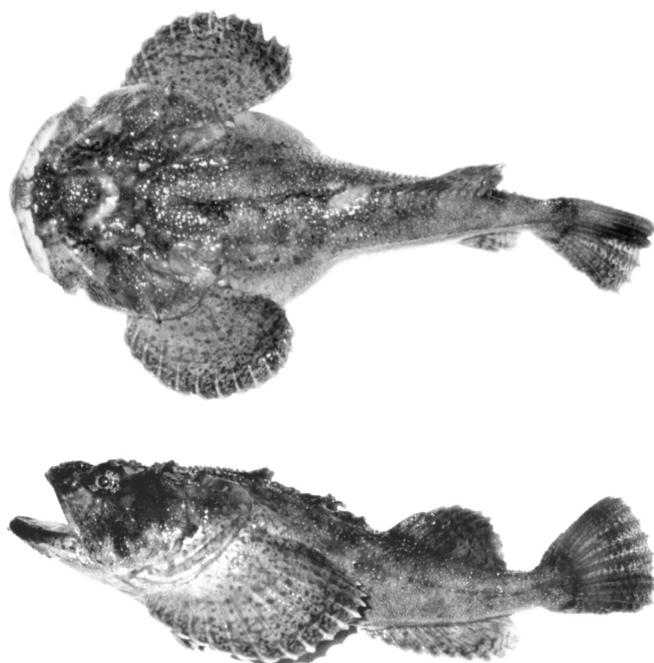


Fig. 14. Bigmouth sculpin (*Ulca bolini*), 430 mm TL, male. Above = dorsal view; below = lateral view.

at depths of 170 - 480 m (with bottom temperatures of 2.4 - 3.6°C). However, most individuals of this species (over 81%) were captured between depths of 200 - 300 m (Fig. 13).

The bigmouth sculpin (Fig. 14) was thought to be a part of the Oregonian ichthyofauna whose representatives are mostly distributed off the West coast of North America (between California and British Columbia), in the Gulf of Alaska, near the Aleutians and in the South and East Bering Sea (Andriashev, 1939; Schmidt, 1950; Allen & Smith, 1988). This species rarely occurs near the Asian shore and its numbers are scarce in all Asian areas (Orlov, 1998a, 1998b, 2000a, 2000b; Poltev & Moukhametov, 1999).

The bigmouth sculpin occurred in almost the entire area surveyed (Fig. 15), though most of the individuals were caught within the lower shelf and upper continental slope

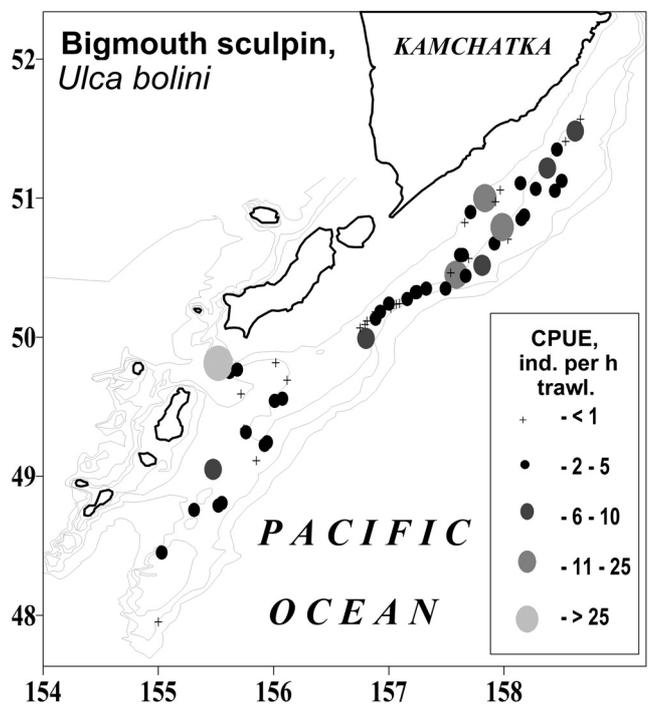


Fig. 15. Distribution and relative abundance categorized by CPUE (specimens per hour trawling) of the bigmouth sculpin (*Ulca bolini*) in the Pacific waters off the Northern Kuril Islands and Southeastern Kamchatka, April - December, 1995 - 2002. Thin lines = isobaths of 100, 200, 500 and 1,000 m; CPUE, ind. per h trawling = catch per unit effort, individuals per hour trawling.

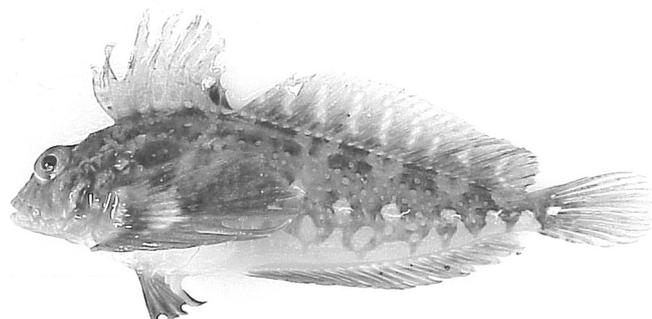


Fig. 16. Scaled sculpin (*Archistes biseriatus*), 122.8 mm TL, female, lateral view. Photo: J.W. Orr.

North to Central Paramushir Island. It was in this area that the maximum catches (over 10 specimens per one hour haul) of this species were observed. Orlov (2002a) showed that for the Western Bering Sea, the spatial distribution of the bigmouth sculpin is probably associated with the fact that this species is most abundant in the areas with a well-developed shelf and flat continental slope.

According to Sheiko & Fedorov (2000), the bigmouth sculpin occurred within the depth range of 30 to 800 m. Analysis of trawl catches shows that this species inhabits depths from 110 to 450 m (bottom temperatures: 1.5 - 3.6°C). However, about 50% of individuals were caught within the upper portion of continental slope at depths of 200 to 300 m (Fig. 15) during the study period.

The scaled sculpin (Fig. 16) was described from 10 specimens collected in 1906 from the Petrel Bank in the Southern Bering Sea off Semisopchnoi Island in the Aleutian Archipelago (Gilbert & Burke, 1912). Later studies (Taranez, 1937; Wilimovsky, 1954, 1964; Quast & Hall, 1972; Fedorov, 1973a), taking into account the data of Gilbert & Burke (1912), included this species in lists of fishes inhabiting the Bering Sea and waters off the Aleutian Islands. Notes on the occurrence of scaled sculpin off the Kuril Islands have been published recently (Boretz, 1997, 2000; Fedorov, 2000; Sheiko & Fedorov, 2000), although all they were only based on field samples and field identifications. No specimens from these records have been deposited in fish collections. Since the original description, only a single additional specimen has been collected (Fig. 17) from the central Kuril Archipelago, off Simushir Island (Yabe & Soma, 2000).

Two specimens of scaled sculpin were caught in October 2000 and May 2001, respectively, at the underwater plateau Southeast of Shikotan Island (Fig. 18) at depths of 138 - 140 m and 100 - 117 m, respectively. The female specimen measured 159 mm standard length (SL) and weighed 90 g while the male measured 150 mm SL and weighed 100 g. Another specimen (123 mm SL, 80 g) was subsequently caught in July 2000 by James Wilder Orr (Alaska Fisheries

Science Center, Seattle, USA) off Seguam Island in the Eastern Aleutians at a depth of 145 m.

The smoothcheek sculpin (family Psychrolutidae) (Fig. 19) is widely distributed in the Northwest Pacific (Nelson, 1982; Amaoka et al., 1995; Boretz, 1997, 2000; Sokolovskaya et al., 1998; Fedorov, 2000; Sheiko & Fedorov, 2000). There were only two records of this species in coastal waters off Southeast Kamchatka during the entire survey period (Fig. 20). These captures were two specimens with total lengths of 25 and 30 cm that were caught in November 1996 at 113 - 152 m depths (bottom temperature 1.2 - 1.5°C). An additional single specimen was caught in August 2000 at 100 - 113 m depth (bottom temperature 0.3 - 0.5°C). Another smoothcheek sculpin of 10.4 cm TL was caught in June 1997 at 160 - 165 m depth in the Western Bering Sea (Fig. 20).

Biological characteristics. – According to our data, the longfin Irish lord is the smallest and has the shortest life span of all the species in the genus *Hemilepidotus*. In trawl catches during 1999 - 2001, this species was represented by individuals with 11 - 26 (mean: 17.6) cm TL and body weight of 50 - 330 g (mean: 136 g) at the age of 3 - 9 years (Fig. 21). However, the bulk of catches consisted of individuals aged 5 - 6 years (> 87% of catches), 16 - 19 cm TL (89% of catches) and 60 - 140 g in weight (60% of catches).

The data show that in contrast to the yellow and banded Irish lords, the female longfin Irish lord are larger than males (maximum length and weight of females are 26 cm TL and 330 g, while those of the males are 23 cm TL and 190 g), have greater longevity (9 and 7 years respectively) and relative number of females sharply increases among the largest individuals (> 18 cm), reaching 100% in fish \geq 23 cm. Similar to other species of *Hemilepidotus*, the longfin Irish lord exhibits sexual dimorphism in terms of colouration and size of fins. Males have significantly longer pelvic fins than females (relative sizes of pelvic fins of males are 29 - 35% and of females, 17 - 22% of TL, respectively) which allows for accurate identification of sex in catches (Fig. 1).

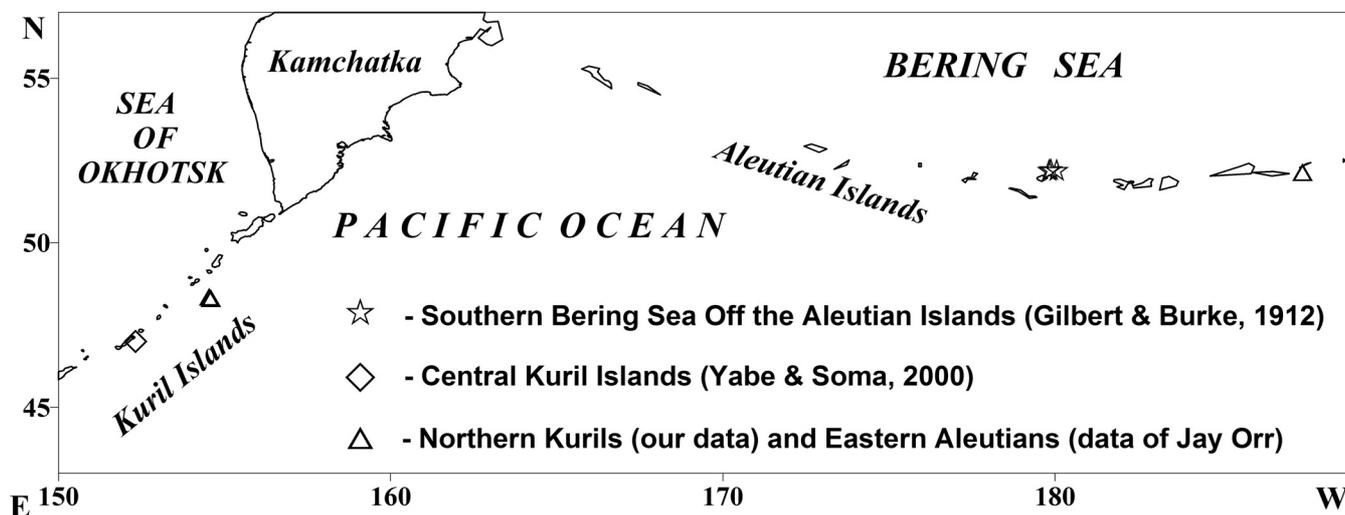


Fig. 17. Map showing locations of new and previous records of the scaled sculpin (*Archistes biseriatus*) in the North Pacific Ocean.

The spawning period of the longfin Irish lord occurs from the end of August to September, similar to the spawning periods of the other two congeneric species, the yellow and banded Irish lords. However, the two congeneric species spawn in shallow coastal waters at depths less than 20 - 30 m (Gorbunova, 1964; Tokranov, 1985, 1988b; Zolotov & Tokranov, 1989) while the longfin Irish lord probably spawns at considerably greater depths, since all pre-spawning and spawning females of this species were caught at the depth of 160 - 190 m (Tokranov & Orlov, 2001). Results of gonad examination showed that males of this species become mature at four years and 14 - 15 cm TL, while the females become mature at five years and 17 - 18 cm TL.

The longfin Irish lord is probably a single-batch species because it has only one portion of oocytes of older generation (in August - September with size 1.0 - 1.7 mm, mean: 1.3 mm) and oocytes of the reserve fund in ovaries of its females. Individual fecundity of the longfin Irish lord (17 - 24.5 cm TL) in the Pacific waters off the North Kurils

varied between 3,700 - 22,600 eggs (mean: 12, 800). Similar to many other species, there is a positive correlation between maternal size and the number of eggs. Thus, average individual fecundity of the longfin Irish lord of 17 - 20 cm TL is 10,200 eggs, for fish 21 - 23 cm TL is 14,300 eggs and for fish > 23 cm TL was 17,900 eggs.

According to our data, the longfin Irish lord is a benthichthyophagus species with a wide food spectrum, which included 16 groups of invertebrates and fishes (Table 2). However, despite considerable variety of food items consumed, the main diet of this species (about 66% by weight) were benthic and benthopelagic crustaceans (Cirripedia,

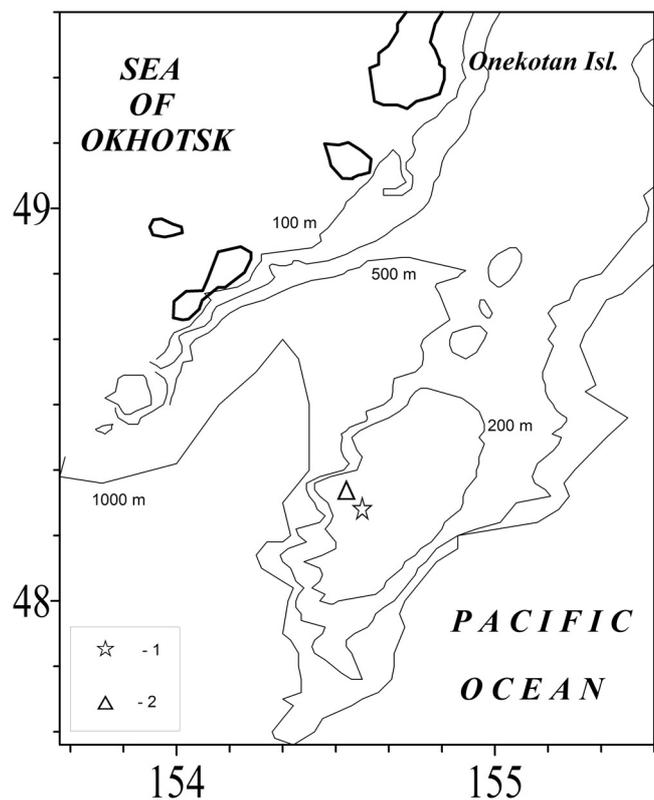


Fig. 18. Sites of scaled sculpin (*Archistes biseriatus*) records off the Northern Kuril Islands. 1 = year 2000; 2 = year 2001; thin lines, numbers = isobaths.

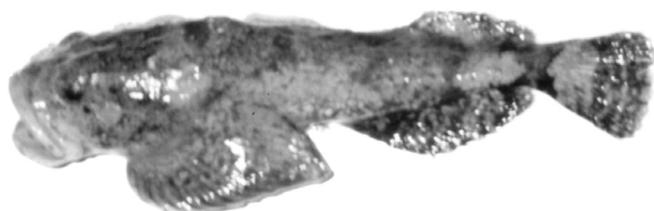


Fig. 19. Smoothcheek sculpin (*Eurymen gyrinus*), 104 mm TL, male, dorso-lateral view.

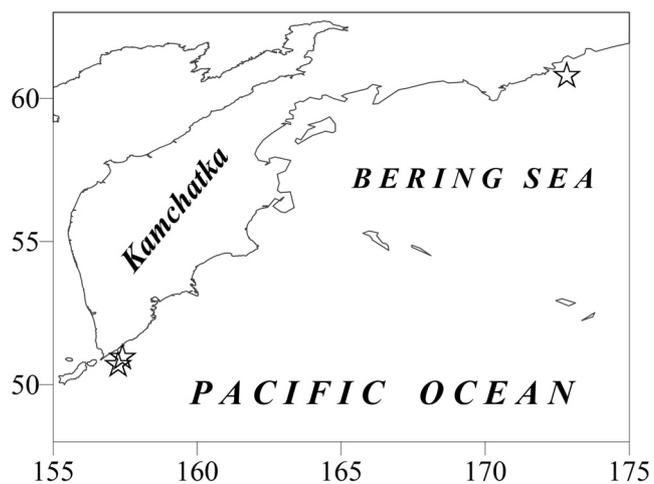


Fig. 20. Sites of records of smoothcheek sculpin (*Eurymen gyrinus*) off Southeastern Kamchatka and Western Bering Sea.

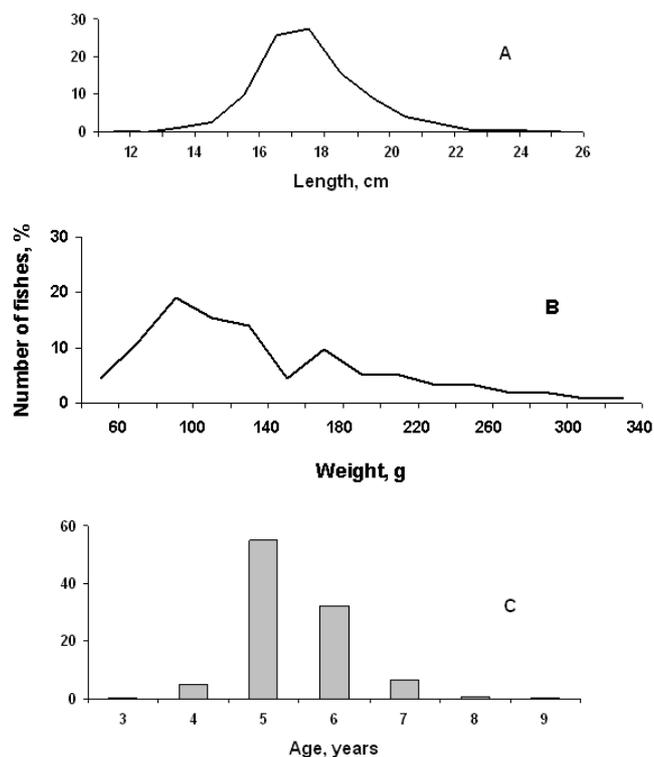


Fig. 21. Distributions of various biological parameters of the longfin Irish lord (*Hemilepidotus zapus*) in the Pacific waters off the North Kuril Islands, 1999 - 2001. A) size, B) weight and C) age.

Table 2. Diet composition (% by weight) of five sculpins from the Pacific waters off the North Kuril Islands and Southeast Kamchatka, 1995 - 2002.

Dietary component	Longfin Irish Lord	Scaly-belly Sculpin	Spatulate Sculpin	Roughskin Sculpin	Sponge Sculpin
Polychaeta	12.4	8.2	2.7	23.1	10.5
Echiurida	0.4	-	-	-	-
Cirripedia	43.7	-	-	-	-
Cumacea	-	-	-	-	0.2
Isopoda	0.3	-	-	-	-
Amphipoda	8.6	53.9	9.8	39.9	20.2
Mysidacea	-	-	-	5.4	0.6
Decapoda	1.6	37.9	46.6	31.6	47.3
Pantopoda	0.2	-	-	-	-
Bivalvia	0.5	-	-	-	-
Gastropoda	7.5	-	-	-	-
Octopoda	2.6	-	-	-	-
Crinoidea	0.1	-	-	-	-
Ophiuroidea	0.5	-	-	-	-
Pisces	4.6	-	40.9	-	21.2
Fish eggs	3.8	-	-	-	-
Fishery offal	13.2	-	-	-	-
Others	< 0.1	< 0.1	-	-	< 0.1
Number of fish examined	244	105	80	10	63

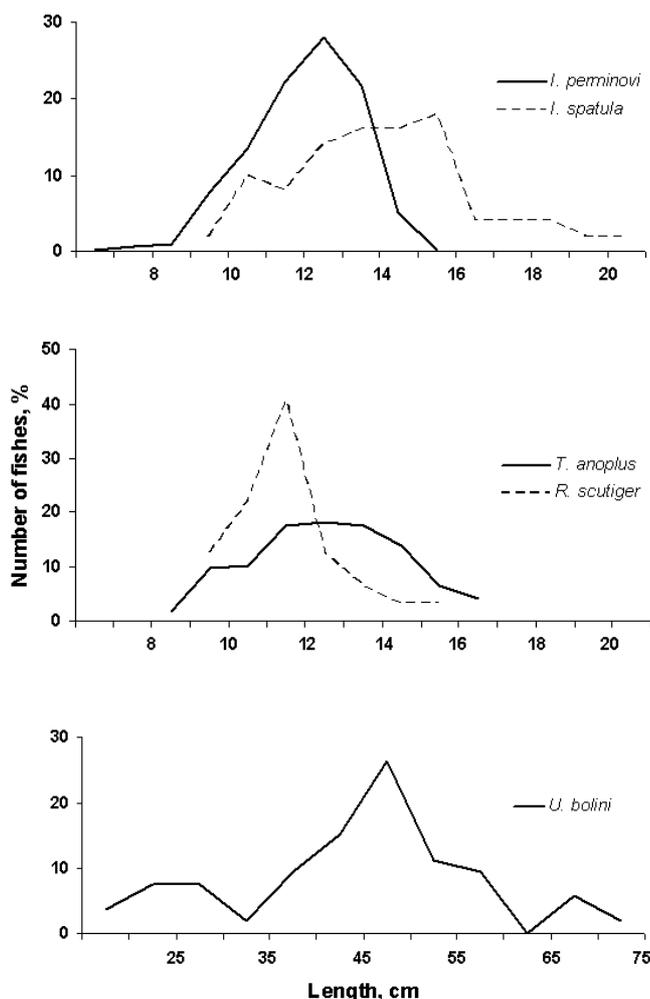


Fig. 22. Length distributions of the scaly-belly sculpin (*Icelus perminovi*), spatulate sculpin (*Icelus spatula*), sponge sculpin (*Thyriscus anoplus*), roughskin sculpin (*Rastrinus scutiger*) and bigmouth sculpin (*Ulca bolini*) from the Pacific waters off the North Kuril Islands and Southeast Kamchatka, 1993 - 2002.

Amphipoda, Decapoda) and polychaete worms. Besides these invertebrates, snails (Gastropoda), cephalopods, fishery offal, fish eggs and small fishes (Cottidae, Psychrolutidae, Stichaeidae and Myctophidae) are also important parts of the diet. The existence in the diet of the longfin Irish lord of midwater species, such as myctophids, is associated with the fact the species perform regular diurnal migrations from surrounding deep-water troughs to the top of underwater plateau.

The longfin Irish lord exhibits well-pronounced seasonal and age-dependent changes of diet composition. Cirripedia (over 57% by weight) are a main part of its diet in spring, while Amphipoda (31%) were more important in the summer/autumn period. In comparison with the spring months, the proportion of fish and fish eggs increases considerably and that of fishery offal decreases in the summer/autumn period. The diet composition also changes with age. Polychaete worms (about 15% by weight) are a significant part of the diet of small individuals (15 - 18 cm) while the worms comprised only 3.8% of the stomach contents of larger

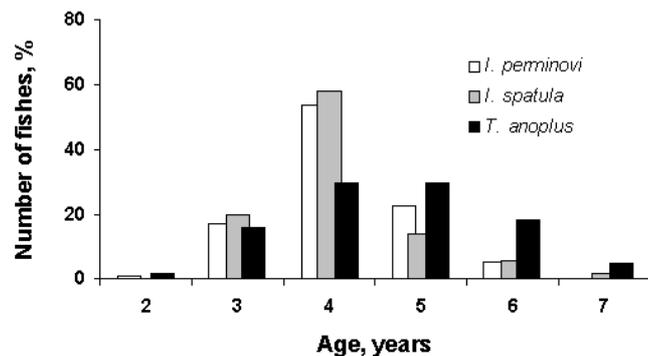


Fig. 23. Age distributions of the scaly-belly sculpin (*Icelus perminovi*), spatulate sculpin (*Icelus spatula*) and sponge sculpin (*Thyriscus anoplus*) from the Pacific waters off the North Kuril Islands and Southeast Kamchatka, 1993 - 2002.

individuals (> 22 cm). In longfin Irish lord individuals of the same size groups (15 - 18 cm and > 22 cm), the proportion of fishery offal in diet increased from 12.3 to 23.0% by weight.

Scaly-belly sculpin are small and short-lived, reaching a maximum length of 156 mm TL and seven years in age. In the trawl catches of 1995 - 2002, this species was represented by individuals with 6 - 16 (mean 12.5) cm TL and weighing 5 - 70 g (mean: 28 g) at ages of 2 - 7 years (Figs. 22 & 23). However, the bulk of catches consisted of fish of 11 - 14 cm SL (about 72%) at the age 4 - 5 years. There were no reliable distinctions between males and females either in external morphological patterns (colouration, size of fins and existence of additional skin formations) or body sizes. However, males differ from females in length, reaching length 65 - 75 mm and having pronounced anal papilla.

The scaly-belly sculpin is a necto-benthophage with a rather narrow food spectrum which included five groups of invertebrates and fishes (Table 2). However, the majority of biomass consumed by this species (about 92%) comprised of two groups of crustaceans: Decapoda and Amphipoda. The Decapoda consumed comprised of the family Hippolytidae (several species of the genus *Eualus*) and the Amphipoda consumed comprised of various species from the families Lysianassidae, Ampeliscidae, Stenothoidae, Melphidippidae and Caprellidae (*Caprella pacifica* and *C. oxyarthra*). The diet composition changed with age. The smallest individuals (\leq 12 cm) consumed mostly amphipods (88% by weight) while larger individuals predominantly fed on shrimps. The size of prey consumed also increased with age.

According to Andriashev (1954), the spatulate sculpin can reach a length of 10.3 cm in Arctic waters and in the Northern Bering Sea. In bottom trawl catches during 1995 - 2002, this species was represented by individuals of 10 - 21 cm (mean 14.6 cm) TL and weighing 20 - 160 g (mean: 56 g) of ages 3 - 7 years (Figs. 22 & 23). However, 4 year-old fishes (58% of catches) with 13 - 16 cm TL (64% of catches) and weighing 20 - 100 g (85% of catches) comprised the bulk of catches.

The spatulate sculpin is probably a single-batch spawning species because it has only one portion of older generation oocytes (in August - October with size 0.8 - 1.5 mm) and oocytes of the reserve fund in ovaries of its females. Males of this species differ from females in having pronounced anal papilla. According to our data, the individual fecundity of spatulate sculpin 13 - 21 cm TL was about 1,700 - 9,100 (mean 4,900) eggs in the Pacific waters off the Northern Kurils

The diet of the spatulate sculpin consisted mainly of rather large benthic organisms such as shrimps (of genera *Pandalus* and *Spirontocaris*), amphipods and polychaete worms in the waters of the Arctic and the Northern Bering Sea (Andriashev, 1954). Apart from shrimps of genera *Neocrangon*, *Lebbeus*, *Eualus* and *Spirontocaris* and amphipods, various small fishes of 30 - 55 mm TL (from the families Cottidae, Agonidae, Liparidae and Stichaeidae) were an important part (over 32%

by weight) of the diet of the spatulate sculpin in the area surveyed probably due to this species growing larger in the areas surveyed (Table 2).

According to our data, the sponge sculpin is a small-sized species with a short life span, with a maximum length of 145 mm TL, weight of 35 g and age of 6 years. In trawl catches of 1995 - 2001, the sponge sculpin was represented by individuals with 9 - 17 (mean 13.1) cm TL weighing 4 - 60 g (mean: 20 g) and of age 2 - 7 years (Figs. 22 & 23). However, individuals of 11 - 14 cm TL (54% of catches) and 10 - 20 g (51% of catches) at the age of 4 - 5 years (about 60% of catches) were most numerous.

Judging from the existence in ovaries of the sponge sculpin of only a single portion of older generation oocytes (in September - November of size 0.9 - 1.6 mm; mean: 1.2 mm) and oocytes of the reserve fund, this species is single-batch spawner. There are no significant distinctions between males and females in external patterns (colouration, size of fins and existence of additional skin formations) and their sizes (Tokranov, 1998a). Male sponge sculpins (\leq 84 mm) differ essentially from females by having a well-pronounced anal papilla. It should be noted that in population of this sculpin, females are more numerous in comparison with males and the sex ratio is 3.3:1.0.

Individual fecundity of the sponge sculpin of 10 - 15 cm TL varied from 200 to 1,100 (average 400) eggs. Larger females produced a higher number of eggs. Thus, average individual fecundity of females of 10 - 11 cm TL was 300 eggs, those of 12 - 13 cm TL was 600 eggs and those of 14 - 15 cm TL was 800 eggs.

The sponge sculpin is a necto-bentho-ichthyophagous species with a rather narrow food spectrum which includes six groups of invertebrates and fishes (Table 2). Three groups of forage organisms (Decapoda, Amphipoda and Pisces) formed the bulk of its biomass (about 89%). The Decapoda consumed comprised of the family Hippolytidae (several species of *Eualus* genera of 7 - 33 mm in size). The Amphipoda consumed comprised of the families Lysianassidae, Ampeliscidae, Stenothoidae, Melphidippidae and Caprellidae (in general *Caprella pacifica*). The fishes consumed comprise mostly of juvenile cottids and liparids of length 12 - 32 mm. The diet composition changes with age. Small individuals (< 10 cm) ate mostly amphipods and shrimps of the family Hippolytidae (96% by weight), while the diet of larger sculpins (> 12 cm) comprised of juvenile fish (43%) and shrimps (29%), but the proportion of amphipods in this size class did not exceed five percent by weight.

Though the information on the roughskin sculpin sizes in the area surveyed is limited, it is possible to conclude that this species (which is similar to the scaly-belly and sponge sculpins) is a small-sized species with a short life span. In trawl catches of 1996 - 2002 from the Pacific waters off the Northern Kurils, the roughskin sculpin was represented by individuals with 10 - 16 (mean: 12.0) cm TL and weighing 10 - 30 g (mean: 18 g) (Fig. 22). However, individuals of

10 - 12 cm TL were most abundant (63% of catches). The sex ratio of males to females was 2:1. Similar to many other sculpins, the roughskin sculpin displays sexual dimorphism in terms of colouration and the size of fins. All fins of freshly-captured males had a dark brown colouration while those of females were grayish-brown. Both dorsal fins in the male are much higher (especially the first dorsal fin) in comparison with the female. These patterns along with existence in males of well-defined anal papilla make accurate visual identification of males and females in catches possible.

The roughskin sculpin is a medium-sized necto-benthophage with a rather narrow food spectrum which included four groups of invertebrates (Table 2). The bulk of biomass consumed (about 72%) was similar to the diet of the scaly-belly, spatulate, sponge and other sculpins, having comparable linear sizes and distributions. The diet consists of amphipods and juvenile shrimps of Family Hippolytidae.

In contrast to all the above mentioned species, the bigmouth sculpin is a large fish that can reach 73 cm and weigh 8.5 kg (Lea, 1986; Orlov, 2000a). In trawl catches from 1993 - 2002, this species was represented by individuals of 16 - 73 (mean: 44.1) cm TL and weighing 0.2 - 3.9 kg (mean: 1.9 kg). Though individuals of 35 - 60 cm TL (72% of catches) and 1 - 3 kg (67% of catches) were the most numerous. Similar to the other species surveyed in the other areas, the bigmouth sculpin in the Pacific waters off the North Kuril Islands and Southeast Kamchatka leads a sedentary habit as an ambush predator whose prey include various fishes and crabs.

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