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The role of turbot (*Psetta maxima*) and flounder (*Platichthys flesus trachurus* Duncker) juveniles in fish communities in the Lithuanian coastal zone of the Baltic Sea

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The abundance of flounder and turbot was studied in August 2005 at 17 stations sited along all the Lithuanian coastal zone and in October at 8 stations at the Curonian Spit. Catches were dominated by flounder and turbot in occurrence frequency. However, in August the prevalent species were juveniles of Baltic sprat and smelt and in October small sand eel. The causative factors of turbot and flounder distribution and abundance in the coastal zone were established. The size–age structure of these fish was studied.

Key words: turbot, flounder, juveniles, Baltic Sea, Lithuania

INTRODUCTION

Juvenile fish make up a significant constituent part of the coastal zone biocenoses (Nero, Sealey, 2005). Investigations of their abundance facilitate the assessment of spawning conditions, growth rate, dominant age groups of the most important commercial fish. Assessment of the results of long-term investigations into juvenile fish abundance makes it possible to forecast fish abundance dynamics and stocks not only for a year, but for many years in advance (Repečka et al., 1996).

Of the four flatfish species occurring in Lithuania, flounder and turbot the most common in the coastal zone (Virbickas, 2000). As the most abundant and the most common bottom-dwelling fish, they perform the main role in forming the structure of the bottom-dwelling fish community (Statkus, 2000) and are important for commercial fishery (Stankus, 2003).

A few studies dealing with fluctuations in the density and biomass of turbot and flounder juveniles in the coastal zone stretch from Klaipėda to Būtingė have been conducted to date in Lithuania (Repečka et al., 1996; Repečka et al., 2003). The spatial distribution of juveniles along the whole Lithuanian coastal zone as well as the role of flatfish in forming fish communities (Piščikas, 2000) have been also analysed. However, neither the factors influencing their abundance in the coastal zone nor the age structure of these fish species have been investigated.

The aim of this study was to assess the role of flatfish juveniles in coastal fish communities, the impact of various factors on their distribution along the whole coastal zone of Lithuania and to determine the size–age structure of these fishes.

MATERIALS AND METHODS

Fishing for turbot and flounder juveniles as well as other fish for the purpose of scientific investigation was conducted in 2005 in the Nida–Būtingė stretch of the Lithuanian coastal zone of the Baltic Sea. In August investigation material was sampled at 17 stations sited all over the coastal zone. In October, however, fishing was carried out only at 8 stations at the Curonian Spit, as it was not possible to collect the material repeatedly at the rest of the stations in the Klaipėda–Būtingė stretch due to unfavourable meteorological conditions. The sampling sites are presented in Fig. 1. Fishing was carried out in the daytime, the sea being calm, as beach seine fishing yields noticeably smaller catches of juveniles when the 6 m/s or stronger wind is blowing (Lewy, Hoffmann, 1984).

To compare fish communities of the Lithuanian coastal zone of the Baltic Sea with the analogous ones of the Curonian Lagoon, in August beach seine fishing was carried out in the Curonian Lagoon at Ventė.

Fishing for fish juveniles was carried out using a 30 metre long beach seine with a sack adapted to fishing in shallow waters.

A total of 8042 fish individuals with the biomass of 9955 g were caught in the Lithuanian coastal zone of the Baltic Sea and 1020 fish specimens with the biomass reaching 1800 g in the Curonian Lagoon.

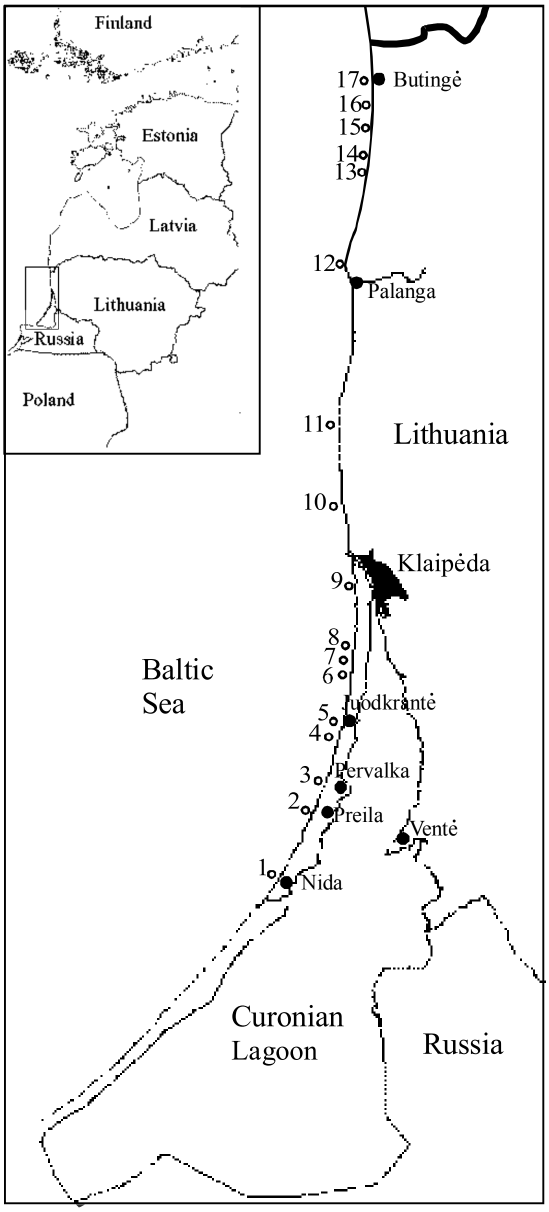

Fig. 1. Location of research stations in the coastal zone of the Baltic Sea

Not only fish juveniles, but also some mature individuals which often share the same habitats with juveniles (small sand eel, three-spined stickleback, bleak, sand goby) were analysed.

Juveniles were fished at a depth ranging from 0.8 to 4 m. An area of 1000 m² was fished out at a haul of a net. At some stations where the area covered was smaller, data were standardised by multiplying them by appropriate coefficients.

In August and October, at each station, at a depth of 1 m we measured water temperature within 0.1 °C and took water samples to determine water salinity. The amount of silt and algae deposit hauled out with a beach seine was visually estimated in points.

The body length (L) of the caught fish was measured within 1 mm and weight 1 mm. Fish age was determined using otoliths.

The density (in units and %), biomass (g and %) and occurrence frequency (V, %) of each fish species were calculated.

The occurrence frequency of fish species was calculated according to the formula presented below: (Йоганзен, Файзова, 1978):

$$V = a/A * 100\%,$$

where a is a fish species caught at several stations and A is the number of all stations.

According to occurrence frequency, the species were divided into four groups: stable ($V > 70\%$), common ($V = 40–70\%$), rare ($V = 15–40\%$) and accidental ($V < 15\%$).

The species structure of the community was expressed through Shannon's species diversity index (H') (Shannon & Weaver, 1949):

$$H' = \sum_{i=1}^{S} p_i \log_2 p_i,$$

where S is the total number of all caught species and p_i is the share of i-species in the abundance of all the species caught.

RESULTS AND DISCUSSION

Structure of the coastal zone fish communities

There were recorded 18 fish species belonging to 10 families. Six fish species belonged to the family Cyprinidae, 3 to Clupeidae and 2 species to the family Percidae. Each of the remaining 7 families was represented by one fish species only.

In August, depending on location, fish density and biomass fluctuated within the limits of 18–3095 ind./1000 m^2 and 80–764 g/1000 m^2 respectively. In October, the corresponding figures were 25–474 ind./1000 m^2 and 97–2710 g/1000 m^2. On average, catches at one station, in the area of 1000 m^2 yielded 419 fish individuals with the biomass of 229 g in August and 115 fish individuals with the biomass of 609 g in October.

The density of fish in the Lithuanian coastal zone as estimated by Piščikas (2000) was 470 ind./1000 m^2 and did not differ much from our results.

The density of fish in the same area of the North Sea was smaller and amounted to 200 individuals on average (Amara, 2003).

A comparison of the August data showed that the mean fish density in the coastal zone of the Baltic Sea was less by a factor of 2.5 and the biomass by a factor of 6 than the density and biomass of the analogous fish communities in the Curonian Lagoon. According to data of other authors (Field et al., 1982, cited in Piščikas, 2000), differences in the density and biomass between the blown sand habitats of the Baltic Sea and ichthyocenoses of the Curonian Lagoon are even greater.

In August, the most abundant were juveniles of Baltic sprat which made up 55.8% of the total fish catch by number. The greatest biomass was that of young-of-the-year smelts (23.9%). According to the data of previous investigations in the Giruliai–Būtingė stretch in August, the most abundant fish species were also juveniles of smelts and Baltic sprats (Repečka et al., 2003).

In October, it was small sand eel that distinguished itself for density and biomass (Table 1).

European bitterling, which had not been recorded in the Lithuanian coastal zone heretofore, was caught in the course of this investigation. A juvenile of gar fish was fished too. These fish do not breed in the Lithuanian coastal zone of the Baltic Sea because of the too low salinity (Virbickas, 2000), therefore catches of gar fish juveniles are rare there.

According to Piščikas (2000), two fish communities can be found in the Lithuanian coastal zone at the end of summer: small sand eel-smelt (spread over the Būtingė–Juodkrantė stretch) and small sand eel (stretching from Juodkrantė to Nida).

Our studies have demonstrated that small sand eel is the most important constituent part of fish communities at the Curonian Spit only in October. In August this fish was caugh in moderate quantities at less than half of the stations. In our opinion, it is flatfishes, the most common species in occurrence frequency (V), that form the most important constituent part of fish communities. They can be attributed to stable fish species because flounders were recorded at all stations and turbot juveniles were not found only at one station in August (Table 1).

The total density of flatfish in August was bigger than that of other fishes at 3 stations out of 17. In October catches of flatfish exceeded those of other species at 3 out of 8 stations. The relatively small density of flatfish in the Palanga–Ošupis area in August is due to the very high concentration of Baltic sprat and smelt juveniles there. The number of fish caught there varied from 730 to more than 3000 individuals.

Shannon's index of biological diversity varied at different stations. Its value fluctuated from 0.74 to 2.74,

Table 1. **Species composition, density, biomass and occurence frequency (V, %) of fish caught in the Lithuanian coastal zone of the Baltic Sea in August (VIII) and October (X) 2005**

Family and fish species		Abundance				Biomass, %		V, %	
		VIII		X		XIII	X	VIII	X
		%	n	%	n				
Clupeidae									
***Clupea harengus membras* (L.)**	**Baltic herring**	**7.6**	**553**	**–**	**–**	**2.1**	**–**	**24**	**–**
Allosa fallax (Lacepede)	Twaite shad	0.4	28	–	–	2.0	–	35	
Sprattus sprattus balticus (Schneider)	Baltic sprat	55.8	4051	0.5	5	15.1	0.3	59	38
Osmeridae									
***Osmerus eperlanus* (L.)**	**Smelt**	**18.4**	**1337**	**–**	**–**	**23.9**	**–**	**59**	**–**
Cyprinidae									
***Alburnus alburnus* (L.)**	**Bleak**	*****	**3**	**–**	**–**	**0.4**	**–**	**12**	**–**
Aspius aspius (L.)	Asp	0.2	12	–	–	0.5	–	18	–
Carassius auratus gibelio (Bloch)	Gibel	*	5	–	–	0.1	–	6	–
Rhodeus sericeus amarus (Bloch)	European bitterling	*	2	–	–	0.1	–	6	–
Vimba vimba (L.)	Vimba	*	4	–	–	1.2	–	12	–
Rutilus rutilus (L.)	Roach	6.6	479	–	–	12.7	–	65	–
Belonidae									
***Belone belone* (L.)**	**Gar fish**	*****	**1**	**–**	**–**	*****	**–**	**6**	**–**
Percidae									
***Stizostedion lucioperca* (L.)**	**Pikeperch**	**0.6**	**47**	**–**	**–**	**4.5**	**–**	**41**	**–**
Perca fluviatilis L.	Perch	1.2	148	–	–	4.7	–	59	–
Ammodytidae									
***Ammodytes tobianus* (L.)**	**Small sand eel**	**0.8**	**55**	**76.4**	**719**	**1.93**	**82.7**	**47**	**88**
Gobiidae									
***Pomatoschistus minutus* (Pallas)**	**Sand goby**	*****	**2**	**4.8**	**45**	*****	**0.4**	**12**	**75**
Scophthalmidae									
***Psetta maxima* (L.)**	**Turbot**	**2.5**	**178**	**8.2**	**77**	**5.8**	**8.4**	**94**	**100**
Pleuronectidae									
***Platichthys flesus trachurus* Duncker**	**Flounder**	**3.9**	**293**	**10.1**	**95**	**18.4**	**8.2**	**100**	**100**
Gasterosteidae									
***Gasterosteus aculeatus* (L.)**	**Three-spined stickleback**	**0.3**	**23**	**–**	**–**	**0.3**	**–**	**24**	**–**

* < 0.1%.

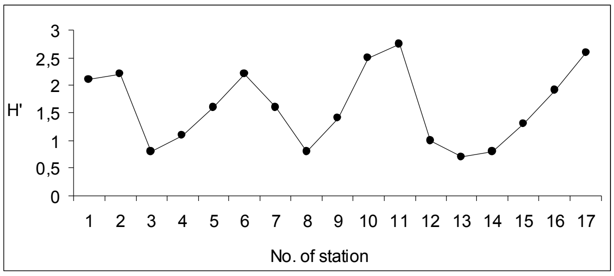

Fig. 2. Shannon–Weaver species diversity index (H') in different stations of the Lithuanian coastal zone in August 2005

the mean equaling 1.61 (Fig. 2). At stations dominated by one particular fish species (Baltic sprat or smelt most often), the value of H' was lower than at stations with a richer species diversity. It must be noted that fresh water flowing into the sea from the Curonian Lagoon and Šventoji also impacts on the number of species and herewith the value of H', as a greater number of freshwater species are recorded in these water areas. Previous investigations (Repečka et al., 2003) yielded similar results, although the obtained mean value of H' was lower – 1.39.

Turbot and flounder distribution in the coastal zone
The coastal stretch from Klaipėda to Būtingė had been considered more important for the reproduction of the majority of fish and the recuperation of juveniles than that at the Curonian Spit (Repečka et al., 1996). Our investigations have shown that flounder juveniles are as abundant at the Curonian Spit as in the coastal zone north of Klaipėda, and turbot juveniles at the Curonian Spit were even more abundant.

In August, the density of turbot and flounder juveniles was 9.6 and 11.9 individuals respectively per 1000 m^2 area at one station on average. A comparison of the coastal zone at the Curonian Spit (stations 1–9) and at the Klaipėda–Būtingė stretch (stations 10–17) proved that the distribution of flounder was nearly the same both north and south of Klaipėda: the density of this fish in the area of 1000 m^2 averaged 17.6 (stations 1–9) and 16.8 (stations 10–17) individuals. The density of turbot yielded 16.1 individuals at stations 1–9 and at stations 10–17 twice less, i.e. 8 individuals (Fig. 3).

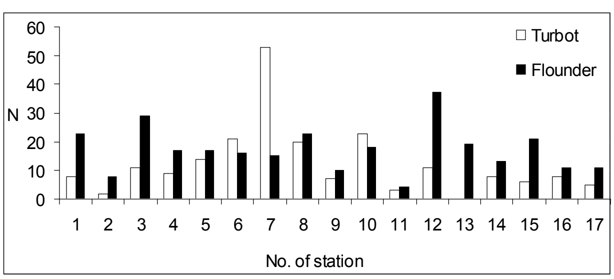

Fig. 3. The density (ind./1000 m^2) of turbot and flounder juveniles at different stations of the Lithuanian coastal zone in August 2005

A comparison of data from different stations showed turbot to be most abundant at Pervalka and north of Juodkrantė (stations 3–8) and at Giruliai (station 10). The abundance of flounder south of Klaipeda only at Preila (station 2) and at Smiltyne (station 9) was about half as high as at the rest of the stations. In the northern coastal zone it was recorded in abundance at Giruliai (station 10) and along the Palanga–Monciškės stretch (stations 12–15).

In October at the Curonian Spit the density of turbot and flounder juveniles was lower (9.6 and 11.9 respectively per 1000 m^2) (Fig. 4). Their abundance fluctuated within lower limits than in August. The highest density of flounder was recorded at Juodkrante (station 5), and that of turbot at Juodkrante (station 5) and north of Juodkrantė (station 8).

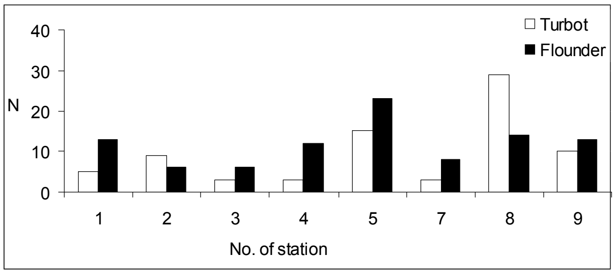

Fig. 4. The density (ind./1000 m^2) of turbot and flounder juveniles at different stations of the Lithuanian coastal zone in October 2005

According to data of the Latvian Fisheries Research Institute, turbot juveniles are recorded in the coastal zone twenty times more rarely than those of flounder (Latvijos…, 1988, cited in Repečka et al., 1995). According to further data (Repečka et al., 1995; Repečka et al., 1996), this difference in density is much smaller: in the Giruliai–Būtingė coastal zone stretch the density of turbot juveniles differs from those of flounder 3–4-fold. In 1996–1997, the difference was higher due to intensive fishing of turbot in the coastal zone (Repečka et al., 2003). Our investigation showed that in 2005 the difference in the density of turbot and flounder juveniles was not great. Flounder juveniles were caught on average 1.4-fold more often than those of flounder, although at some stations turbot individuals were even more abundant. In different stretches of the coastal zone the ratio between these fish species was not the same. If in the Giruliai–Būtingė stretch flounders were caught 2.1-fold more often than turbots, at the Curonian Spit the ratio between turbot and flounder catches was almost the same – 1:1.1.

In fish communities of the North Sea coastal zone, as distinct from the Baltic Sea, flounder and turbot do not play a significant role. During the summer–autumn period, density of flounder in the coastal zone varied from 0.3 to 0.07 ind./1000 m^2. Turbot density was even lower – approximately 0.06 ind./1000 m^2 (Amara, 2003). The most common flatfishes in the North Sea are sole (*Solea solea*), dab (*Limanda limanda*) and plaice (*Pleu-*

ronectes platessa) (Daan et al., 1990). They constitute about 29% of the total fish catch in the coastal zone. Their density varies with seasons, amounting to 1.71–11.98, 0.6–10.18 and 2.89–27.61 ind./1000m^2 respectively (Amara, 2003).

Size-age structure of flatfishes

The majority of young-of-the-year turbot and flounder as well as 1+year-old fish recuperate at the depth of 2 m. Meanwhile, 2+year-old and elder fish keep to greater depths and therefore are not abundant in beach seine catches (Витиньш, 1989). In the current investigation, young-of-the-year fish made up the major part of flatfish catches (YOY flounder made up 77.9% of catches in August and 77.9% in October. YOY turbot constituted 99% and 74% of catches respectively). 1+year-old fish made up from 1 to 24.7% of catches. Of all the fish caught with a beach seine, only a 19.3 cm long, 3+year-old flounder individual was mature.

The body length of the caught turbot varied from 2 to 15.1 cm and that of flounder within the limits 2.6–19.3 cm. In August, 3–5.9 cm long fish constituted the major part of turbot juveniles (82.6%). In autumn, the body length of YOY fish increased on average by 2.1 cm. Fish with the body length of 5–7.9 cm made up the bulk of catches – 66.7% (Fig. 5).

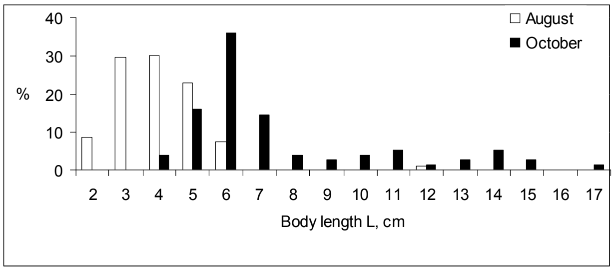

Fig. 5. Body length structure of turbot

YOY fish also made up the bulk of flounder catches. In August, fish with the body length of 3–5.9 cm constituted 71.1% of hauls, and in October 85.7% of catches were made up by 4–6.9 cm long fish (Fig. 6). In autumn, the body length of the YOY fish was longer by 0.9 cm on average in comparison with that in summer.

The smallest caught YOY turbot measured hardly 2 cm in length and the body length of YOY flounder was 2.6 cm, the mean body length being the same – 4.3 cm (Table 2). YOY turbot starts feeding on other fish juveniles (Stankus, 2003), while flounder juveniles stick to benthic organisms (Bubinas, Ložys, 2000). As a result, in October the body length of turbot individuals was already longer by 1.2 cm than that of flounder juveniles. The length of 1+year-old fish differed even more due to differences in the diet (Table 2).

Decisive factors of flatfish distribution in the coastal zone

Various biotic and abiotic factors affect the abundance of flatfish juveniles in the coastal zone: salinity (Bos, 2000), water temperature (Витиньш, 1989; Gibson, 1994; Piščikas, 2000), ground structure (Витиньш, 1989; Sparrevohn, Støttrup, 2003), depth (Piščikas, 2000; Støttrup et al., 2002), feeding objects (Шапошникова, 1964; Gibson, 1994), commercial fishery intensity (Repečka et al., 2003). Our investigation confirmed the influence of some factors on the distribution of turbot and flounder individuals in the coastal zone.

The density of flounder in the coastal zone did not coincide with that of turbot. This fact can be accounted for by the different abundance of potential feeding objects at various stations.

The significant relation between the density of turbot and Baltic sprats (in August) and that of turbot and sand gobies (in October) as well as the correlation between the amount of flounder and algae in a beach seine (Table 3) can be explained by differences in the diet of these fish. The index of their diet homogeneity is only 5.6% (Kostrzewska-Szlakowska & Szlakowski, 1990).

Flounders are typical benthophages. Their juveniles mainly feed on molluscs and crustaceans (Bubinas, Vaitonis, 2003). It was proved by visual assessment of algal

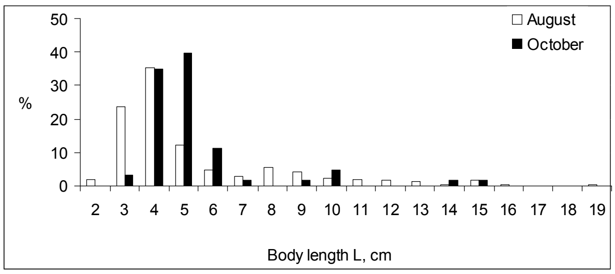

Fig. 6. Body length structure of flounder

Table 2. **Age structure of turbot and flounder**

Age	Turbot						Flounder					
	August			October			August			October		
	mean ± SE	%	n	mean ± SE	%	n	mean ± SE	%	n	mean ± SE	%	n
0+	4.3 ± 0.078	99	194	6.4 ± 0.129	75.0	57	4.3 ± 0.058	77.9	205	5.2 ± 0.101	90.5	57
1+	12.1 ± 0.071	1	2	12.7 ± 0.449	24.7	19	9.2 ± 0.208	17.5	46	10.2 ± 0.324	6.3	4
2+	–	–	–	17.2	1.3	1	14.1 ± 0.392	3.8	10	14.7 ± 0.600	3.2	2
3+	–	–	–	–	–	–	17.8 ± 1.550	0.8	2	–	–	–

Table 3. **Correlation between flatfish abundance in the coastal zone and various factors**

Factor	Abundance of flounder		Abundance of turbot	
	August	October	August	October
Abundance of flounder	–	–	NS	NS
Abundance of sand goby	–	NS	–	*
Abundance of Baltic sprat	NS	–	**	–
Wash of algae	**	**	NS	NS
Temperature	NS	NS	***	*
Depth	*	**	**	*

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; NS – $p > 0.05$ (not significant).

deposit that it was rich in nectobenthic crustaceans – potential feeding objects for flounder.

The diet composition of turbot juveniles is entirely different. Sand gobies and Baltic sprats play an important role in the diet of YOY turbot (Stankus, 2003).

A significant negative correlation was established between the abundance of flatfish juveniles and depth because the majority of them, young-of-the-year fish and 1+year-old fish in particular, keep to the depth of 1–2 m. The greatest numbers of juveniles were caught in shallow, up to 1 m deep bays (station 7). The least catches of flatfish juveniles were at deep (over 2 m) stations (station 11).

No correlation was established between salinity and flatfish abundance. Several flatfish species dwell in waters of the coastal zone with a low salinity, but it is only juveniles of flounder that can dwell in fresh water (Bos, 2000). They are often fished up in the Curonian Lagoon and in river mouths (Virbickas, 2000). Turbots do not favour freshened water so much, but even they have acclimatized to the relatively fresh water of the Baltic Sea and spawn there successfully (Iglesias et al., 2003).

Catches of turbot juveniles were especially abundant at Giruliai where salinity amounted to 4.3% only. However, water temperature at this station was high (22° C). It must be this factor that has determined great density of turbot juveniles at this station.

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Svajūnas Stankus

OTO (*PSETTA MAXIMA*) IR UPINĖS PLEKŠNĖS (*PLATICHTHYS FLESUS TRACHURUS* DUNCKER) JAUNIKLIŲ VAIDMUO BALTIJOS JŪROS LIETUVOS PRIEKRANTĖS ŽUVŲ BENDRIJOSE

S a n t r a u k a

Upinių plekšnių ir otų gausumas tirtas 2005 m. rugpjūtį 17-oje stočių, kurios buvo išdėstytos visoje Lietuvos priekrantėje, ir spalį 8-e stotyse, išdėstytose ties Kuršių Nerija. Laimikiuose pagal aptinkamumo dažnį vyravo upinės plekšnės ir otai, nors pagal gausumą rugpjūtį – bretlingio ir stintos jaunikliai, spalį – mažieji tobiai. Nustatyti otų ir upinių plekšnių jauniklių paplitimą bei gausumą priekrantėje lemiantys veiksniai. Ištirta šių žuvų matmeninė ir amžiaus struktūra.

Raktažodžiai: otas, upinė plekšnė, jaunikliai, Baltijos jūra, Lietuva