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ON THE ECOLOGY OF SEBASTES MARINUS L. OF WEST GREENLAND

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The Soviet Union started investigations in the area of West Greenland in 1957 where great attention was paid to Sebastes marinus L. The purpose of this paper is to give an account of the results of the treatment of data sampled by the scientists of the Polar Research Institute from scouting vessels in 1957-61.

The West Greenland waters form the northern limit of the distribution of Sebastes marinus L. in the North-West Atlantic. Sebastes marinus L. is the predominant species here. Sebastes mentella Travin is scarce here and occurs mainly in the southern parts of the area.

The biology of Sebastes marinus L. of West Greenland has not been studied thoroughly. The life cycle of Sebastes marinus L. is not known sufficiently. The greatest part of the data about Sebastes marinus L. deals with the distribution of their larvae and the young taken in fiords. Little attention was paid to the way of living of adult Sebastes marinus L. on the bank slopes.

Material methods. Our investigations covered a great part of the West Greenland fishing region from Cape Farewell to Disko Island. Samples for age and length determination (males and females separately), and for field examination of stomachs were taken.

Table I

The number of Sebastes marinus L. measured

Subdivisions	Year					
	1957	1958	1959	1960	1961	Total
1 B					214	214
1 C		17,369	27,106	9,533	24,534	78,551
1 D	3,934	4,598	6,533	3,228	2,200	20,493
1 E		5,996	11,789	1,877	1,882	21,544
1 F					1,444	1,444
Total	3,934	27,963	45,428	14,638	30,283	122,246

Size composition. The analysis of the size composition data by months shows that Sebastes marinus L. of 30-50 cm occur on bank slopes of the whole area investigated (Fig.1). Fish under 30 cm occurred more seldom. In some cases Sebastes marinus L. of more than 50 cm constituted the essential part of catches. As a rule the average size of males and females was the same. The size range of Sebastes marinus L. in the catches varies in some subareas. These variations can be seen from the annual size ranges of 1959 and 1961 (Table 2).

From 1 C to 1 F the number of small Sebastes marinus L. (40 cm) decreases and the share of larger fish (41-50 cm) increases.

Table 2.

Size composition of Sebastes marinus L. (per cent).

	1959			1961			
Length of fish	1 C	1 D	1 E	1 C	1 D	1 E	1 F
30	4.6	1.3	0.6	9.7	5.3		0.4
31-40	41.3	32.4	23.9	62.6	49.9	46.5	17.9
41-50	47.2	59.0	72.9	25.9	38.4	52.5	78.1
51-60	5.1	4.8	2.1	1.6	3.5	0.7	2.8
60	1.8	2.5	0.5	0.2	2.5		0.8
n	27,106	6,533	11,789	24,543	2,200	1,882	1,444

The occurrence of great number of Sebastes marinus L. under 41 cm in Subarea 1 C (north-western slopes of the Banan Bank can be explained by the fact that Sebastes marinus L. with the length from 5 to 40 cm, fish of 10-25 cm prevailing (Fig.2), inhabit, according to Hansen's data, fiords of Godthaab and Julianehaab. Sebastes marinus L. of more than 40 cm were rarely found. In the course of several years the size composition of Sebastes marinus L. remained practically unchanged in both the fiords. It may be presumed that as Sebastes marinus L. grow they leave fiords for the slopes of the neighbouring banks. The young are transported to the fiords by currents from the Denmark Strait.

The fact that Sebastes marinus L. occur at depths of more than 500 m is a peculiarity of their distribution off West Greenland. There are cases when commercial catches of Sebastes marinus L. were taken at the depth of 350-450 m whereas in some

other regions (the Barents Sea, Labrador, Newfoundland) only individual specimens occur at such depths. It was found that the size of Sebastes marinus L. increases with the depth. In November 1959 the average size of Sebastes marinus L. on the northern and north-western slopes of the Banan Bank was 33.3 cm at the depth of 85 m, 38.3 cm - at 100-200 m, 50.7 cm - at 200-300 m (Fig. 7). In May 1960 in the same region the average size of Sebastes marinus L. was 37.1 cm at the depth of 100-200 m, 40.3 cm at 200-300 m, 54.7 cm - at 300-400 m, 58.0 cm - at 400-500 m.

Age composition. Sebastes marinus L. catches on the slopes of banks in 1960-61 included 6-39 years-old fish, with 16-21 year-olds predominating. Using the data of 1959 v.I. Travin found that in Subarea 1 C younger Sebastes marinus L. (15-18 years old) prevailed as compared with Subarea 1 D and 1 E (17-20 years old). According to Hansen's data the younger stages of Sebastes marinus L. inhabit fiords (Table 4).

Table 4.

The growth rate of Sebastes marinus L. in the fiord of Godthaab (Hansen)

Age	2	3	4	5	6	7	8	9	10	11
Length of fish (cm)	8.3	10.5	13.7	16.5	19.5	22.2	24.8	26.4	28.0	30.2
Length increment		2.2	3.2	2.8	3.0	2.7	2.6	1.6	1.6	2.2

Table 5 gives mean weights of Sebastes marinus L. males and females of various sizes.

When Sebastes marinus L. reaches 40 cm in length its weight equal 1 kg and when it is 50 cm its weight doubles.

Table 3.

Age composition of Sebastes marinus L. in the subarea of West Greenland in 1960-61 (per cent)

	Subareas			
Age of fish	1 C	1 C	1 D	1 E
	1960 V	1961 IV,X	1960 IV	1960 IV-V
1	2	3	4	5

1	2	3	4	5
6		1		
7		6		
8		30		
9		56		
10		29		
11		35	3	
12		41		
13		33	5	5
14	7	58	22	25
15	47	79	54	37
16	93	117	94	129
17	100	147	169	154
18	153	107	140	70
19	198	91	142	70
20	187	67	113	51
21	93	46	94	37
22	53	22	62	61
23	20	11	48	37
24	27	10	16	35
25	13	6	13	45
26	7	2	8	58
27	7	2	3	53
28		1	5	18
29		1	5	29
30		1	-	22
31			-	26
32			-	8
33			-	13
34			3	13
35				
36				
37				
38				
39				3
Average age	19.1	16.1	18.9	22.3

Table 5

Mean weight of Sebastes marinus (gramm)

Length of fish	Mean weight	n	Mean weight	n
	males		females	
25-26	300	2	341	9
27-28	424	13	369	22
29-30	479	13	476	22
31-32	571	25	604	11
33-34	648	29	633	20
35-36	783	29	771	39
37-38	911	109	835	97
39-40	972	145	1,027	123
41-42	1,189	149	1,178	111
43-44	1,316	130	1,318	115
45-46	1,463	122	1,508	110
47-48	1,673	53	1,733	15
49-50	1,838	15	1,905	17
51-52	2,005	7	2,275	8
53-54	2,366	6	2,278	13
55-56	2,450	4	2,740	9
57-58	2,833	9	3,028	12
59-60	3,220	22	3,193	19
61-62	3,600	7	3,437	8
63-64	3,913	8	3,898	14
65-66	4,030	3	3,940	5
67-68	5,100	2	5,325	10
69-70	6,166	4	4,925	5
71-72	5,500	1		

Feeding. Very little is known about the feeding habits of Sebastes marinus L. in the West Greenland area. According to Boldovsky's data, borrowed from Jonsson, capelin and shrimps were the main food items of Sebastes marinus L. Grenadier and halibut were also found.

The feeding of Sebastes marinus L. was analysed according to the three types of data:

1. Frequency of occurrence of food organisms (per cent from the number of fish with full stomachs).
2. The percentage of fish with empty stomachs.
3. The average degree of fullness (from the number of fish with full stomachs).

In spring (April-June) the feeding of Sebastes marinus L. was not intensive Euphausiidae (Fig. 4) being their main food item.

In June 1958 shrimps and fish were predominant in the stomachs. In May 1960 only cod intestines were found but the majority of Sebastes marinus L. caught in that season had empty stomachs (Table 6) with the exception of April-May 1961, when less than half of the examined Sebastes marinus L. had empty stomachs. The average degree of fullness was comparatively high. (Table 6).

In summer (July-September) the feeding of Sebastes marinus L. was at its highest level. The number of food items increased due to shrimps, ctenophore, squids. Together with Euphausiidae they camprised the main food for Sebastes marinus L. in that period.

In August 1957 Sebastes marinus L. fed mainly on sand-eel, but in 1958 some other fish and shrimps were dominant.

The percentage of fish with empty stomachs was mush lower than that in the previous months. In summer the nutrition factor in Sebastes marinus L. was higher than in springtime. This is shown by the higher degree of stomach fullness.

In November - December Euphausiidae were predominant. Less than half of the examined Sebastes marinus L. had empty stomachs. The average degree of stomach fullness was somewhat lower as compared with the summer months data.

Reproduction. The majority of scientists suggested the probability of spawning of Sebastes marinus L. near West Greenland because of the abundance of their larvae in this area. Most likely, in case spawning takes place near West Greenland, females with maturing ovaries and developing embryos can be taken. Yet, it has been confirmed only by Hansen who caught two females in pre-spawning stage in June 1947 in the fiord of Godthaab. This fact and an amount of young Sebastes marinus L. in fiords induced Hansen to state that Sebastes marinus L. started spawning in Davis Strait and in the fiords of South-West Greenland.

Our investigations into the condition of Sebastes marinus L. ovaries throughout the period of exploration near West Greenland indicated that in all the subareas, in various seasons of the year, the ovaries of all the females examined (over 5000 specimens) looked alike: small-sized, of a yellow-orange colour with a thin, almost transparent pellicle. Even females of 50-70 cm had ovaries of only 1-2 cm in diameter. Through the pellicle small eggs of nearly 0,1 mm in diameter each could be seen. Such a structure of ovaries is typical of immature females of Sebastes

Table 6.

The average degree of stomach fullness and percentage of fish with empty stomachs

Month	1957			1958			1959			1960			1961		
	Index	empty	n	index	empty	n	index	empty	n	index	empty	n	index	empty	n
IV					100.0	26	1.68	91.2	696	2.08	68.2	791	2.14	37.5	778
V				1.84	93.5	184		100.0	90	1.78	94.4	466	1.67	54.0	445
VI				1.33	87.6	97	2.14	84.1	377						
VII					100.0	18	1.74	48.5	407						
VIII	1.47	7.3	137	1.12	34.2	38	2.47	46.3	382						
IX				1.49	51.0	90	2.25	43.0	222		1.93	48.0			148
X											1.26	28.1			324
XI							1.36	47.0	118						
XII	1.00	42.0	95								1.31	86.0			110

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marinus L. in the Barents Sea. The males of Sebastes marinus L. of more than 45 cm in length were in stages either close to mating (4), or in the stage of mating (5), or in the post-mating stage (6). At stage 5 the tests were white and bulky; milt ran when they were cut. The structure of testes indicates than the fish were mature.

The maturity coefficient of West Greenland Sebastes marinus L. females in April - May when the ovaries of Sebastes marinus L. in the Barents Sea reach the greatest weight is almost 50 times as low as that of the Barents Sea Sebastes marinus L. (Table 7). In this respect the West Greenland Sebastes marinus L. females stand closer to the immature Sebastes marinus L. of the Barents Sea whose maturity coefficient is 0.26 (according to V.P. Sorokin's data).

Table 7.

The maturity coefficient of Sebastes marinus females

Region	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
West Greenland				0.25	0.20				0.34			
The Barents Sea				I3	33				2			
Sorokin, 1958	4,7 2	7.1 12	11.3 12	11.3 2	-	0.5 12	1.2 12	-	2.3 2	2.1 8	3.6 18	4.2 35

It is difficult to determine whether males of Sebastes marinus L. are mature enough for mating since the weight of testes in the period of developing increases but inconsiderably. Histological cuts of testes at stage 4 (close to mating) indicated the presence of spermatozoa inside the ducts of testes. The structure of bladder serves as an indirect indication of males for mating. It is supposed (Magnusson) that when a male is getting mature the bladder produces secretin to dissolve the sperm. It was found that the males of Sebastes marinus L. of

West Greenland in stage 4 and especially 5 have their bladders expanded to the size of a hen's egg. It may be stated that in autumn in the West Greenland area adult males of Sebastes marinus are mature for mating.

As we know the mature males and females of Sebastes marinus L. are geographically more or less dissociated in certain seasons of the year (Sorokin V.P., Magnusson). The unisexual stocks of mature Sebastes marinus L. join only during the period of mating. The sex ratio remains 1 : 1. The data on the West Greenland Sebastes marinus L. showed that from April to December the sex ratio in the catches was always close to 1 : 1 (Table 2). The constant sex ratio indicates that the separation of sexes has not been observed in this area.

The outward appearance of ovaries, maturity coefficient and the sex ratio indicate that Sebastes marinus L. females and immature specimens are much alike. The occurrence of mature males confirm the fact that mating does take place near West Greenland. The absence of females with maturing ovaries and developing embryos in catches of various seasons of the year allows us to believe that shedding of larvae in the area investigated has not taken place in recent years.

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Year	1957				1958				1959			
Subdivision	1 D		1 C		1 D		1 E		1 C		1 D	
Month	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
April			51.7	48.3	45.0	55.0			56.5	43.5	52.5	47.5
May			58.4	41.6			68.3	31.7			47.9	52.1
June			61.5	38.5					47.8	52.2	54.3	45.7
July			51.2	48.8					38.6	61.4	63.4	38.6
August	3.3	68.7	53.1	46.9	52.2	47.8			56.8	43.2	58.6	41.4
September							53.7	46.3	54.0	46.0		
October												
November									52.2	47.8		
December												

Table 8.

1960								1961							
1 A		1 C		1 D		1 A		1 C		1 D		1 A		1 F	
♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
50.6	49.4	49.5	50.5	48.6	51.4	51.9	48.1	45.4	54.6	34.3	65.7				
		52.3	47.5			49.8	50.2	48.1	51.9						
57.0	43.0							57.8	42.2	49.8	50.2			56.0	44.0
								45.4	54.6	50.6	49.4	53.1	46.9		
50.5	49.5														
										49.2	50.8	55.7	44.3		

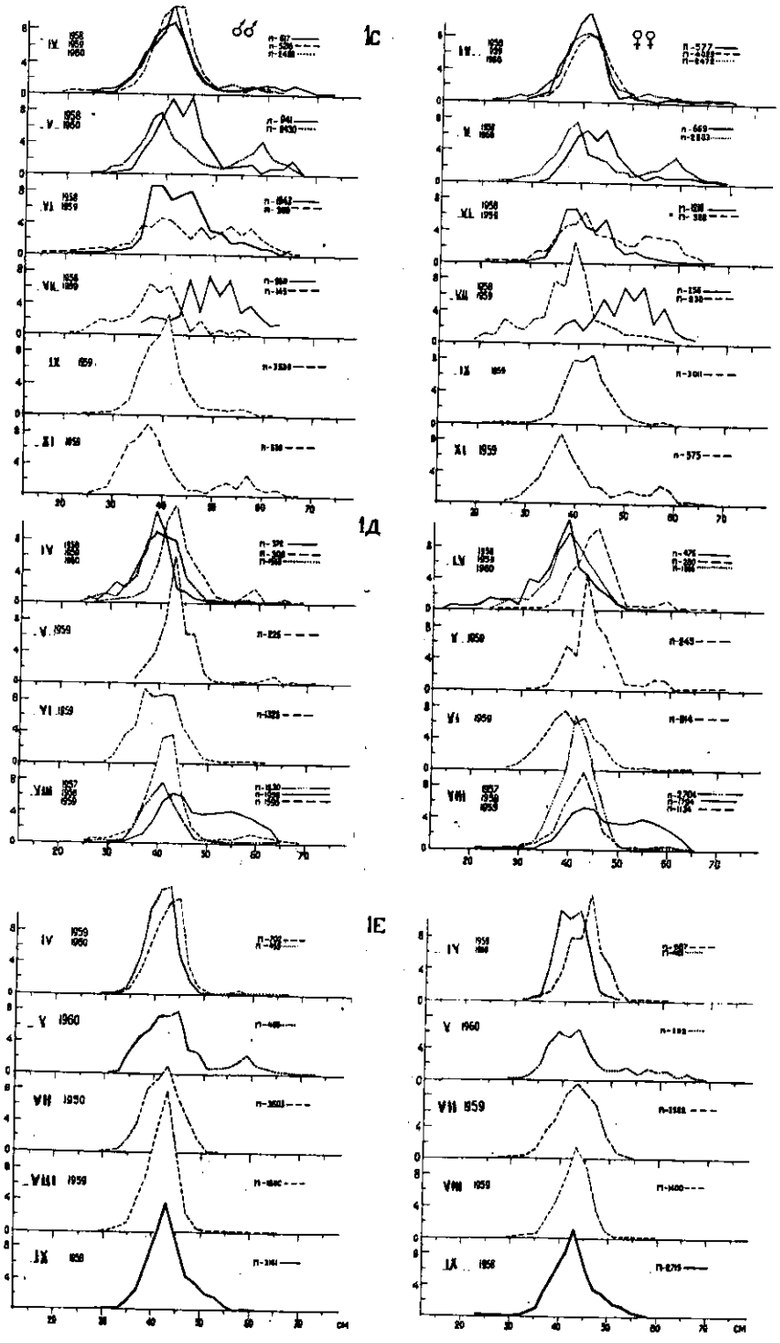

Fig. I. Size composition of Sebastes marinus L. in commercial catches.

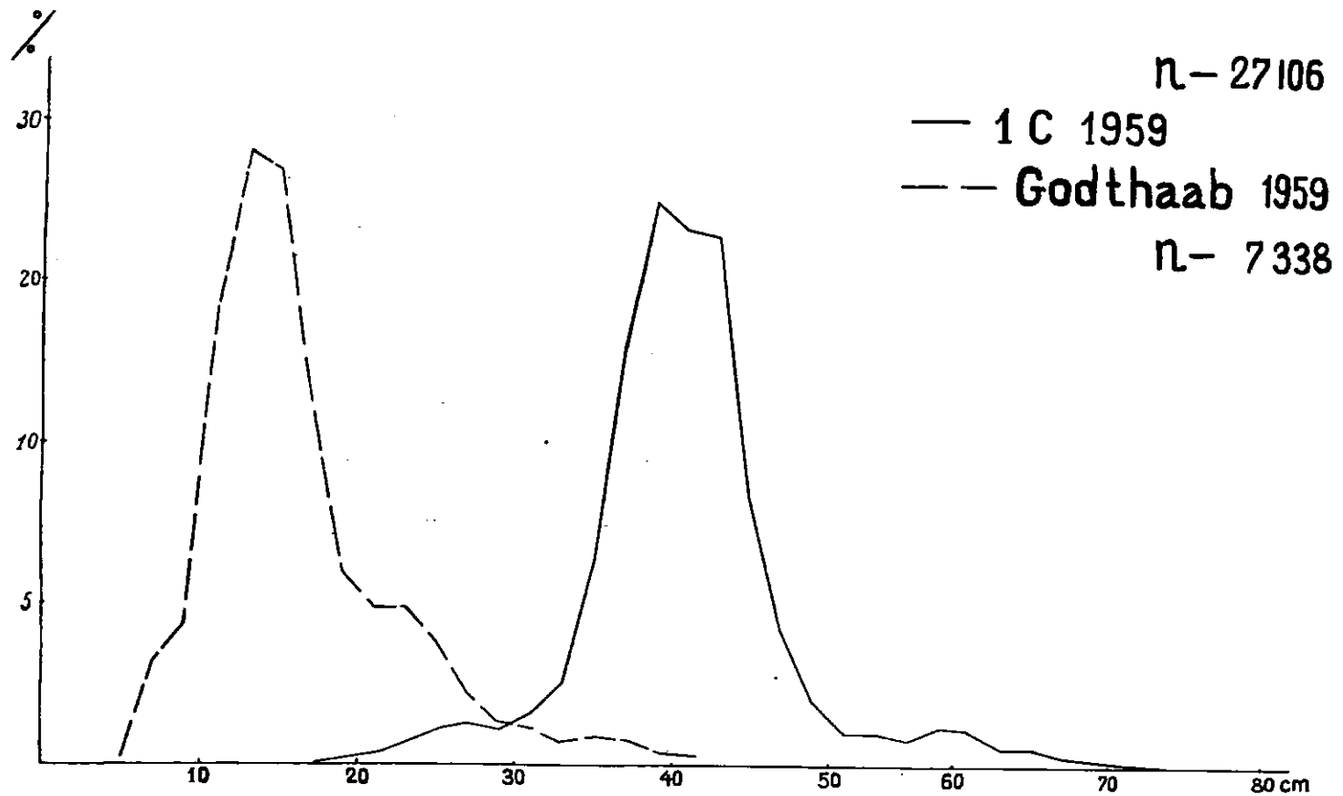

Fig. 2. Size grades of Sebastes marinus. A comparing of size composition of Sebastes marinus L. in fiords and at the slopes of the grounds.

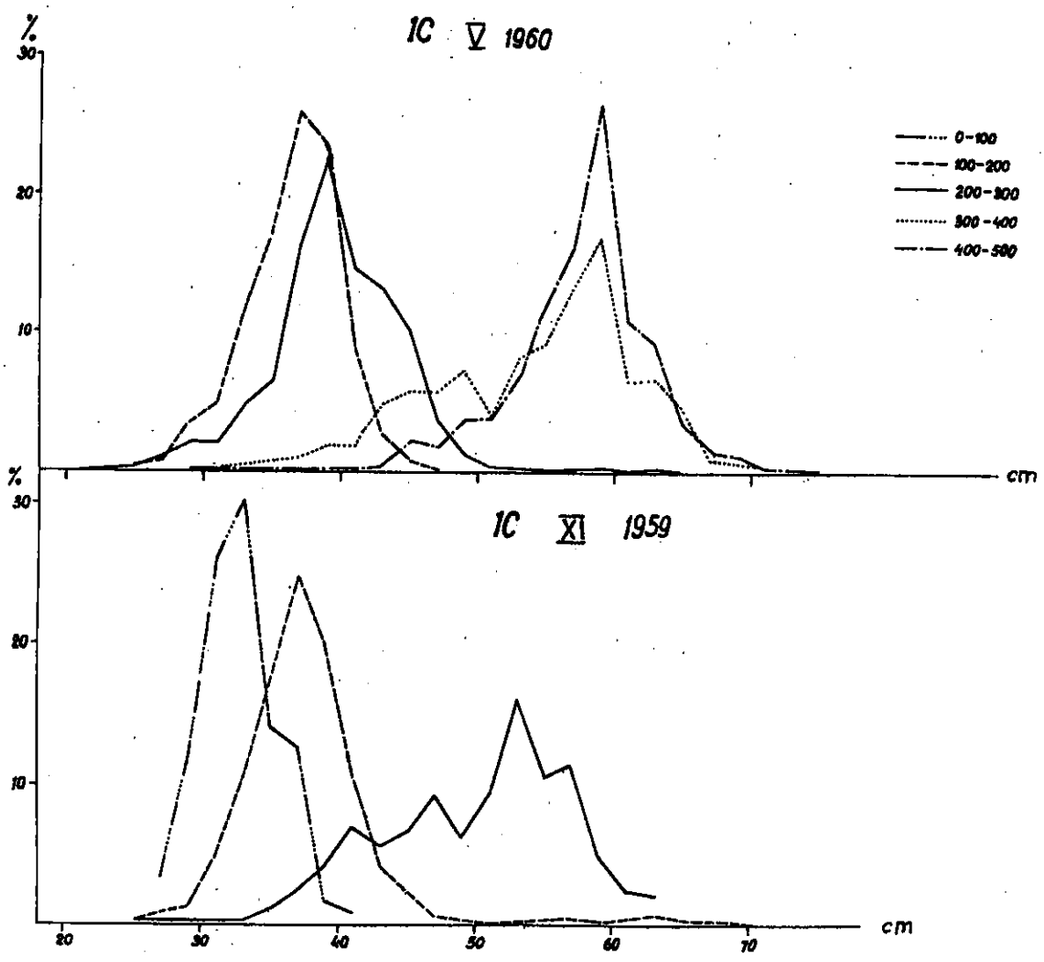

Fig. 3. Size composition of Sebastes marinus L. at different depths of slops of the ground Banan.

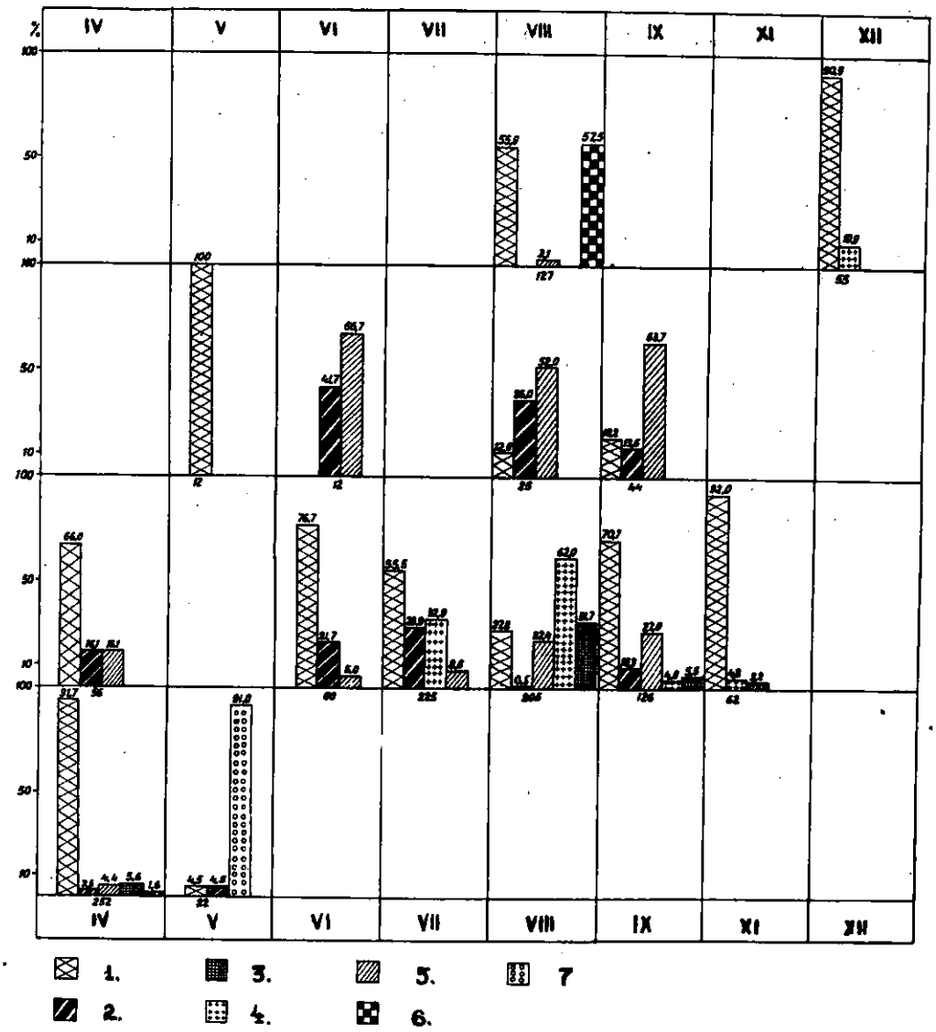

Fig. 4. Seasonal and annual changes of qualitative food composition for Sebastes marinus L. (the number of cases with this or that kind of food per cent). Figure under the diagrames - the number of full stomachs examined. I - Euphausiid ; 2- shrimp; 3 - anchovy ; 4 - plankton ; 5 - other fish ; 6 - sandeel ; 7 - varia.