FISHERIES RESEARCH BOARD OF CANADA

Translation Series No. 1539

Feeding habits and food relations of benthos-eating fish in the Gulf of Riga (from "Problems of commercial hydrobiology")

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Original title: Pitanie i pishchevye otnosheniya bentosoyadnykh rub Rizhskogo zaliva ("Problemy Promyslovoi Gidrobiologii").

From: Trudy Vsesoyúznogo Nauchno-Issledovatel'skogo Instituta Morskogo Rybnogo Khozyaistva i Okeanografii (VNIRO) (Proceedings of the All-Union Scientific Research Institute of Marine Fisheries and Oceanography. Publ. by: Pishchevaya Promyshlennost, Moscow, 65 : 326-336, 1969.

Translated by the Translation Bureau(MS)
Foreign Languages Division
Department of the Secretary of State of Canada

Fisheries Research Board of Canada
Halifax Laboratory, Halifax, N.S.
Marine Ecology Laboratory, Dartmouth, N.S.

1970

20 pages typescript

FRB 1539

DEPARTMENT OF THE SECRETARY OF STATE
TRANSLATION BUREAU

FOREIGN LANGUAGES DIVISION

CANADA

SECRÉTARIAT D'ÉTAT
BUREAU DES TRADUCTIONS

DIVISION DES LANGUES ÉTRANGÈRES

TRANSLATED FROM – TRADUCTION DE	INTO – EN
Russian	English

AUTHOR – AUTEUR

Kostrichkina, E.M.

TITLE IN ENGLISH – TITRE ANGLAIS

Feeding habits and food relations of benthos-eating fish in the Gulf of Riga (from "Problems of Commercial hydrobiology").

Title in foreign language (transliterate foreign characters)

Pitanie i pishchevye otnoshenifya bentosoyadnykh rub Rizhskogo zaliva (Problemy promyslovoi gidrobiologii).

REFERENCE IN FOREIGN LANGUAGE (NAME OF BOOK OR PUBLICATION) IN FULL. TRANSLITERATE FOREIGN CHARACTERS.
RÉFÉRENCE EN LANGUE ÉTRANGÈRE (NOM DU LIVRE OU PUBLICATION), AU COMPLET. TRANSCRIRE EN CARACTÈRES PHONÉTIQUES.

Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Morskogo Rybnogo Khozyaistva i Okeanografii (VNIRO).

REFERENCE IN ENGLISH – RÉFÉRENCE EN ANGLAIS

Proceedings of the All-Union Scientific-Research Institute of Marine Fisheries and Oceanography (VNIGO).

PUBLISHER – ÉDITEUR	DATE OF PUBLICATION / DATE DE PUBLICATION			PAGE NUMBERS IN ORIGINAL / NUMÉROS DES PAGES DANS L'ORIGINAL
Pishchevaya Promyshlennost	YEAR / ANNÉE	VOLUME	ISSUE NO. / NUMÉRO	326-336
PLACE OF PUBLICATION / LIEU DE PUBLICATION				NUMBER OF TYPED PAGES / NOMBRE DE PAGES DACTYLOGRAPHIÉES
Moscow	1969	65		20

REQUESTING DEPARTMENT / MINISTÈRE-CLIENT: Fisheries & Forestry

TRANSLATION BUREAU NO. / NOTRE DOSSIER N°: 1244

BRANCH OR DIVISION / DIRECTION OU DIVISION: Fisheries Research Board

TRANSLATOR (INITIALS) / TRADUCTEUR (INITIALES): M.S.

PERSON REQUESTING / DEMANDÉ PAR: Dr. M.S. Mounib, Halifax Laboratory Halifax, N.S.

DATE COMPLETED / ACHEVÉ LE: SEP - 9 1970

YOUR NUMBER / VOTRE DOSSIER N°: 769-18-14

DATE OF REQUEST / DATE DE LA DEMANDE: 15.5.1970

UNEDITED DRAFT TRANSLATION
Only for information
TRADUCTION NON REVISÉE
Information seulement

SOS-200-10-6 (REV. 2/68)

CLIENT'S NO. / Nº DU CLIENT	DEPARTMENT / MINISTÈRE	DIVISION/BRANCH / DIVISION/DIRECTION	CITY / VILLE
769-18-14	Fisheries & Forestry	Fisheries Research Board	Halifax, N.S.
BUREAU NO. / Nº DU BUREAU	**LANGUAGE / LANGUE**	**TRANSLATOR (INITIALS) / TRADUCTEUR (INITIALES)**	**DATE**
1244	Russian	M.S.	SEP - 9 1970

FEEDING HABITS AND FOOD RELATIONS OF BENTHOS-EATING FISH IN THE GULF OF RIGA.

Data is available in the literature on the feeding habits of certain types of fish in the Gulf of Riga (Zheltenkova, 1954; Shurin, 1957; Kostrichkina, 1962, 1964; Shchukina, 1962; Erm, 1963). However, there is little data on their feeding relations. The aim of our investigation was to determine the mechanism of feeding of benthos-eating fish and their food relations, and to clarify their utilization of the available food.

We collected data on the feeding habits of benthos-eating fish during 1960-1964 in various regions of the Gulf of Riga. A total of 4800 digestive tracts were analyzed using standard methods (Manual, 1961). Data on the available food was kindly provided by A.T. Shurin, while information on the distribution of fish was taken from V.S. Tanasiichuk's data and augmented by us.

The four-pronged goby Myoxocephalus quadricornis L is a typical benthos-eating bottom dwelling fish which lives mainly in the deep zones of the Gulf and does not carry out extensive migrations.

The weight of food in their stomachs as a percent of bodyweight is considerably higher than that of other fish, and very few specimens with empty digestive tracts were encountered. Food of small speciments (14-17 cm) consists primarily of Mysis, while that of larger fish is mainly Mesidothea entotomon. Goby longer than 16-17 cm. eat fish (sprat, eelpout, smelt). The size of food eaten by the goby varies considerably. Thus the length of Mesidothea entomon varies from 10 to 80 mm, while fish food is up to 59% of the length of the goby.

The four-pronged goby has little flexibility in its feeding habits (Kostrichkina, 1964) and the composition of its food is relatively constant. The minor regional and seasonal variations result from varying availability of food. Thus the increased role of sprat in the food of the goby in June and October, 1962, was related to formations of spawning accumulations of sprat. Increased consumption of Mysis in the autumn coincides with the formation of their autumn concentrations. A reduction in nourishment of the goby occurs from the spring to the autumn (Table 1).

During the course of the year goby are basically distributed independently of the location of food, with a direct relationship being observed only in June ($r = +0.62$ at $P = 0.999$). There is no relation between the biomass of the feed benthos and the goby's nourishment during the different seasons. The correlation coefficient between these variables varied from -0.02 to +0.44 in 1962-1964. However there is a strong negative relationship between the average bottom temperature in the gobys' habitat and their isochronous nourishment during the different seasons ($r = -0.94$ at $P > 0.995$). Biologically this can be (328) explained by the fact that the goby belong to the Arctic complex (Mikol'skii, 1947) and increased temperature, evidently, reduces their feeding activity.

Food composition of four-pronged goby of the Gulf of Riga in 1960-1964 (in wt. %). Table 1 Таблица 1

Состав пищи четырехрогих бычков Рижского залива в 1960—1964 гг. (в % по весу)

Кормовые объекты / Items of food.	1960 1960 г. VI, VII	1960 X	1961 III, IV	1961 VI, VII	1961 XI	1962 VI	1962 VII	1962 VIII—IX	1962 IX—X	1963 VII	1963 X—XI	1964 V
Mesidothea entomon	70,16	70,02	90,20	79,80	88,48	79,58	83,82	87,26	79,69	93,69	83,88	94,88
Pontoporeia femorata	0,48	1,85	—	0,42	0,06	5,85	1,30	—	3,34	0,19	0,05	0,09
Pontoporeia affinis	0,28	0,10	—	0,03	0,06	—	0,29	0,18	0,20	0,06	0,04	0,06
Gammarus locusta	0,02	—	—	—	0,04	—	—	—	—	—	0,01	0,02
Mysis oculata v. relicta	—	—	—	6,34	5,70	0,07	2,47	10,44	7,80	0,99	8,78	0,10
Mysis mixta	2,47	20,70	1,97	—	0,04	—	—	0,53	0,32	0,17	0,04	0,01
Neomysis vulgaris	—	—	—	—	—	—	—	—	—	0,10	0,02	+
Macoma baltica	—	—	—	0,23	—	—	—	—	—	—	0,01	—
Салака. Sprat	—	—	—	—	—	13,71	5,31	1,22	7,26	3,49	2,42	2,86
Корюшка Smelt	—	—	—	—	—	—	0,31	—	—	—	—	0,08
Бельдюга Eelpout	—	—	—	—	—	—	5,62	—	—	0,27	—	—
Малый бычок Small goby	—	—	—	—	—	0,40	—	0,05	—	—	—	0,08
Трехиглая колюшка (Three-spine stickleback)	—	—	—	—	—	—	—	—	—	0,76	—	—
Неопределенные виды рыб Undetermined types of fish	25,90	6,41	4,75	12,85	5,38	0,34	0,87	0,22	0,98	0,02	1,89	0,12
Прочие Miscellaneous	0,69	0,91	1,40	0,33	0,27	0,05	0,01	0,01	0,41	0,26	0,04	0,08
Общий индекс, ‰ Total index	302,0	300,0	361,0	187,0	148,2	228,2	149,5	184,2	154,4	292,6	156,9	339,2
Число исследованных рыб, шт. Number of fish investigated, units.	40	35	55	56	60	60	120	147	172	113	149	152

Smelt Osmerus eperlanus L can be classified as pelagic bottom dwelling fish by their way of life and are widely distributed in the Gulf of Riga. Smelt feed on various crustaceans and fish in the Baltic Sea and its gulfs. Worms and shell fish are absent from their food (Shevcheniya cited by Berg, 1940; Kublitskas, 1963; Kostrichkina, 1964, et.al.).

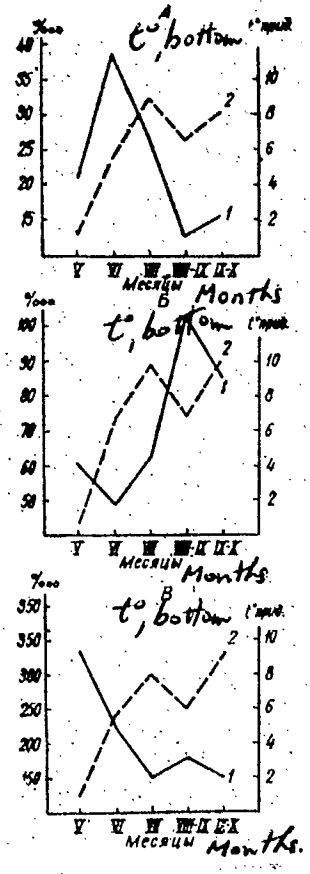
The most important items in the food of smelt of the Gulf of Riga are various forms of Mysis, especially Mysis oculta v. relicta and M. mixta, and sometimes Pontoporeia (Table 2). Benthonic organisms are first found in the food when the smelt are 6.0 - 6.5 cm. long. Specimens 9-10 cm. long already eat nektobenthos. Fish (eelpout, sprat, small goby) are found in the food of medium and large specimens more than 13-14 cm. long.

The diet of smelt in different regions consists of various foods since smelt is very flexible in its feeding habits and when one food is not available can switch to another (Kostrichkina, 1964).

The nourishment of smelt increases from the spring to the autumn with some reduction being observed during the summer months (see Table 2). The increased weights of food in stomachs as % of body weight are normally related to the higher percentage of Mysis in the feed. It has been established that during the autumn and winter Mysis concentrate in the deep areas of the Gulf and spread out over the entire Gulf in the spring. They are widely dispersed in the summer (Chekhova, 1961). Study of the number of Mysis caught by our auxiliary trawl net, which was attached to the upper frame of the bottom trawl net, confirmed this data. All this indicates that the variations in feeding rate of the smelt are, to a large extent, dependent on the availability of Mysis.

Smelt, like other school fish, feed intensively in areas where they accumulate. The effect of bottom temperatures, in the areas where smelt

exist, on the variation in feed rate is small (Figure). However T.N.Belyanina (1965) observed a more rapid rate of growth as a result of feeding conditions in warm years. Further study of the biology and feeding habits of these fishes will show whether such a relationship exists for Gulf of Riga smelt.



Seasonal variation of the noutishment index and bottom temperature: A) ellpout, B) smelt; C) four-pronged goby; 1) average weight of food in stomachs as %of body weight, 2) average bottom temperature in the areas of fish habitation.

Eelpout Zoarces viviparus L is widely distributed in the Gulf of Riga, and is found in both shallow and deep areas. It is a bottom-dwelling, benthos-eating fish whose food ration includes 24 components. The main components are:

Pontoporeia affinis, Mesidothea entomon, Macoma baltica, Mysis ocultata v. relicta and small goby-Pomatoshistus minutus. This fish eats the same type of food in the area of the Estonian Islands and in Pyarnusk Bay (Shchukina, 1962).

Food composition of Gulf of Riga smelt in 1960–1964 (in % wt.%). Table 2. Таблица 2

Состав пищи корюшки Рижского залива в 1960—1964 гг. (в % по массе)

Кормовые объекты / Items of food	1960 г. IV, V	1960 г. X	1961 г. I	1961 г. III, IV	1961 г. VIII	1961 г. XI	1962 г. VI	1962 г. VII	1962 г. VIII—IX	1962 г. IX—X	1963 г. VII	1963 г. X—XI	1964 г. V
Mysis oculata v. relicta	—	67,40	79,90	—	10,50	36,29	22,93	50,12	56,62	43,20	57,44	61,58	44,56
Mysis mixta	—	31,93	12,60	70,00	68,40	5,56	13,72	3,71	11,83	15,63	23,47	22,57	13,14
Neomysis vulgaris	—	0,44	—	—	12,80	1,15	6,24	1,02	14,60	10,36	7,02	2,50	7,94
Pontoporeia affinis	2,27	0,13	1,50	8,57	—	3,64	7,53	16,32	1,28	0,54	0,52	0,46	2,84
Pontoporeia femorata	65,70	0,10	6,00	8,57	—	26,83	7,54	—	0,62	11,23	3,86	0,40	5,12
other Amphipoda: Прочие Amphipoda	—	—	—	0,72	0,90	+	4,60	0,27	0,14	0,04	0,13	0,06	4,01
Mesidothea entomon	12,35	—	—	—	—	—	—	—	+	0,24	—	0,18	0,20
Limnocalanus grimaldii	—	—	—	—	—	—	16,47	0,75	0,20	+	2,10	0,64	11,77
other Copepoda, Cladocera: Прочие Copepoda, Cladocera	—	—	—	—	—	—	+	0,64	0,01	—	0,40	+	1,02
Sprat: Салака	—	—	—	—	—	—	8,66	8,03	9,69	2,55	—	—	—
Бельдюга. Eelpout	—	—	—	—	—	—	—	11,43	—	2,40	—	1,25	—
Small goby: Малый бычок	—	—	—	—	7,40	—	9,63	—	4,42	4,47	—	10,36	7,48
undetermined types of fish: Неопределенные виды рыб	12,58	—	—	10,33	—	26,26	0,43	7,71	—	8,90	5,06	—	1,92
miscellaneous: Прочие	—	—	—	—	—	—	—	—	0,59	0,43	—	—	+
Digested residues: Переваренные остатки	7,10	—	—	1,81	—	0,27	2,69	—	—	—	—	—	—
Total index: Общий индекс, ‰	140,2	248,7	77,4	61,4	—	41,3	48,2	63,6	103,3	84,4	36,6	136,7	59,4
Число исследованных рыб, шт. / Number of fish investigated, units	41	40	22	57	43	119	138	98	236	480	129	295	186

The size of objects encountered in the digestive organs of eelpout (330) varies as follows: Mesidothen entomon from 5 to 40 mm, Macoma from 2 to 15 mm, mysis from 10 to 25 mm and Pontoporeia from 1 to 9 mm. Shell fish form a greater portion of the food of large eelpout than of small ones (Shchukina, 1962). Small goby (30-40 mm long) and young eelpout (60-65 mm long) are found in the stomachs of fish with a minimum length of 16.5 cm. Larger specimens eat sprat. Eelpout normally eats whatever food is available since it has a great flexibility in feeding habits (Kostrichkina, 1964).

In spite of the variation in food composition of eelpout throughout the year, its basic food during the entire period of study was Pontoporeia affinis. The quantity of shell fish in the food decreases from the summer to the autumn.

This is a result of the fact that at the beginning of the summer eelpout concentrates in the northwestern sector of the Gulf where shell fish and cray fish form the major part of the bottom fauna. Later eelpout scatters throughout the Gulf and occupies large areas where the bottom fauna consists primarily of crayfish. In addition, the Mysis portion of the feed increases in the autumn when autumn concentrations of Mysis are formed. Worms are found in the eelpout's food only in the summer.

The feeding rate of eelpout also varies regionally and seasonally. The maximum and minimum indices occur in June and August-September, respectively (Table 3). The low feeding rate in August-September is, according to V.S. Tanasiichuk (1963), due to the fertilization of their eggs. During this period a direct relationship between the distribution of (331) eelpout and P.affinis crayfish ($r = +0.72$ at P 0.999) is also observed. This relationship is considerably weaker or totally absent in the other months. There is no definite connection between the degree of nourishment of eelpout and bottom temperature.

Food composition of (in wt. %) the Gulf of Riga during 1961–1964 Table 3 Таблица 3

Состав пищи бельдюги Рижского залива в 1961—1964 гг. (в % по массе)

Items of food / Кормовые объекты	1961 1961 г.			1962 1962 г.			1963 1963 г.		1964 1964 г.
	VI—VIII	XI	VI	VII	VIII—IX	X—XI	VII	X—XI	V
Macoma baltica	19,42	—	28,36	16,12	12,70	1,54	11,79	5,07	0,40
Mytilus edulis	6,28	—	2,91	—	—	—	—	—	—
Pontoporeia affinis	49,51	23,50	52,48	33,47	51,47	36,22	36,06	47,44	—
Pontoporeia femorata	—	—	0,17	9,58	0,65	14,60	4,47	2,02	68,26
Pontoporeia affinis + P. femorata	—	—	0,36	3,55	—	12,43	1,92	—	10,67
Прочие Amphipoda	2,35	—	0,15	—	1,26	—	—	3,95	—
Mesidothea entomon	21,13	—	9,81	31,38	20,93	6,36	22,70	9,49	6,50
Mysis oculata v. relicta	0,12	76,50	+	—	0,62	1,43	2,25	25,84	5,32
Mysis mixta	—	—	+	0,03	1,04	22,27	—	3,30	0,88
Салака	—	—	—	2,80	—	—	7,50	—	—
Бельдюга	—	—	—	2,01	3,15	—	—	—	—
Малый бычок	—	—	—	—	—	4,90	13,02	2,50	—
Остатки рыб	0,41	+	1,39	—	1,29	—	—	—	—
Halicryptus spinulosus	—	—	1,91	0,54	6,21	—	0,29	—	—
Прочие	+	—	2,46	0,18	0,67	0,25	—	0,39	7,97
Общий индекс, ‰	?	3,60	38,24	27,45	12,38	15,73	19,32	15,88	20,91
Число исследованных рыб, шт.	100	6	100	149	132	57	167	166	38

Number of fish investigated, 330 units.

River flounder Pleuronectes plesus trachurus Dunker is a benthonic fish which lives in the coastal areas of the Gulf during the summer and in the open waters during the cold season. Full-grown flounder feeds primarily on shellfish (Mikel'sarr, 1950; Zheltenkova, 1954; Shurin, 1957; Kostrichkina, 1962; Shchukin, 1962 and others). Benthonic organisms, small Amphipoda, are found in the food of the current year's brood, while shellfish occur in the food of two year olds (Mikel'saar, 1950). Older flounder (22-24 cm and longer) feed almost exclusively on shell fish (Zheltenkova, 1954).

The basic components of its food in the Gulf of Riga are: Macoma baltica, Pontoporeia affinis, various Mysidae, and occasionally Mesidothea entomon. In addition they eat fish: sprat, small goby, three-spine stickleback. The size of the various foods found in the digestive tracts of flounder are as follows: Macoma 3-15 mm, Mesidothea 5-47 mm, Pontoporeia 3-12 mm, Mysidae 12-15 mm. In certain cases they can swallow even larger items: 12-13 cm

long sprat were found in the intestines of fish 21 cm long.

The composition of the flounder's food varies depending on its habitat and the related variation in food base, and is a result of its great feeding flexibility (Kostrichkina, 1964). Seasonal changes in the flounder's food, which are the major variations, are caused by its migrations. During the cold season the flounder lives in deep water and feeds on crayfish which are the main constituent of the bottom fauna. In the spring they migrate to the coastal zone, which are basically shell fish areas and become shell fish eaters (Table 4).

коеда (табл. 4).

Seasonal variation of food composition of the Gulf of Riga flounder in 1960-1964 (in wt. %). Таблица 4 Table 4.

Сезонные изменения состава пищи камбалы Рижского залива в 1960—1961 гг.
(в процентах по массе)

Кормовые объекты Items of f.d	Месяц Month		
	IV, V	VII—VIII	IX, XI
Macoma baltica	16,70	83,71	10,13
Poltoporeia affinis	25,59	1,30	49,60
Poltoporeia femorata	25,00	1,31	2,16
Mesidothea entomon	3,36	6,67	13,40
Mysidae	—	—	14,18
Рыба . . . Fish	8,40	0,39	7,80
Прочие . . . others	20,95	6,62	2,73
Общий индекс, ‰ . Total index	131,0	249,9	52,7
Число исследованных рыб, шт. Number of fish investigated, units.	28	63	41

The diet of flounder living in deep waters throughout the year does not experience any sharp changes consisting only of crayfish at all times. For example, in July and November 1963, in the Kolka-Rukhnu region, 98.7 - 97.7% of the food intake of flounder consisted of two types of Pontoporeia at a depth of 30 m.. Pontoporeia femorata was the predominant species found in the intestines in July, while in October it was P. affinis.

Nourishment of the flounder varies with the season (see Table 4). It feeds most intensively during the summer (M.W.Zheltenkova, 1954). (332) Its nourishment varies from year to year. Thus in 1962 and 1963 the average weight of food in stomachs as % of body weight for July-October were 122.8°/000 and 118.0°/000, respectively. This is evidently a result of different temperature conditions during these years. Bottom temperature was 1.3° higher in 1962 than in 1963[1]. This indicates a tendency to better nourishment of the flounder in warm years. It is known that the feeding conditions, along with other factors, have a significant effect on the growth rate of flounder. The direct relationship between the growth rate of the flounder and the temperature conditions during its feeding period established by K.A. Zemskaya (1961) are confirmed by our data.

Vimba vimba vimba L is a transient fish of the Gulf of Riga. Its largest concentrations are observed at the southern and eastern coasts of the Gulf. The coastal zone is its feeding area. There is little published data about the feeding habits of this fish. It is known that in rivers (Nyamunas River) it eats the larvae of hironomids, caddis flies, shell fish and other invertebrae (Kublitskas, 1962). Vimba east crayfish, polychaete and shell fish in the Gulf of Kursk (Kublitskas, 1959, 1963) The main food of vimba in the Gulf of Riga is Macoma baltica, Corophium volutator, Bathyporeia pilosa, Pontoporeia affinis.

A regular variation in the nature and intensity of feeding of vimba is observed during theyear (Table 5). The significance of warm water complex crayfish Corophium and Bathyporeia in the food decreases from summer to autumn

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1. Data of Gidrometsluzhba.

while that of cold water complex crayfish Mesidothea and Pontoporeia increases. This variation is a result of the dynamics of the food base and the migration of the vimba. Vimba use food which is available to them at a given time because of their feeding habit flexibility (Kostrichkina, 1964). It feeds most intensively during the summer (June-July). This is confirmed by the studies of L.I. Spirinova (1960), whose data indicate that 50% of the annual weight gain of the vimba occurs during June-August.

Food relations of fish. Intensified feeding relations between the various fish species occur as a result of their use of the same food. Due to lack of complete data in studying the food relations of benthos-eating fish of the Gulf of Riga, we calculated only the similarity indices of food composition by A.A. Shorygins (1962) method. As an example we will examine the food relations of fish during 1961 (Table 6).

During the spring (April-May) four-pronged goby, smelt and eelpout are the main inhabitants of deepwater areas of the Gulf, while flounder and vimba remain primarily in the shallow waters. The maximum coincidence of feeding grounds[1] (65.5%) at that time was observed for smelt and goby, with flounder and vimba feeding in approximately the same spots. The feeding areas of other fish coincide to a lesser degree (34.5%). There is little similarity between the food of the goby, smelt and eelpout[2], which eat cold water complex crayfish (Mesidothea etomon, Pontoporeia affinis, Pontoporeia famorata, Mysis oculata v. relicta, M. mixta) and fish (see Tables 1, 2, 3, 5). Pronged goby, smelt and, evidently, eelpout[3] by genesis belong to the ~~ocean~~ Arctic ocean complex (Nikol'skii, 1947; Lishev, 1950).

1. We considered coincidence of feeding grounds to be the simultaneous occurrence of fish in trawl catches.
2. Due to lack of data on the feeding of eelpout during the spring of 1961 we used data from 1964 when the maximum food similarity (FS) index for these fishes did not exceed 14.4%.
3. We considered eelpout to belong to the Arctic complex based on the similarity of its way of life to that of other cold water fish of the Gulf of Riga. Although eelpout is more of a warm water fish than goby it is not found in warm southern seas.

Food composition of vimba of the Gulf of Riga in 1960–1963 (in wt%)

Table 5 Таблица 5

Состав пищи сырти Рижского залива в 1960—1963 гг. (в % по массе)

Items of food / Кормовые объекты	1960						1961					1962				1963	
	IV	VI	VII	VIII	XI	XII	V	VI	VIII	IX	XI	VI	VII	VIII	X	VII	X
Macoma baltica	89,60	32,20	33,00	79,70	64,30	41,00	32,75	55,96	8,95	0,77	48,50	100,00	89,39	90,10	41,30	99,50	57,50
Other shellfish — Прочие Mollusca	0,29	—	—	5,39	—	—	3,37	—	—	—	1,15	—	—	—	—	—	—
Pontoporeia affinis	8,33	0,72	11,00	—	—	—	2,37	0,13	86,10	93,83	0,25	—	4,36	3,10	23,50	0,50	42,50
Gammarus locusta	—	4,42	—	—	—	—	1,39	—	—	—	1,50	—	—	—	—	—	—
Bathyporeia pilosa	—	4,98	8,00	—	—	—	29,70	3,26	0,23	—	—	—	—	—	—	—	—
Corophium volutator	—	48,20	8,95	1,41	—	—	17,80	34,30	0,05	—	1,40	—	—	—	—	—	—
Undetermined species of Amphipoda — Неопределенные до вида Amphipoda	0,32	6,20	27,40	—	—	—	0,18	—	—	—	—	—	—	—	—	—	—
Mesidothea entomon	1,41	3,09	1,91	—	35,70	5,00	0,79	—	0,75	5,40	45,25	—	1,00	6,80	35,20	—	—
Neomysis vulgaris	—	—	—	—	—	—	5,47	1,21	0,07	—	0,55	—	—	—	—	—	—
Nereis diversicolor	—	0,07	7,20	—	—	—	—	—	—	—	—	—	0,25	—	—	—	—
Small goby — Малый бычок	—	—	—	—	—	54,00	0,37	—	0,02	—	—	—	—	—	—	—	—
Seaweed and vegetative plant remains — Водоросли и растительные остатки	—	—	0,24	4,00	—	—	0,16	0,13	0,20	—	—	—	—	—	—	—	—
Digested residues — Переваренные остатки	—	—	—	9,50	—	—	1,90	0,26	0,29	—	1,40	—	—	—	—	—	—
Earth — Грунт	—	0,12	2,30	—	—	—	3,39	4,75	3,34	—	—	—	5,00	—	—	—	—
Total index — Общий индекс, ‰	62,26	125,70	53,80	44,01	7,10	0,72	59,80	6,90	30,60	5,70	0,79	198,00	84,48	21,30	9,77	140,02	17,30
Number of fish investigated, units. — Число исследованных рыб, шт.	6	25	17	11	17	42	157	50	100	9	52	20	60	34	5	30	16

According to G.V. Nikol'skii (1953) the greatest difference in food composition occurs between representatives of different faunal complexes. Therefore the insignificant similarity in food of the goby, smelt and eelpout is quite reasonable. Flounder and vimba which eat shell fish and crayfish of the warm water complex (Corophium volutator, Bathyporeia pilosa, Gammasus lucusta and Neomysis vulgaris) and less frequently those of the cold water complex and fish, have a considerably larger FS coefficient. These fishes differ in origin: flounder is a sea inhabitant of the Arctic (Nikolskii, 1947), while vimba is, evidently a ponti Caspian dweller. This explains the large food similarity indices.

Table 6.

Food similarity of benthos-eating fish of the Gulf of Riga in 1961 (in FS coefficients)

Таблица 6

Объем пищевого сходства бентосоядных рыб Рижского залива в 1961 г. (в СП-коэффициентах)

Items of food. Кормовые объекты	Four-pronged goby Четырехрогий бычок	Eelpout Бельдюга	Vimba Сырть	Flounder Камбала	Smelt Корюшка
Весна Spring					
Четырехрогий бычок	—	—	2,65	12,66	8,39
Сырть	2,65	Нет данных No data	—	43,15	8,20
Камбала	12,66		43,15	—	11,56
Корюшка	8,39		8,20	11,56	—
Лето Summer					
Четырехрогий бычок	—	21,93	0,64	3,33	13,74
Бельдюга	21,93	—	58,07	26,87	1,43
Сырть	0,64	58,07	—	12,96	2,16
Камбала	3,33	26,87	12,96	—	3,12
Корюшка	13,74	1,43	2,16	3,12	—
Осень Autumn					
Четырехрогий бычок	—	5,75	45,35	24,56	11,21
Бельдюга	5,75	—	0,25	37,68	48,38
Сырть	45,35	0,25	—	23,78	0,60
Камбала	25,56	37,68	23,78	—	24,89
Корюшка	11,21	48,38	0,60	24,89	—

The distribution of fish varies somewhat from the summer (June-August) to the Spring; goby, smelt and eelpout are found in the open areas, while flounder and vimba, as well as eelpout, occur in the coastal areas. The general pattern of feeding remains the same, while the ratio of individual components varies. The coincidence of feeding grounds of fish living in the open areas of the Gulf was more than 60%. The habitats of the other fish also coincided to a large extent. The FS coefficients of the first group of fish were small. The relative similarity of food of goby and eelpout is caused by the greater consumption of Mesidothea entotom by eelpout. It should however be noted that goby prefer a larger size of Mesidothea entotomon (4-6 cm) than eelpout (1-2 cm). The food relations of the second group of fish are closer. The maximum FS coefficient (58.1%, Table 6) is observed for eelpout and vimba which eat Macoma Corophium and other Amphipoda.

The fish distribution changes in the autumn (October-November). When the water cools off flounder leave the coastal area for the deep water, while vimba and eelpout depart from the coasts. The food of the goby, smelt, eelpout and flounder, living in the open areas of the Gulf at this time, consists of the same components as during the other seasons in these regions, but the similarity of food increases. The maximum similarity* coefficient observed in the smelt and eelpout (48.4%), while that of the flounder and eelpout is 37.7% (Table 6). This is a result of the greater consumption of Amphipoda by smelt and of Mysis and Amphipoda by other fish.

The increased similarity of food within one faunal complex is in this case, evidently, a result of good availability of food for the fishes. A concentration of Mysis occurs in deep waters in the autumn (Chekhova, 1961).

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* I believe that there is an error in the Russian text: it refers to the fill coefficient where I believe the similarity coefficient is meant.

In addition, according to I.I. Nikolaeva (1960) there is an increase in availability of Pontoporeia for pelagic and, evidently, pelagic benthonic (including smelt) fish due to increased vertical migration of these crayfish. Fairly large FS coefficients (45.3%) are noted at this time for representatives of different faunal complexes, goby and vimba, as a result of Mesidothea entomon consumption. However, the feeding grounds of these fishes do not coincide. Therefore in this case we can only speak of their indirect influence on each other's food supply.

Due to the yearly variation in food base and fish distribution their food composition varies each year. This is reflected in a certain variation in food relations of the fish. Thus in the summers of 1961 and 1962 eelpout-vimba and ellpout-goby had the most similar food composition. The FS coefficients were higher in 1961 than in 1962.

CONCLUSIONS.

Examination of the use of benthonic fauna of the Gulf of Riga by benthos-eating fish shows that all organisms, except mature Balanus improvisus and large Mytilus edulis, are eaten by fish. The major role is played by the bulk forms of invertebrae: Macoma baltica, Pontoporeia affinis, P. femorata, Corophium volutator, Bathyporeia pilosa, Mysis oculata v. relicta M. mixta, Neomysis vulgaris, Masidothea entomon.

However the consumption rate of these organisms varies throughout the year.

Warm water crayfish C. volutator and B. pilosa as well as shell fish M. baltica are consumed at a higher rate during the spring-summer season, when the main feeding of flounder, vimba and eelpout occurs. Cold water crayfish are eaten at a high rate throughout the year, particularly during the autumn. We do not have at our disposal detached information about benthos production of the Gulf of Riga. It is known only that some increase in benthos biomass

occurs from the summer to the autumn (Shurin, 1964). This leads to the conclusion that fish fattening occurs as a result of only partial use of benthos production.

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