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Peculiarities of Feeding and Quantitative Food
Consumption of Eastern Baltic Cod

by

D.Uzars

Baltic Fisheries Research Institute

(BaltNIIRH)*

Material and methods

The seasonal changes in the type of food in relation to size, sex and stages of gonad development, the daily rate of feeding and the trophical relations of cod were studied.

The stomach material came from 11000 cod.

Seasonal and yearly food rates of cod according to size and age were calculated on the base of daily food intake (Lipskaja and others, 1972; Arntz, 1974).

The distribution of stomach filling indices** for different lengths, sexes, stages of gonad development were compared

*) BaltNIIRH, Daugavgrivas 6, Riga-49, Latvian SSR, USSR

**)weight of stomach content . 10 000

weight of fish

using Kolmogoroff's criterium with 95% confidence limits (Mitropolskij, 1961).

The ripening stages were recorded in accordance with 6-stage scale.

Feeding of the immature cod

The food composition and stomach filling indices for the immature and mature cod differ statistically significantly. The length at maturity 28-35 cm is found to be the size at which the relay in feeding takes place.

Crustaceans (Mysis mixta, Pontoporeia femorata, P. affinis and Mesidotea entomon) polychaetes (Harmothoe sarsi) constitute the main elements in the food of the young cod. The seasonal differences in the weight percentages of main food groups in relation to size classes are considerable (Table I).

In autumn cod up to 20cm shows a preference for mysids. The importance of small crustaceans declines and of isopods (M. entomon) - increases with the increase of the fish size.

In winter the value of mysids declines for the whole range of fish. The polychaetes constitute the main food of cod.

In spring the young cod, as well as the adult one, is situated mainly in deeper waters (below 80m). The feeding intensity of the young cod decreases, apparently due to a reduction of mysids biomass in that period (during the spawning a high mortality of Mysis is observed).

The polychaetes and mysids are as a food of cod 5 to 20cm in length. The cod over 20cm eats mostly polychaetes, isopods and fishes.

Feeding of adult cod

The fishes (herring, sprat), isopods, mysids and polychaetes are the dominant food of adult cod (Table 2).

There are some seasonal changes in the composition of food for cod.

The isopods, mysids and herring are consumed intensively during the second half of the year. In autumn the share of sprat in the food of cod is low as in that time the feeding areas of cod and sprat do not coincide: the sprat is dispersed in the middle and upper layers, while the cod inhabits the deeper ones.

In winter cod continues to feed intensively. The food composition remains the same as in autumn. With the exception of the cold winters (1969, 1970), when sprat concentrates in the mid-water layers of the Eastern Baltic and intensively is consumed by cod (Table 3).

In spring (March-June) the adult cod is situated mainly on the spawning grounds. The maturing cod (stages III-IV) proceeds feeding on herring and sprat (Table 3). There are considerable changes in the food composition of adult cod in years of different oxygen supply on the eastern spawning grounds during the period 1963-1973 (Table 4).

In 1963 and 1968 a low oxygen content and salinity decrease were noted in the Gotland Deep, and cod left for the southwest.

In 1966 and 1967 the hydrographic conditions improved and cod partly migrated to the west.

In 1964-65 and 1969-73 the oxygen values in eastern Baltic were favourable and concentration of cod - good.

In years, when cod stay in the eastern Baltic (sub-divisions 26 and 28) where clupeids are abundant, cod prefer the sprat (Table 4).

However, in 1969 and 1972-73 cod showed a preference for herring. It was caused, apparently, by the appearance of very good 1967 year-class in the eastern Baltic and of high abundance of southern herring in 1972-73.

In the years of unfavourable hydrographic conditions, importance of clupeids in the food of cod is minimal as cod migrates to the west where abundance of small herring and sprat is lower.

Feeding of males and females

During the period of ripening of gonads the sexual differences in the behavior, food composition and process of metabolism are observed (Strzyzewska, 1962; Thurow, 1970; Jpatc, 1974).

Males come to spawning grounds earlier and remain there longer than females (Naumov and Radakov, 1954). The fish consumption by pre-spawning females is 2-3 times higher as compared with males (Uzars, 1971).

According to the distribution of feeding intensity, the mature stock may be divided in two statistically different groups (Table 5)

The first group with high intensity of feeding includes females (on stages) II-IV and males II-III.

Second group with relatively low intensity of feeding - females V, VI and males IV-VI.

The feeding intensity is closely bounded with ripening of cod.

Heavy feeding is needed in pre-spawning period to provide energy

for generative metabolism. The amount of energy necessary for generative processes is different in males and females. Mature

males end the feeding earlier than females and long before the spawning time, sometimes in december, their intensity of feeding becomes lower. In spawning period males on the IV stage of ripening are similar in feeding to the spawning fishes.

Differences in food requirements evidently cause the vertical stratification of males and females in spawning time. Consuming clupeids females are higher from bottom than males and therefore are less exploited by ground trawls: females constitute 40% of the catch.

At the feeding grounds the proportion of females rises to 56%. This is caused by higher mortality of males both from physiological causes and the catch in the spawning time.

The quantity of food consumed

The average amount of food consumed by cod population in the East Baltic was estimated using the data of total abundance of cod, biomass of single age and length groups, the food composition in different seasons and regions food consumption rate and food conversion indices (Table 6).

Consuming the clupeid fish in considerable amounts, cod becomes essential factor of natural mortality of herring and sprat, and influence their stock and catches (Lishev, 1966; Lishev, Uzars, 1967). However, in assessment of a trophical role of cod in the ecosystems of Baltic, it must be taken into account that cod practically is the only consumer of large resources of isopods and polychaetes.

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Table 1.

Food composition (% by weight) of young cod in 1963-1973.

Season	Autumn			Winter			Spring		
	5-20	20-25	25-30	5-20	20-25	25-30	5-20	20-25	25-30
Length of cod, cm									
Mysidacea	71	54	51	61	47	42	30	14	7
Mesidothea	4	15	22	3	10	11	5	18	19
Harmathoe	14	9	11	26	27	32	49	33	24
Other crustaceans	7	15	8	7	6	-	13	12	9
Herring	-	1	2	-	3	3	-	7	9
Sprat	1	1	2	2	4	7	1	14	29
Other fishes	3	5	4	1	3	5	2	2	3

Table 2.

Food composition (% by weight) of adult cod in the first (A) and second (B) half year; in 1963 - 1973.

Length of cod, cm	A			B		
	30-35	35-40	>40	30-35	35-40	>40
Herring	9	12	25	3	10	25
Sprat	31	40	30	6	9	7
Other fishes	2	2	10	7	2	6
Mesidothea	21	18	19	28	33	44
Mysidacea	8	6	2	37	28	11
Harmathoe	23	17	12	13	13	6
Other crustaceans	6	5	2	7	6	2

Table 3

Food composition (% by weight) of adult cod January (A) - in different winters; (B) March-June - by areas

Food species	A		B			
	cold winter	mild winter	Gotland	Klaipeda	Gdansk	Slupsk Bornholm
Herring	24	25	10	27	11	21
Sprat	36	7	61	34	61	32
Other fishes	4	7	5	7	3	7
Mesidothea	13	31	15	13	12	8
Mysidacea	14	24	2	16	5	7
Harmathoe	7	3	7	3	8	17
Other crustaceans	2	3	-	1	-	8

Table 4.

Food composition (% by weight) of the adult cod in **spring**
(groups of years according to oxygen conditions)

	1963, 1968	1966, 1967	1964, 1965 1970, 1971	1969, 1972 1973
Herring	16	4	8	31
Sprat	16	24	59	23
Other fishes	7	3	3	5
Mesidothea	33	29	9	15
Mysidacea	8	6	4	5
Pontoporeja	6	3	1	2
Polychaeta	13	27	14	16
Other crustaceans	1	4	2	3

Table 5.

Feeding intensity of cod in the Eastern Baltic in 1970
in relation to maturity stage.

Month.	Sex and maturity stage	Stomach content index classes												n
		0	1-40	41-80	81-120	121-160	161-200	201-240	241-280	281-320	321-360	361-400	401-440	
January	♀ II-III ♂ II	30	4	9	11	8	4	5	4	2	3	3	16	253
	♂ III-IV	48	8	9	13	5	2	6	1	1	0	0	8	98
March	♀ II-IV ♂ II-III	36	15	13	8	6	5	2	3	2	3	2	3	876
	♂ IV-Y ♀ Y	58	13	8	6	3	3	2	2	1	1	1	2	620
April	♀ II-IV ♂ II-IV	44	5	10	7	6	6	4	1	3	2	3	6	211
	♂ Y-Y1 ♀ Y-Y1	64	6	5	6	2	4	3	2	2	1	1	4	312
May	♀ II-III ♂ II	31	2	5	13	9	9	7	4	6	3	0	7	66
	♀ Y-Y1 ♂ IV-Y1	68	4	7	7	3	2	1	1	2	1	1	1	215
December	♀ II-III ♂ II	24	20	20	12	8	2	2	4	1	1	3	4	215
	♂ III-IV	39	22	17	9	7	3	1	0	0	0	1	2	101

Table 6.

The Yearly food consumption (thous. tons) by cod in the eastern Baltic.

Length in cm.	5-25	25-30	30	Total
Age	0+,1	2,3 (50%)	3, (50%) older	
Biomass of cod (thous. tons)	32	79	122	233
Herring	17	57	202	276
Sprat	27	159	222	408
Isopods	69	213	271	553
Mysids	305	352	232	889
Polychaetes	180	225	110	515
Others	97	122	135	354
Total	695	1128	1172	2995

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