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Food Links of some Fishes and Invertebrates on the Flemish Cap Bank

by

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Abstract

The Flemish Cap Bank is a well-isolated ecosystem including many species of plankton, benthos and necton. Isolation of some populations, first of all commercial fishes, facilitates the revealing of biological regularities and fishery role in the fish abundance dynamics.

Naturally, the regular International researches determined by the Flemish Cap Project are just carried out on the Bank. As the data for 1970-1978 and 1981 showed, concentrations of mesozooplankton reach usually here 555 mg/m^3 in spring/summer. The minimum concentration (63 mg/m^3) is observed in winter months.

Thus, by maximum concentration of mesozooplankton the Flemish Cap surpasses other areas of Grand Bank. Possibly, it is mesozooplankton that plays such an important role in cod feeding there.

The role of benthos in cod feeding is considerably lower than in Labrador areas.

The most peculiar feature of cod feeding spectrum on the Flemish Cap is a deficiency of capelin which are in fact not found in the area. The young redfish and their own juveniles are prominent in cod feeding.

The above mentioned peculiarities of cod feeding affect their growth, maturation, fatness and abundance dynamics. So, fluctuations of cod year classes, as well as of other commercial fishes, are pronounced more clearly on the Flemish Cap than in Labrador area. For that reason the scientific substantiation of limits and yearly catch quotas of the main

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commercial fishes should be paid a special attention.

Introduction

The Flemish Cap Bank is isolated from the continental shelf by a deep ("iceberg road") and is located beyond the 200-mile economic zone. The Bank area outlined by the 1000 m isobath is equal to 51.5 thou. km^2.

A regular trawl fishery for redfish started in summer 1956 when the Soviet large trawlers began to fish on the south-western slope of the Bank. The regular fishery for mainly mature cod started as well there in spring 1957. Simultaneously the Soviet scientists promoted ichthyological and oceanological researches on the Flemish Cap Bank , first in the frames of national and later also international programmes.

For many reasons the Flemish Cap Bank should be regarded as a region exclusively convenient for fishery researches and for solving the cardinal problems of ichthyology and fishery. The fishery statistics and scientific observations allow to trace the fish populations and their living conditions back to undisturbed ecosystems, i.e. to 1956. The investigation of the commercial fish abundance dynamics is facilitated by the isolation of their populations from other parts of the continental shelf. The Soviet researches such as mass tagging, studying of parasitic fauna and morphometric characteristic showed that isolated local populations of bottom commercial fishes keep to the Flemish Cap Bank (Postolaky, 1962 ; Yanulov, 1962; Templeman, 1962, 1974; Templeman and Fleming, 1963; Konstantinov, 1970; Shestov, 1970).

True, it is possible that in some cases ichthyoplankton is transported to the Bank. So, the rich 1981 year class of haddock appeared in the southern part of Grand Bank; next year haddock yearlings were found in quantity on the Flemish Cap Bank (Konstantinov, MS 1983) where in general they occur rarely. Undoubtedly, the bulk of developing haddock eggs or larvae were transported to the Bank in summer 1981. However, the conclusions concerning the isolation of the commercial fish populations at the rest developmental stages - from settling of fingerlings on the ground to the last egg laying - remain valid.

The Flemish Cap Bank is still very convenient for regular fishery researches because it is never covered with ice and is wholly located beyond territorial waters and 200-mile economic zone.

At the 20th Annual Meeting of the ICNAF Scientific Council (St.John's, 1970) a report was delivered (Konstantinov, 1970, MS 1970 a) on expediency of cod fishery regulation on the Bank. The report provoked an animated discussion. The talks were initiated on organization of co-ordinated International researches on the Flemish Cap Bank as on a very convenient ground. In April 1977 the Meeting of Working Group was held in Murmansk in which participated scientists from the USSR, Canada, USA and Polish People's Republic. The chairman of the Meeting Konstantinov K.G. read a preliminary report (Konstantinov, MS 1977). A detailed programme of International researches - hydrographic, hydrochemical, hydrobiological and ichthyological - was developed.

Beginning from 1978 the agenda of all ICNAF (later on NAFO) Sessions includes the item " Flemish Cap Project" envisaging the discussion of results and programmes of fishery researches on the selected ground. The Summary Reports (e.g. NAFO SCR Doc. 81/IX/27) illustrated many times a great progress of the researches done.

In the given report the authors try to elucidate how the food resources and relations between fish and invertebrates from the Flemish Cap Bank affect the abundance fluctuations and other aspects of biology of commercial species.

There is little information in literature on the Flemish Cap cod feeding. Certain data on the subject can be found in papers by Postolaky and Popova (Postolaky, 1963; Popova, 1962) who concluded that in winter/spring cod feed on shrimps and different species of <u>Amphipoda</u> while in summer/autumn - on plankton and deep-water fish. The analysis of cod feeding made by Lilly (Lilly, MS 1979) showed that in winter adult cod prefer to prey on fish (mainly redfish) and plankton crustaceans (<u>Hyperiidae</u>). The near-bottom crustaceans, chiefly <u>Pandalus borealis</u>, are found more rarely and mostly in small cod. Benthic organisms such as crabs, Echinodermata, Polychaeta and Gastropoda are of small importance in the Flemish Cap cod feeding.

Material and methods

The data collected in regular cruises of the PINRO research vessels from 1970 to 1982 were used in the paper. Two methods were applied: the field analysis of cod feeding and quantitative-weight analysis of stomachs, preserved in the 4% formalin solution, at the Institute Laboratory.

The field analysis included a definition of the food item occurrence in per cent of the number of cod stomachs containing food and also a determination of the average index calculated as the arithmetic mean of all stomach fullness indices.

The quantitative-weight analysis embraced a division of food objects into taxonomic categories. The objects from each taxonomic group were dried on the paper and then were weighed with an accuracy of 0.1 g. The relative importance of different components was estimated by two indices:

1. A partial index of stomach fullness - the ratio of the given food organism weight to the fish weight expressed in $^{\circ}/_{\circ\circ\circ}$;
2. A total index of stomach fullness - the ratio of the total weight of food items to the fish weight expressed in $^{\circ}/_{\circ\circ\circ}$.

In addition, fatness and condition factor were determined for each fish. The ratio of liver weight to fish weight expressed in per cent was taken for an index of fatness and the ratio of fish weight (g) to its length cubed (cm) multiplied by 100 - for condition factor.

In all 11712 cod specimens were investigated including 830 specimens - by the quantitative-weight analysis and 10882 spec. - by the field analysis.

The analysis of plankton distribution in the Flemish Cap Bank area is made according to data of quantitative treatment of 260 plankton samples collected in February 1978, March 1971, 1976, 1981, April 1971 to 1974, 1977, 1981, June 1975, 1977, 1978 and in July 1978. Until 1981 the plankton investigations were just carried out on section 6A (47°00'N) and in 1981 the survey enveloping the whole Flemish Cap Bank was made three times (March, April, May). Plankton was collected by a Juday net (diameter 37 cm, gauze No.38) in the layers of 50-0, 100-50, 200-100 m according to the VNIRO methods (Yashnov, 1934). The detailed methods of plankton collection and treatment were presented in our previous paper (Kamotskaya and Plekhanova, 1975). The analysis of the data was given chiefly for the 0-50 m layer since the main plankton concentrations were found during the survey in that layer. The seasonal variations in abundance and biomass of plankton and separate zooplankters were traced on section along 47°00'N and terms of development of *Calanus finmarchicus* as one of the most numerous representatives of the Flemish Cap Bank zooplankton judging by the survey data for 1981 and previous years were also observed on section 6A (47°00'N).

The Table lists the long-term mean data of the main plankton indices.

A general characteristic of cod feeding on the Flemish Cap Bank

The species composition of cod feeding on the Flemish Cap Bank is rather a diverse one and differs notably from other areas of Labrador and Newfoundland.

As the stomach dissection showed the main food items were mesozooplankton (*Calanoida*, *Sagitta*, *Ctenophora*), macroplankton (*Euphausiacea*, *Themisto*) and also *Gammaridae*, shrimps, some benthic organisms and fishes (*Myctophidae*, young redfish).

Plankton representatives in cod stomachs were *Calanoida*, *Sagitta* and *Ctenophora*. *Calanoida* (mainly *Calanus finmarchicus*) were eaten by young small cod (below 30 cm) nearly at all depths. Especially high occurrence of Calanus was recorded in spring at the 250-300 m depth (49%) and in summer at the 100-150 m depth (40%). Unlike Calanus, *Sagitta* were found more often in stomachs of larger cod (above 30 cm) caught at the 200-300 m depth. Adult cod (40-60 cm) preferred *Ctenophora* of all plankton organisms which were spread at small depths (100-200 m). They were practically not found in cod above 72 cm.

Euphausiacea were always observed in cod stomachs though in small quantity. A certain increase in their occurrence at the 100-200 m depth (35%) was noted. Euphausiacea occurred more often in the food of smaller cod than in large specimens. But on the whole their occurrence was not high and did not differ much by the cod length groups.

Themisto was the most numerous food item which was found in specimens of all length groups caught within a wide depth range (from 100 to 400 m). Very often their occurrence in cod stomachs reached 100%.

Unlike Themisto (pelagic Amphipoda), Gammaridae (bottom Amphipoda) were found in cod stomachs singly and occasionally.

Shrimps were observed in the food of adult cod rather often. In fact, it was the second after Themisto food item of cod. Occurrence of shrimps was, as a rule, higher in small and medium specimens than in large ones. The depth range of shrimp consumption was rather wide - to 600 m. Their occurrence was the highest in spring and summer at the 250-300 m depth (58%) and 350-400 m depth (72%).

Bottom organisms such as Crustacea, Ophiura, Polychaeta, molluscs were found in cod stomachs sporadically without any dependence on certain depth. Polychaeta were most common, bottom Crustacea and Ophiura - more rare, though more frequent than other benthic organisms. In recent years (since 1976) the occurrence of molluscs, especially that of squids, increased considerably. Earlier they ocurred singly.

A higher occurrence of fish in the stomachs was noted with the cod growth and fishing depth increase. These were in the main previously mentioned Myctophidae and young redfish.

On the whole the amount of food in the Flemish Cap cod stomachs was small. The mean degree of stomach fullness ranged within the year from 0.65 to 2.60.

As the field analysis showed the feeding spectrum of cod was rather wide. However, only few organisms were of great importance by weight in cod feeding. As a result of investigation into partial indices of stomach fullness one can state that only three species of food items made up the bulk of the Flemish Cap cod feeding: Themisto, shrimps and deep-water fish (Fig.1). Euphausiacea, Gammaridae, Polychaeta, molluscs and other bottom organisms occurred frequently but their weight was insignificant. Cases of cannibalism were also negligible.

Themisto was the most numerous food item the weight of which was very great in feeding of all cod length groups and in all years. It may be noted that consumption of Themisto by cod was particularly intensified in summer (June - 1991.3, August - 2282.5 °/₀₀₀), decreased considerably in winter and reached the minimum values in spring (March - 5.8, April - 9.2 °/₀₀₀).

Shrimps were the second after Themisto in the Flemish Cap cod feeding. In winter the importance of shrimps was considerably lower than in summer (January - 3.5, July - 272.9 °/₀₀₀).

Young redfish were the third in cod feeding in general and the first among the fish food. Cod ate especially many redfish in February/March - 2276.6 °/₀₀₀.

It is interesting to note that Myctophidae were the first in cod stomachs by occurrence and young redfish were the first by weight. Obviously the feeding on young redfish was of local nature.

On the Flemish Cap Bank unlike other areas of Labrador and Newfoundland young cod fed on plankton a greater part of the year. The amount of plankton consumed was large both by occurrence and by weight. Especially much plankton was found in cod stomachs, as a rule, in spring (April - 4246.1 °/₀₀₀). The plankton investigations being carried out regularly give grounds for regarging the area as a highly productive one (Vladimirskaya, Elizarov and Movchan, 1976; Plekhanova, MS 1980). The long-term mean plankton biomass was in March 153 mg/m^3, in April - 302 mg/m^3, in May - 334 mg/m^3, in June - 555 mg/m^3 and in July - 321 mg/m^3 (Table 1).

Mainly one oceanic boreal complex of zooplankton corresponded to transformed Atlantic waters of the Flemish Cap Bank. Calanus finmarchicus, Oithona similis, O.atlantica, Thysanoessa longicaudata, Metridia lucens, Tomopteris were common in plankton. In spring/summer Arctic species Calanus hyperboreus, C.glacia-

lis, *Metridia longa* were observed in small quantity in the west and north of the area (1-2%). Their abundance grew with intensification of the cold Labrador Current. In the centre of the Bank these species were hardly found. Zooplankton was more isolated here from the influence of Labrador Current than in the marginal areas of the Bank. The stability of hydrographic regime determined the constancy of zooplankton species composition and its distribution by years and seasons.

The larvae of *Echinodermata* (63% of the whole amount) and *Copepoda* (92%) made up the bulk of zooplankton in February; *Copepoda* (90-97%) - in March to July. *C.finmarchicus* (13% - in February, 48 to 68% - in March to July) and *Oithona similis* (16% - in February, 28 to 42% - in March to July) were the most numerous of *Copepoda* in spring/summer 1970-1981. The largest zooplankton concentrations were recorded in the 0-50 m layer. The biological spring on the Flemish Cap Bank was characterized by mass spawning of *C.finmarchicus*, development of diatoms and occurrence of young *Echinodermata* in plankton.

In spring/summer 1970 to 1981 a weak development of phytoplankton was observed. In April/May the diatoms developed most intensively in the west of the Bank. In the eastern part the mass development of algae was just recorded in cold 1972, in late May. Phytoplankton was presented by diatoms *Thalassiosira Nordenskhiöldii*, *Thallasiothrix longissima*, *Chaetoceros decipiens*, *Rhyzosolenia hebetata semispina*, *Coscinodiscus oculus iridis* and by peridineans *Ceratium longipes* and *Peridinium depressum* (Plekhanova, Rhyzov, MS 1976, MS 1977). Calanus spawning occurred on the Flemish Cap Bank in April: somewhat earlier in the west (March/early April), later in the east (from mid- to late April). Calanus grew and developed in the western part more intensively than in the eastern one. Copepodite stages V and VI (females) of Calanus were found in February. Males made up 2-8%, nauplii occurred sporadically, eggs lacked. In March the Calanus population was mainly presented by females (Fig.2). Their young (nauplii, copepodite stages I-III) were encountered in the west and marginal areas of the Bank. They were the most numerous in the west. In April

Calanus consisted of all copepodite stages with prevalence of stages I-III. Calanus nauplii were abundant and most numerous in the west of the area. Quite a number of eggs was observed. The abundance of copepodite stages IV-V of Calanus increased throughout the whole area as compared to March. The highest abundance was recorded in the east and north-east of the Bank. The abundance of Calanus females decreased. They were mainly spread in the centre of the Bank. In May Calanus of all age stages were found in plankton as before but stages III-IV prevailed. A small number of young Calanus was observed in the north and east of the Bank. Nauplii were scarce and eggs lacked. In June copepodite stages IV-V of Calanus occurred and only in the eastern part stages II-III prevailed in the population. In July stages IV-V were found throughout the whole area.

Echinodermata larvae were observed in quantity in February and March. In February they were mainly recorded in the 0-50 m layer, in March - in the 50-200 m layer.

From February to June the abundance and biomass of zooplankton increased and in July - decreased (Table 1). The increase occurred due to mass spawning of Calanus, growth of their young and appearance of summer zooplankters and decrease - as a result of spawning completion, sinking of Calanus to lower depths and, perhaps, consumption of them by predators. In spring/summer the most productive areas were: western and northern parts of the Bank - in March/April, northern - in May (Fig.3) and eastern - in June (Table 1).

Hence, in spring/summer 1970 to 1981 there were good conditions for feeding of larvae and young fish on the Flemish Cap Bank: in earlier period (April/May) - in the west and in later period (May/June) - in the east.

It follows from the above that in spring the Flemish Cap cod start feeding on intensively developing plankton for lack of more caloric food.

Seasonal and year-to-year fluctuations of biological indices of the Flemish Cap cod

It is established by the long-term data that the intensity of the Flemish Cap cod feeding depends on the season. In spring/summer cod fed more intensively as evidenced by high indices of stomach fullness (Fig.4). In winter the intensity of feeding decreased and reached the minimum in January. As the quantitative-weight analysis showed the increase in cod feeding is explained by an intense consumption of developing plankton and Themisto. In winter the conditions for cod feeding on pelagic crustaceans were much worse. Shrimps, bottom organisms and young redfish made up the bulk of cod diet. Until the age of 5-7 years the redfish keep isolated not forming stable concentrations. Separate cod specimens had rather high indices of stomach fullness due to swallowed redfish but on the average the amount of food in stomachs was low in winter throughout the whole area.

The mean index of fatness and condition factor were the highest in autumn and winter after an intense period of feeding (fatness - 8%, K - 1.0). In spring and summer they were minimum (Fig.5).

Due to isolation of the Flemish Cap Bank and locality of cod stock the species composition of consumed by cod organisms did not change considerably by years. In separate years those or other food items prevailed in cod feeding which affected greatly the fat accumulation of cod. The highest average annual fatness was recorded in 1972 in large cod (60-80 cm) due to consumption of shrimps and in 1974 in cod of medium size (40-60 cm) due to consumption of Themisto and Myctophidae (Fig.4). The minimum average annual fatness was registered in cod of all sizes in 1970, 1975 and 1979 when plankton organisms (with prevalence of Ctenophora) made up the bulk of cod diet.

In the present paper we tried to characterize in short the feeding of some fish dwelling on the Flemish Cap Bank and being the most important for fishery, and also to combine two notions "food organisms" and "fish" with the help of some indices.

The comparison of data on cod feeding in different seasons of a year was indicative of their high feeding plasticity (Fig.5). In winter/spring the shrimps, young redfish and different fish species prevailed in cod feeding. In summer/autumn

Themisto, shrimps, squids and Ctenophora were very significant together with the fish food (young redfish, Myctophidae and others).

The mean index of stomach fullness increased slightly in summer (August) and it was minimum in winter.

Redfish were the second after cod in catches taken on the Flemish Cap Bank. Two species- redfish and beaked redfish - were caught by the fishery. Plankton organisms (Copepoda) and Myctophidae of fish prevailed all the year round in redfish feeding. In addition, Amphipoda, mainly Hyperiidae (Themisto) and also Euphausiacea were found in redfish stomachs.

Amount of food in the stomachs increased as well in summer months (VI-VIII).

Unlike redfish, the American plaice are benthophages. Echinodermata (Ophiura and Echinoidea) made up the bulk of their diet - 100% occurrence. Molluscs and worms were observed in far less amount (to 10%). The seasonal periodicity of stomach fullness was analogous: it increased in summer and decreased in winter (Fig.5).

To estimate the food similarity we used a coefficient of food similarity derived from the formula:

$$CFS = \frac{n \cdot 100}{N} ,$$

where N - the sum of the highest and n - the sum of the lowest values of all food item occurrence in the fish compared. At the full difference of food the coefficient was equal to zero and at the full similarity - to 100.

A high food similarity was recorded in July in cod and beaked redfish (CFS = 24.84) during their feeding on Themisto. Redfish and beaked redfish had also similar food, namely Copepoda (CFS = 67.46).

The feeding spectra of cod and other fish coincided considerably, and the coefficient of food similarity was high. But in some cases the value of similarity was just seeming. So, the competition relations between cod and beaked redfish were hardly probable as the latter kept to greater depths (400 m and more) than cod. Apparently, the food similarity between those fishes was of incidental character.

Fluctuations of the bottom commercial fish abundance on the Flemish Cap Bank

Explanation and prediction of fluctuations of the year class abundance are one of the most important tasks of the fishery ichthyology. In our opinion, the problem was dealt with in considerable detail in the book by Izhevsky (1961) published more than 20 years ago. The author found regular quantitative relationships between abiotic conditions (a convenient indicator of which is the temperature on the standard hydrographic sections) and strength of successive year classes. Abiotic conditions predetermine the terms and mass character of microplankton development - the food of fish larvae in the most critical period of their life, i.e. in the beginning of active feeding. And the strength of the forming year class just depends on survival of eggs and larvae.

The idea of Izhevsky was later corroborated and detailed by his pupils and followers. It helps to foresee the abundance of investigated population.

Nevertheless, it is very difficult to answer the following question of practical value: why the fluctuations of two (or some) local populations are of unequal long-term amplitude. It would be natural to consider the greatest fluctuations be peculiar to that population in the range of which abiotic conditions change most sharply. But there is no such a general rule in reality. When comparing the dynamics of local population abundance one must find (but not always successfully) the particular, specific reasons explaining different amplitude of the year class fluctuations.

For instance, the fluctuations were more prominent in cod from the southern Barents Sea than in cod of the Labrador stock. However, it would be impossible to draw such conclusions comparing the long-term fluctuations of temperature on the standard sections (Table 2). Let us remember that the developing eggs and larvae of the Barents Sea cod drift to the north and east where they may be in the areas unfavourable for survival (in cold arctic waters, poor with food for larvae and fry). Meanwhile, the eggs and larvae of Labrador cod drift to the south, in more favourable for survival areas. The Soviet ichthyologists repeated these and other important differences in the formation of the Barents Sea and Labrador cod year classes (Konstantinov, 1969, 1983; Postolaky, 1978).

For the present we cannot explain why the fluctuations of the bottom commercial fish (cod in particular) are so great on the Flemish Cap. The Bank is located in the area where seasonal and year-to-year fluctuations of abiotic conditions are not so sharp as in other areas. At all stages including the larvae the Flemish Cap cod is well supplied with food - micro- and mesozooplankton. But the long-term assessment of the young shows that the strength of the Flemish Cap cod year classes fluctuates considerably (Table 3) - more than in other local populations.

It may be mentioned that the Flemish Cap cod occupy the southernmost part of the commercial range of their species. True, the Atlantic cod penetrate along the North America shelf further south as far as 35°N (Wise, 1958) but already as secondary in size species. Settling near the southernmost boundary of the species range (i.e. within the limits of possible living conditions) makes the population very sensitive to all fluctuations of temperature, especially to the increase. The comparison of hydrographic conditions on different sections and in different layers, on the one hand, with the strength of cod year classes, on the other (Konstantinov, MS 1975, MS 1977, MS 1980, MS 1981; Konstantinov, 1982 a) showed that the negative temperature anomalies favoured the appearance of rich year classes of the Flemish Cap cod. It is not surprising as the decrease in temperature brings the living conditions of the Flemish Cap cod close to those which are typical of the central part of the species range.

All the intermediate links of hypothetic chain of interrelated phenomena have not yet been traced; it is not clear how just the water temperature influences the terms of appearance and abundance of zooplankton; how it affects the development and survival of the commercial fish larvae and the formation of their year classes. Further systematic researches are in prospect.

The Soviet ichthyologists do not carry out regular assessments of young redfish abundance on the Flemish Cap Bank. At least three species of gen. Sebastes (Ni, 1982) are spread in this area; we fail to diagnose their young at sea so fast as to sort out the trawl catches weighing sometimes many tons.

But there are no grounds for boubt that S.mentella always prevail in commercial catches taken on the Flemish Cap Bank. Judging by year-to-year variations of their length/age composition (Konstantinov, MS 1982b) the amplitude of this stock fluctuations is very great.

The total trawl survey indicated also very significant fluctuations of the Flemish Cap American plaice (Konstantinov, 1983). Their reasons (which are undoubtedly connected with the nutritive base and food interrelations) will be explained by further researches.

Nevertheless, the following conclusion of practical value is sure: the fluctuations of the bottom commercial fish are very prominent on the Flemish Cap Bank.

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Table 1 A comparative characteristic of the Flemish Cap zooplankton in February to July 1970 to 1981 (mean data, section 6A, 47°00'N, 0-50 m layer)

Area of survey	Month	Calanus abundance, spec/m^3	Zooplank- abundance, spec/m^3	Calanus biomass, mg/m^3	Zooplank- biomass, mg/m^3
western Flemish Cap	February	36	684	98	I09
	March	I54	274	I58	I76
	April	2564	3262	I72	340
	May	2I00	2807	I70	284
	June	I097	2248	239	440
	July	465	II66	24I	3I6
eastern Flemish Cap	February	53	I7I	54	64
	March	I05	299	74	93
	April	I3I2	2558	I34	274
	May	I525	2558	I32	378
	June	2032	4237	482	72I
	July	65I	I725	278	324
Mean by the area	February	63	484	67	87
	March	I33	280	I3I	I53
	April	I944	29I0	I53	302
	May	I795	2674	I50	334
	June	I480	3063	339	555
	July	558	I445	260	32I

Table 2 Temperature in the 0-200 m layer on standard sections in November 1964 to 1982, t°C

Year	Kola meridian, 70°30' - 72°30'N	Section 8A, 53°51'N, 55°24'W - 54°50'N, 53°32'W
I964	5,30	0,32
I965	4,I0	I,66
I966	3,52	I,72
I967	5,25	I,I9
I968	3,70	0,50
I969	5,50	0,50
I970	4,85	0,60
I97I	3,96	0,57
I972	4,8I	-0,I7
I973	4,85	0,72
I974	4,55	0,27
I975	4,95	0,70
I976	4,60	0,36
I977	4,33	2,32
I978	3,50	0,82
I979	4,II	0,99
I980	4,36	0,82
I98I	4,03	I,28
I982	4,50	0,4I
Amplitude for I964 - I982	2,00	2,49

Table 3 Number of young cod specimens of the 1961 to 1981 year classes in the mean catch per trawling hour on the Flemish Cap Bank

Year class	Age, years		
	I	2	3
I96I	-	-	6
I962	-	7	29
I963	0	6	I4
I964	0	I	I4
I965	3	2	9
I966	0	0	I3
I967	0	I3	20
I968	I0	I06	58
I969	0	2	2
I970	0	I	I
I971	22	87	3
I972	3	29	22
I973	303	350	568
I974	I33	50	57
I975	5	I7	I7
I976	0	2	I3
I977	8	5I	8
I978	3	2	2
I979	0	0	2
I980	2	II	-
I98I	4	-	-
Mean for 19 years	26	39	45

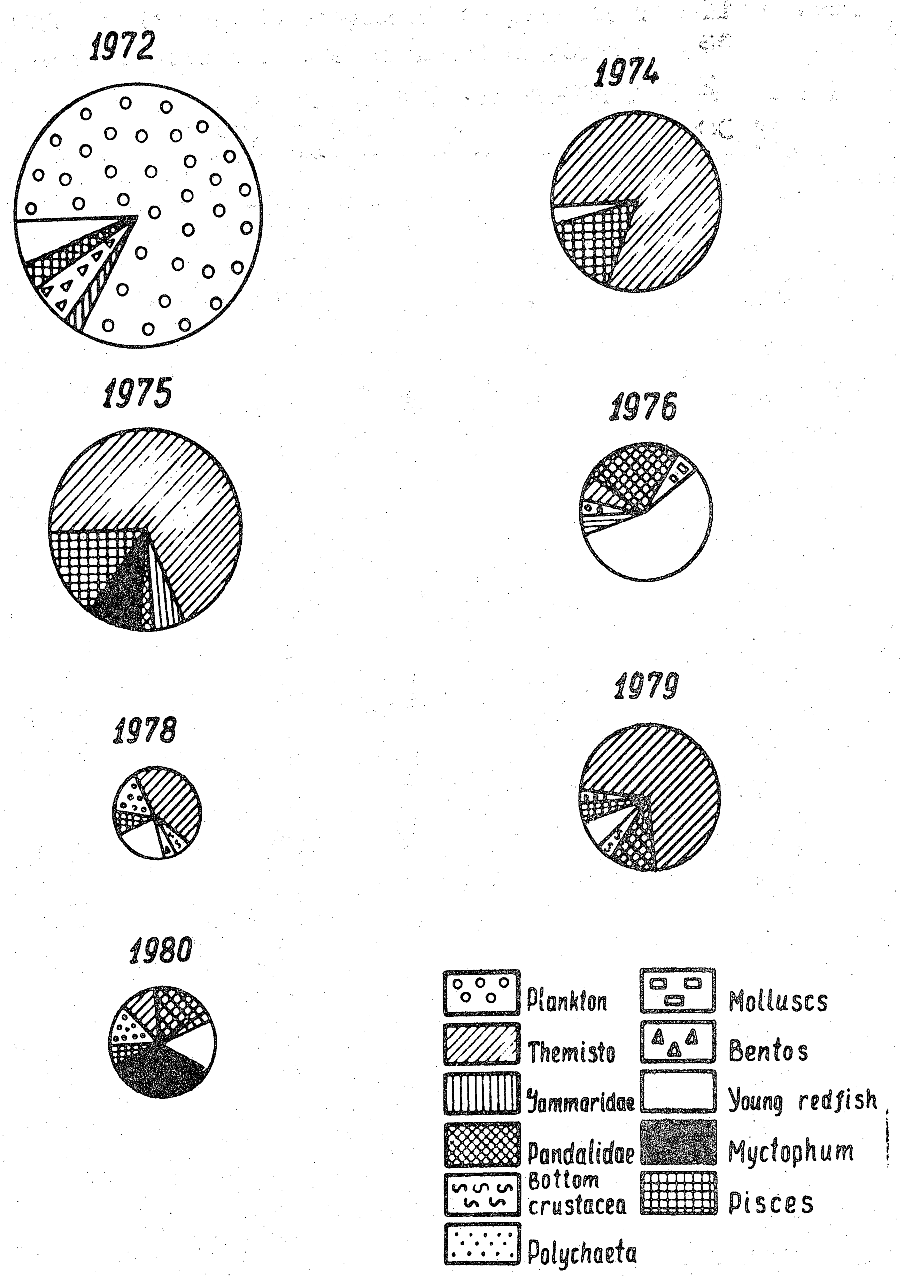

Fig.1 Quantitative-weight indices of the Flemish Cap cod feeding.

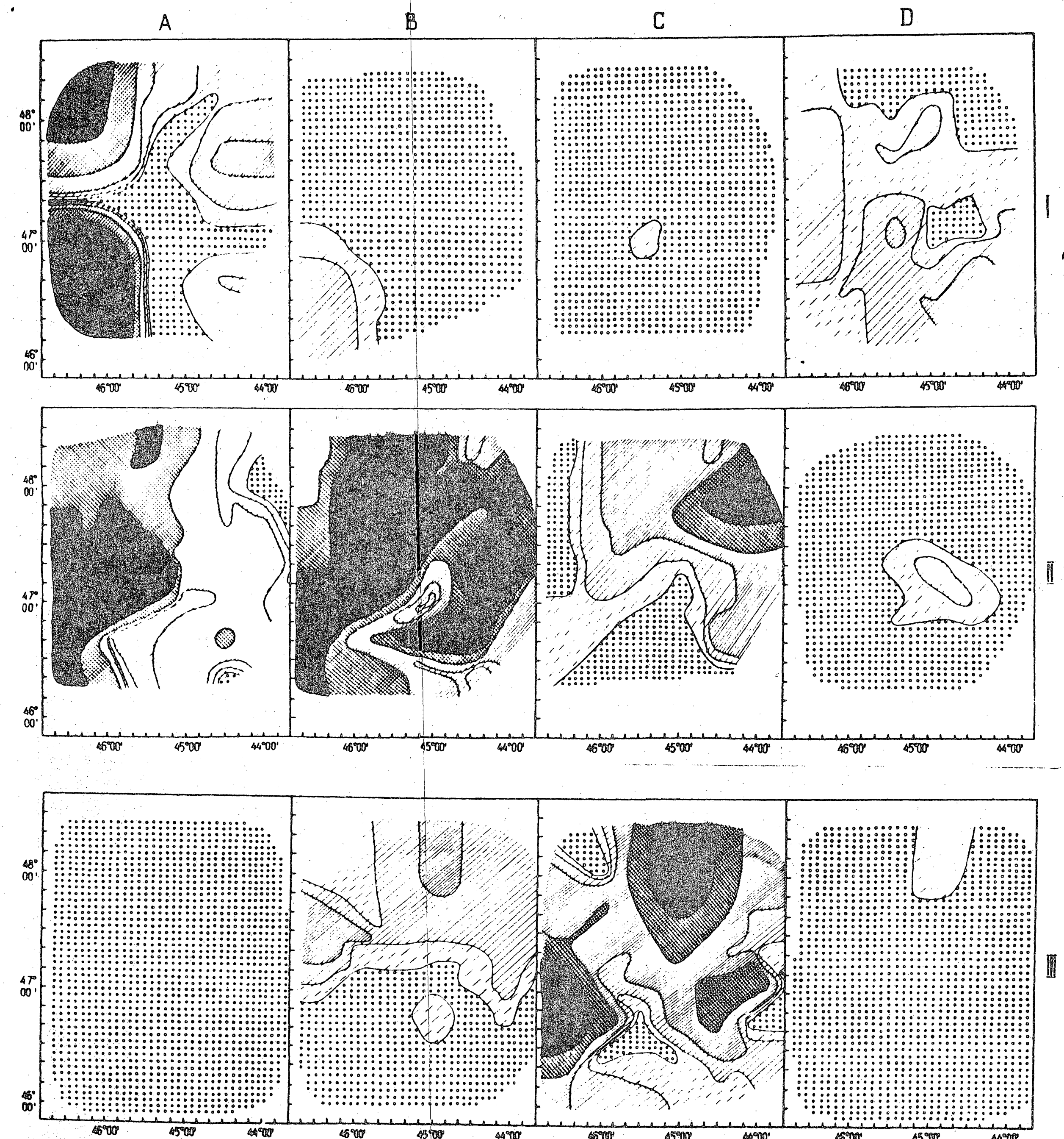

Fig.2 Distribution of different age groups of <u>Calanus finmarchicus</u> in the 0-50 m layer of the Flemish Cap Bank in spring 1981.

I - March, II - April, III - May;

A - nauplii, B - copepodite stages I-III, C - copepodite stages IV-V, D - copepodite stage VI (females).

I - 0-50, 2 - 51-100, 3 - 101-200, 4 - 201-500, 5 - 501-1000, 6 - more than 1000 (spec/m^3).

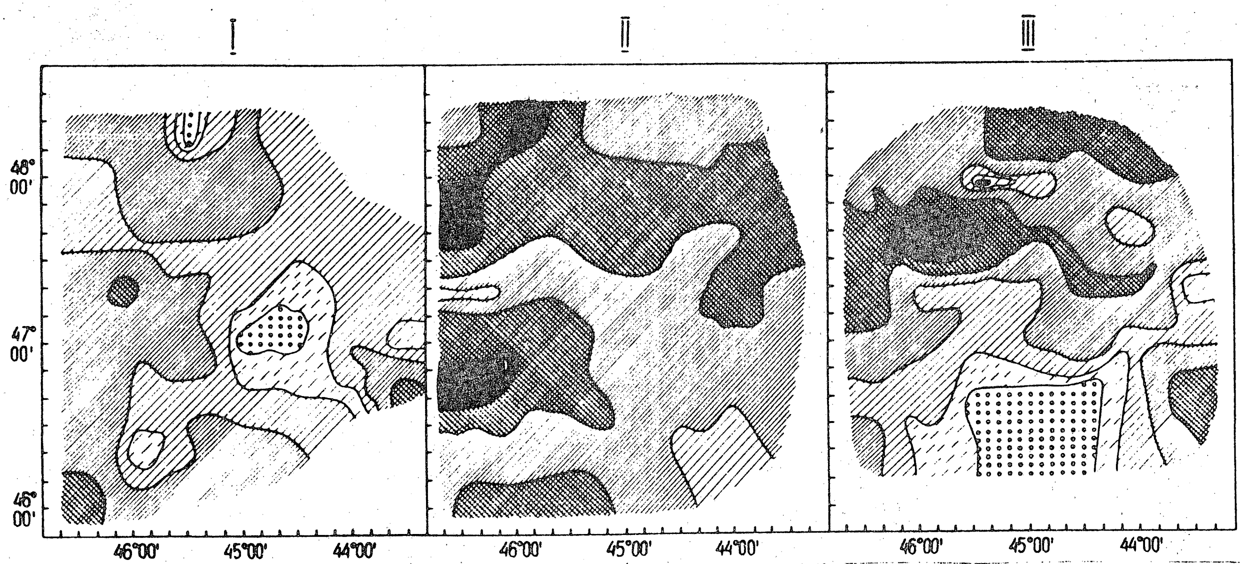

Fig.3 Distribution of the plankton biomass on the Flemish Cap Bank in spring 1981.
I - March, II - April, III - May.
I - 0-50, 2 - 51-100, 3 - 101-200, 4 - 201-500, 5 - 501-1000, 6 - more than 1000 (mg/m^3).

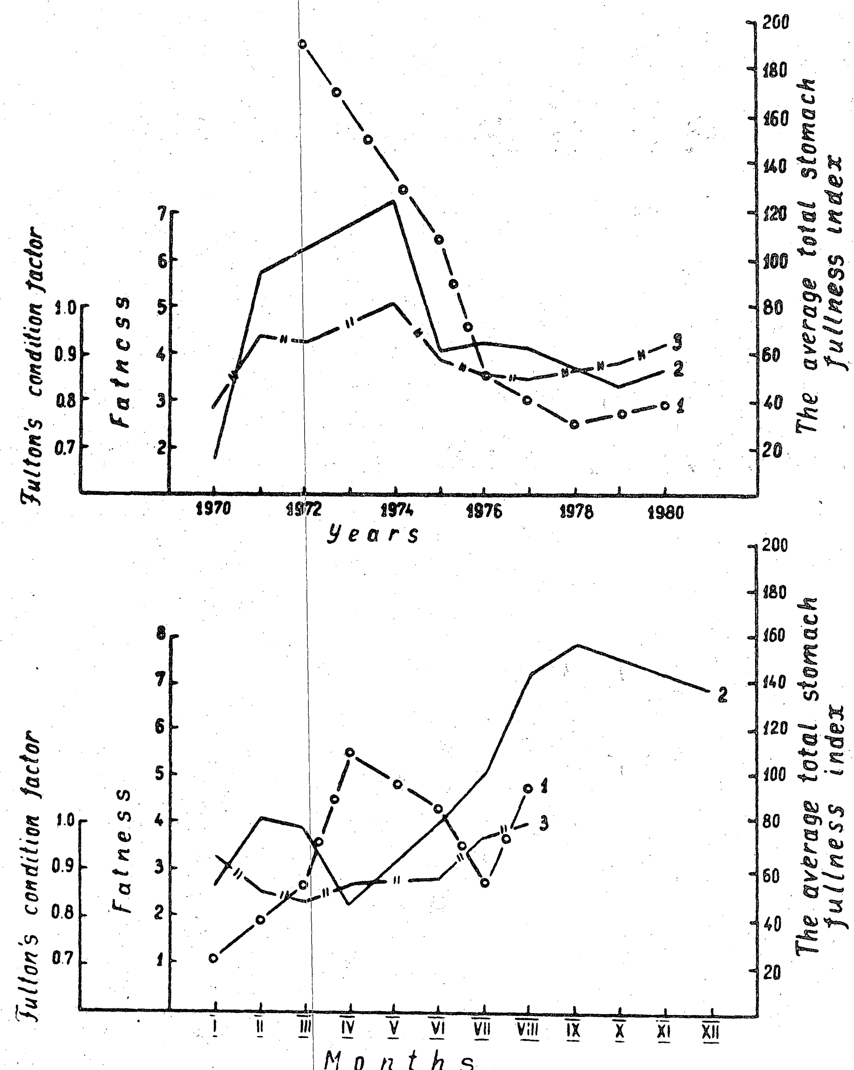

Fig.4 Variation of biological indices of the Flemish Cap cod by years and seasons.

1 - total stomach fullness index;

2 - fatness;

3 - Fulton's condition factor.

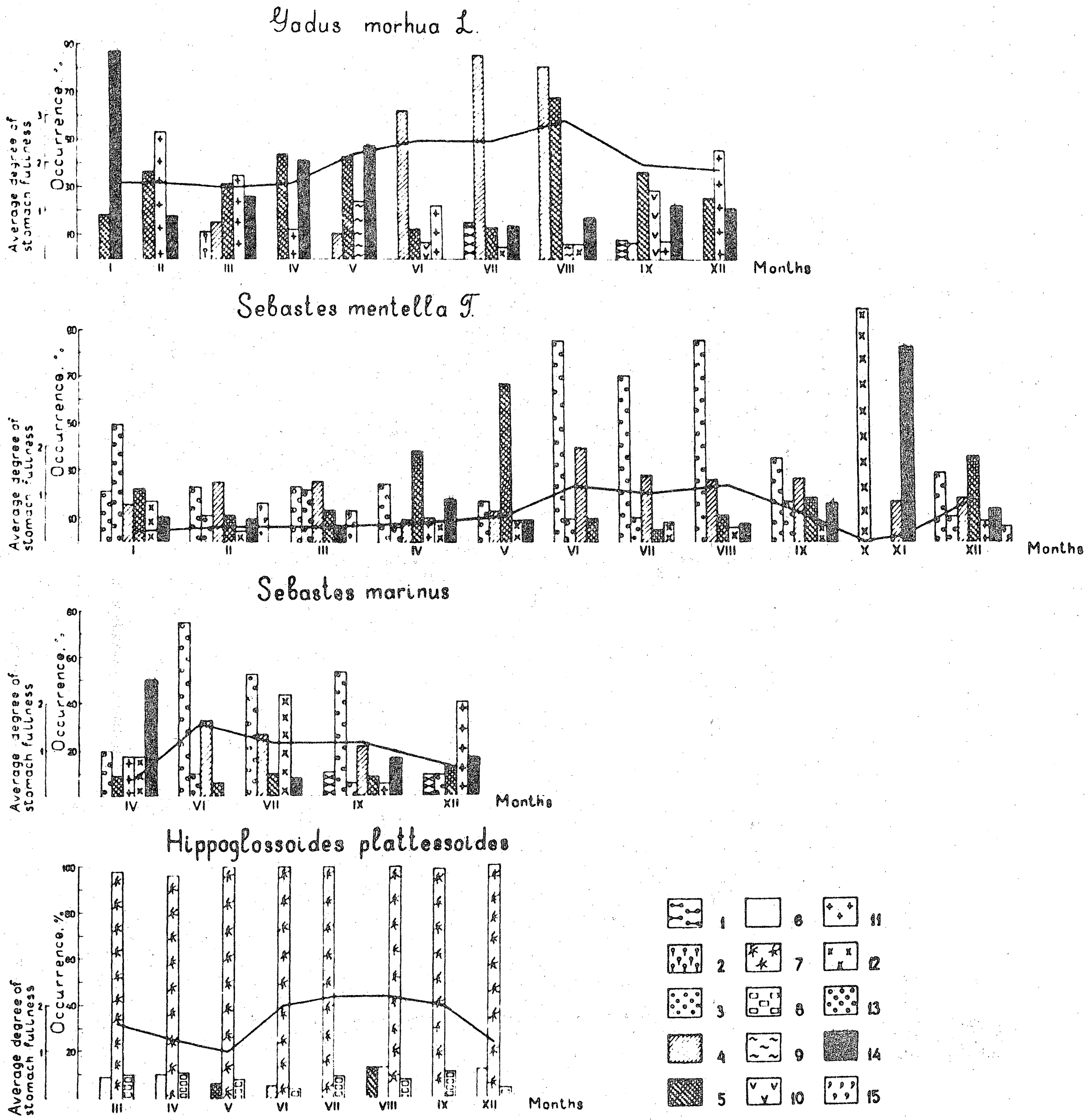

Fig.5 Seasonal variations in feeding of the main commercial fish on the Flemish Cap Bank

1 - Ctenophora;
2 - Oikopleura;
3 - plankton;
4 - Themisto;
5 - shrimps;
6 - worms;
7 - Echinodermata;
8 - molluscs;
9 - other benthic organisms;
10 - squids;
11 - young redfish;
12 - Myctophidae;
13 - euphausids;
14 - other fishes;
15 - digested food.