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Feeding and Trophic Relations Between Cod and Capelin off the Northwestern Newfoundland (Div. 3K) in Spring-Summer

by

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ABSTRACT

Peculiarities of distribution of cod and capelin stocks off the Notre Dame Bay (3K) in spring-summer 1987-1990 were considered in the paper. Rate of consumption of capelin by cod at different year was analyzed. Feeding on capelin was shown to be non-typical of the main portion of cod population , as a result of isolation of areas for predator and prey in that period. Feeding may take place in local areas and its essential spatial and year-to-year variation has been noted.

INTRODUCTION

Importance of capelin as commercial species and feeding object for cod accounts for the interest in studying the trophic relations between these species. Application of results from food consumption calculations,when evaluating stock status of these fishes by MSVPA methods, defined further perspectives for this trend. However, quantitative estimates for feeding rate are to be considered with allowance for regional, seasonal and year-to-year peculiarities of feeding.

Yearly feeding of cod off the Notre Dame Bay (3K), compared to other parts of the Newfoundland shelf, remained to be less studied up till now. Information on cod feeding in this area are mainly available for autumn period (Lilly, 1984, 1987, 1989).As for summer and spring it is insufficient and results from investigations are much differed for different years. Some authors showed an importance of capelin in cod ration to be minor in different seasons (Minet & Perodou, 1978), others indicated the importance of capelin in cod feeding in summer period (Popova, 1962; Turuk, 1968; Akenhead et al., 1982). Discrepancies in the data presented by different authors, may result from both the objective year-to-year variations in feeding of cod by capelin and fragmentary sampling.

An attempt to analyse feeding rate of the main populational part of cod has been undertaken in the paper on the basis of peculiarities in cod and capelin distribution during spring-early summer 1987-1990 in Div.3K.

An importance of other food items , significant for cod feeding, were not discussed in the paper. One can refer to the table including frequency of occurrence of different food items in spring-summer 1987-1990.

MATERIAL AND METHODS

The paper uses the results from spring-autumn trawl-acoustic surveys for bottom fishes and acoustic surveys of capelin stocks for 1987-1990. Distribution of cod biomass density was charted by results from catches taken by bottom trawls with a small-meshed incertion. The survey was carried out by strata with a 30-minute trawl duration. The acoustic survey of capelin stocks was conducted by echosounder EK-38 and echo-integrators.

Data from field and quantitative-weight analysis for feeding were used to characterise cod feeding. Index for "occurrence frequency" was calculated as a relationship between number of stomachs with food object and total amount of stomachs analyzed (%). We are of the same opinion that the "occurrence frequency" index causes errors in results when studying importance of different organisms in fish feeding. Thus, probably, an importance of smaller, however, frequently occurring organisms, was overestimated and underestimated for larger ones , seldom occurring. In this particular case when analysing a consumption of a single object by predator, undoubtedly, "occurrence frequency" indices, obtained during mass sampling , should be regarded representative.

Index of stomach fullness was calculated as a relationship between weight of capelin in stomach and cod weight (‰). Mean degree of stomach fullness was estimated as arithmetical mean from degrees of fullness of all stomachs analysed (by 5-point scale).

RESULTS AND DISCUSSION

The Labrador-Newfoundland cod population forms aggregations of heavy density along continental slope at 400-500 m depths as a result of sharp cooling of water masses in winter period. In March-April cod spawning takes place and with a beginning of water masses heating fish start to migrate to the shallows (Templeman, 1982; Serebryakov, 1967; Akenhead et all., 1982; Postolaky, 1982). Early in spring capelin concentrate in schools and start to migrate for spawning to the coast from wintering

grounds; some concentrations shift in a coastal flow of the Labrador Current to the north of the Grand Newfoundland Bank (Kovalyov and Kudrin, 1973; Pinhorn, 1976; Akenhead et al., 1982).

Level of consumption of capelin by cod population in that period should be much dependent on peculiarities of both species distribution and extent of their areas overlapping.

Some heavy (to 100 t/m^2) capelin aggregations, minor by area, and distributed to the west of 52°W, have been registered during acoustic survey in Div.3K in the second half of May-early June 1987. Disperced cod were found along the whole bank area. Cod aggregations of maximum density (0.7-1.5 t per trawling) were concentrated off the Funk Island Bank northern slopes, northeasterly of the capelin aggregations discovered. Rate of cod feeding in that area was low, mean degree of stomach fullness amounted to 0.78. 61.5% of examined stomachs were empty and no capelin were found in the rest portion.

High rate of capelin consumption by cod was observed in the central and southern parts of Div.3K where capelin mainly aggregated with its frequency of occurrence in stomachs being 50-88% (Fig.). On the whole, it amounted to 18.8% in the area. Thus, the main portion of cod population did not feed on capelin in Div.3K in that period.

The survey conducted in 1988 in terms earlier than in previous years, - in late April-early in May, - also showed that the most considerable cod aggregations occurred in the north of the Funk Island Bank, where catches constituted 2-4 t per trawling. Their position, similar to that in 1987, was much easterly relative to capelin, distributed to the west of 52°30'. As indicated by the results from field analyses, fulfilled in the area of main cod aggregations, no capelin were registered in its stomachs.However, Cod's "patch" of mean density (about 500 kg/trawling) has been found in the central part of the area in close vicinity of capelin aggregations, where cod actively fed on capelin with its occurrence frequency in cod stomachs being 60-93%. High indices for capelin occurrence frequency were registered in the south of Div.3K too, in the vicinity of capelin aggregations. Thus, a possibility of local feeding of cod on capelin is shown as it was exemlified by 1988, what, however, was non-typical of the whole cod stock off the Notre Dame.

In 1989 the survey has been conducted later - in mid-June. Cod, already moved from slopes to the central part of Div.3K, created aggregations of heavy density (to 12 t/trawling) along the frontal zone of Labrador and Atlantic waters, notably westerly against 1987-1988. In previous years it was the area of distribution of capelin aggregations in April-early June. How-

ever, by mid-June 1989 no its aggregations were found on the bank. Thus, in June no overlapping of areas of the main biomass of prey and predator also took place.

High indices for stomach fullness of cod were fixed in a sample taken near minor capelin aggregation. Mean partial index of stomach fullness made up 256.9‰, occurrence frequency reached 92%. However, a lack of heavy capelin aggregations, where cod could actively feed on it, gives no reasons to believe that a level of consumption of the whole population of fish-predators is high. On the whole occurrence frequency made up 13.2% in the area, mean partial index of stomach fullness in sample taken randomly in the south of the area, constituted 11.3 ‰.

Special attention should be focused on the analysis of the 1990 data. The survey has been carried out in the first half of June. Hydrographic observations allowed to make a conclusion about abnormally low thermohaline indices of water masses in the area; wide distribution of ice fields was noted (Borovkov and Tevs, 1991). Area of cod distribution, compared to previous years, was limited, and extensive sites with negative water temperatures at the bottom were recorded , where no cod were in trawl catches. Heavy aggregations of cod developed along the Funk Island Bank eastern slope , where higher bottom water temperature was noted compared to the previous year and long-term mean. Catches amounted to 7 t per trawling. Acoustic survey of capelin stocks was not conducted. As it was done previously, an attempt to represent capelin distribution by its occurrence in cod stomachs was undertaken. However, in samples,taken in different parts of the Notre Dame for cod feeding, either capelin were not found in stomachs, or it constituted quite minor portion in ration. On the whole cod occurrence frequency amounted to 4.7% in the area. Hence, as a result of existing unfavourable hydrographic conditions, redistribution of stocks of cod and, mainly, capelin, took place, what essentially influenced the rate of its consumption by cod.

CONCLUSIONS

As a result of the investigations conducted in Div.3K during spring-early summer it was elucidated that a possibility of capelin consumption by cod was much reduced by spatial isolation of areas of prey and predator. Apparently, adaptation of capelin , as cod's food object to preservation of population, providing optimal conditions for its survival during prespawning migrations consists in this.

Local feeding of cod on capelin may take place , what is non-typical of the whole predator population. Therefore, it is impossible

to use the calculated quantitative data (on rations) for cod samples, collected in the sites of maximum capelin aggregations, for the whole population, since it results in overestimating of actual consumption.

Real essential year-to-year fluctuations are available in total number of capelin consumed by cod in spring-summer in Div.3K, as a result of variation in hydrodynamic factors and related to this redistribution of both the prey and predator stocks.

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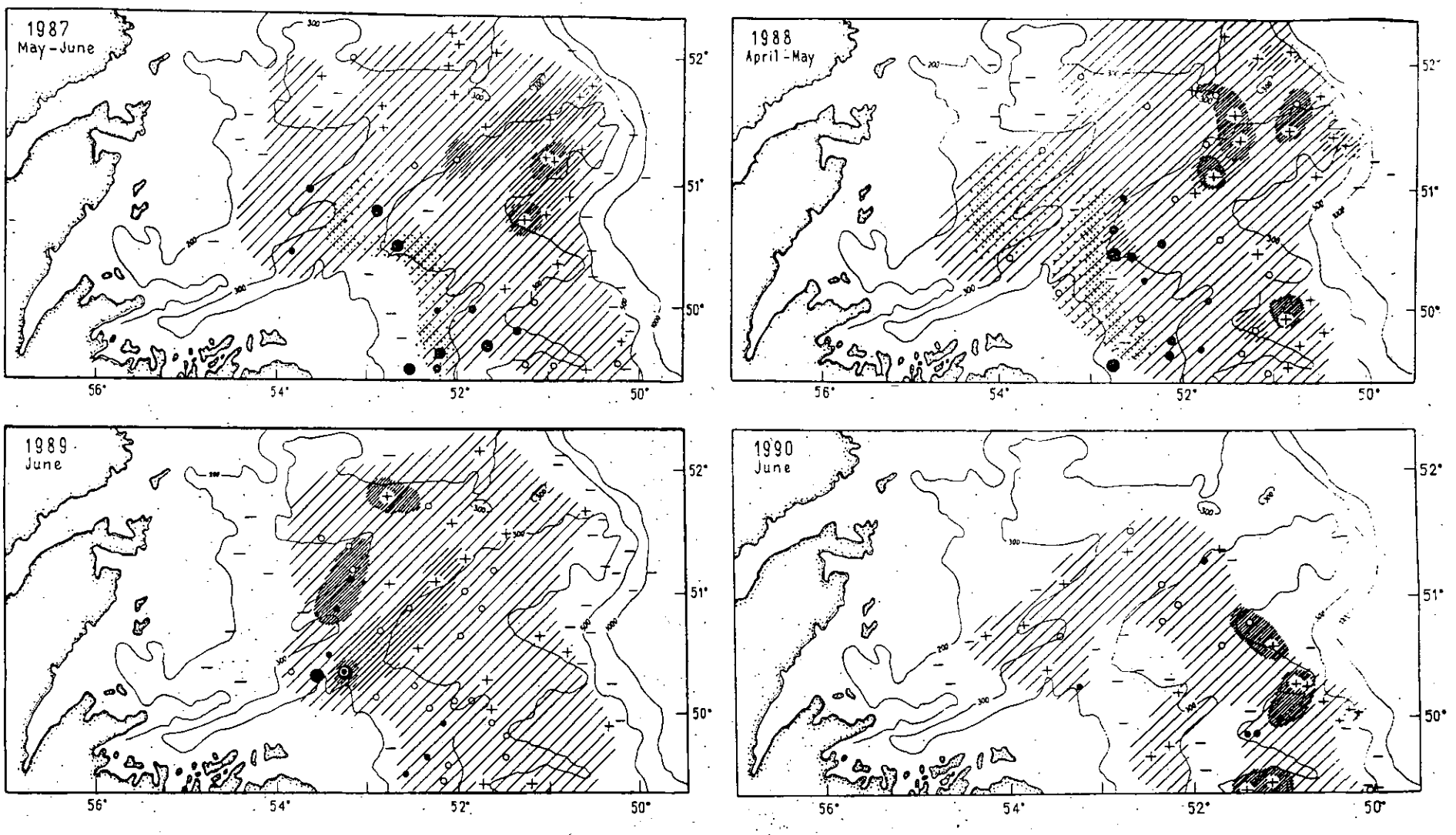
Table 1. Frequency of occurrence (%) of food items in cod stomachs off the Northern Newfoundland Bank in spring-summer 1987-1990

Food items	1987	1988	1989	1990
	May-June	April-May	June	June
Copepoda	-	0,4	-	0,1
Hyperiidae	1,8	0,7	4,0	3,4
Gammaridea	4,1	-	0,5	1,5
Euphausiacea	2,4	1,9	0,5	0,6
Shrimp	23,2	18,2	56,8	40,1
Crabs	5,2	16,1	10,3	11,8
Other crustaceans	-	-	0,5	0,2
Bivalved molluscs	0,3	-	0,2	0,1
Gastropoda	0,3	0,1	0,1	0,1
Cephalopoda	0,3	-	0,3	0,1
Echinodermata	1,8	0,3	0,5	0,6
Polychaeta	2,2	1,5	0,9	2,3
Ctenophora	0,6	-	9,3	-
Coelenterata	0,2	-	0,5	0,3
Redfish	0,1	0,1	-	0,1
Grenadier	0,1	-	-	0,1
Halibut	0,1	-	1,0	-
Cod	-	-	-	0,4
Capelin	18,8	14,0	11,4	4,7
American plaice	-	-	0,3	0,1
Sand eel	-	-	0,1	0,3
Gobiidae	-	-	0,1	-
Polar cod	-	0,8	0,1	-
Digested fish	3,4	3,1	3,3	6,4
Digested food	5,2	3,2	2,5	8,0
No.of stomachs	966	721	825	685
Percent empty	38,6	46,0	13,2	30,8
Mean degree of fullness	0,98	1,2	2,0	1,54



Distribution of cod and capelin and occurrence frequency of capelin in cod stomachs (%) in Div. 3K in spring and summer seasons of 1987 - 1990.