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Feeding of three species from the genus Sebastes in the Barents Sea

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Abstract

Qualitative and quantitative analysis was used to study feeding of 3 redfish species (Sebastes mentella, S. marinus and S. viviparus) in the Barents Sea in 2002-2010.

The analysis focuses on interannual, seasonal, spatial and ontogenetic variations of feeding intensity and diet of those species, caused by differences in habitat preferences, spatial distribution and length composition.

Keywords: redfish, diet, feeding, Barents Sea
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INTRODUCTION

Three species of redfish genus Sebastes inhabit the Barents Sea – deepwater redfish S.mentella, golden redfish S.marinus and Norway redfish S.viviparus (Andriashev, 1954; Andriashev and Chernova, 1995; Dolgov, 2004). Among these species S.mentella is the most abundant species with the widest distribution there, while S.viviparus is the rather occasional species with local distribution near Norwegian coast (Andriashev, 1954).

Investigations of redfish feeding in the Barents Sea were started since 1920-1930th yet, but only preliminary data on diet were initially collected (Idelson, 1929; Zenkevich and Brotskaya, 1931). The first special paper on feeding habits of redfish on data collected in 1934-1935 was published by G.V.Boldovsky (1944), but these data were mix of S.marinus and S.mentella due to original description of S.mentella as a new species was done only considerably later (Travin, 1951).

Later for deepwater redfish feeding of larvae (Konchina, 1970; Karamushko and Karamushko, 1995), juveniles at age 0-3 years (Antonov et al., 1989; Dolgov and Drevetnyak, 1995) and adult fishes (Antonov et al., 1989; Dolgov and Drevetnyak, 1993) have been studied. Besides, calculations of daily rations and food consumption (Dolgov and Drevetnyak, 1990, 1992) have been executed.

Diet of other redfish species were studied much less. For golden redfish feeding of juveniles off the Murman coast (Pozdnyakov, 1970) and feeding of adult fish under aquarium conditions (Antonov et al., 1989) were studied. Data on feeding of Norway redfish in the Barents are practically absent.

Therefore the main goals of the present paper were : 1) summary of data on feeding intensity and food composition of three redfish species in the Barents Sea, and 2) consideration of onthogenetic, spatial, seasonal and interannual variation in their feeding.

MATERIAL AND METHODS

This paper uses Russian data obtained by using of two standard methods accepted in Soviet/Russian trophic investigations – quantitative weight analysis method and method of the field analysis of a feeding (Anon., 1974).

At redfish feeding investigations it is necessary to take into account a considerable number of fishes with regurgitated stomachs which portion can reach 40-70 % and even more (Boldovsky, 1944). Due to this point the number of regurgitated stomachs didn't included to the number of investigated stomachs.

Quantitative data on redfish diet have been collected since late 1980th - 15509 stomachs of deepwater redfish (1997-2010), 1379 stomachs of golden redfish (1988-2010) and 156 stomachs of Norway redfish (1998-2010).

Qualitative data on redfish diet have been collected since 1950th – 88 429 stomachs of deepwater redfish (1957-2010), 27 928 stomachs of golden redfish (1957-2010) and 922 stomachs of Norway redfish (1969-2007).

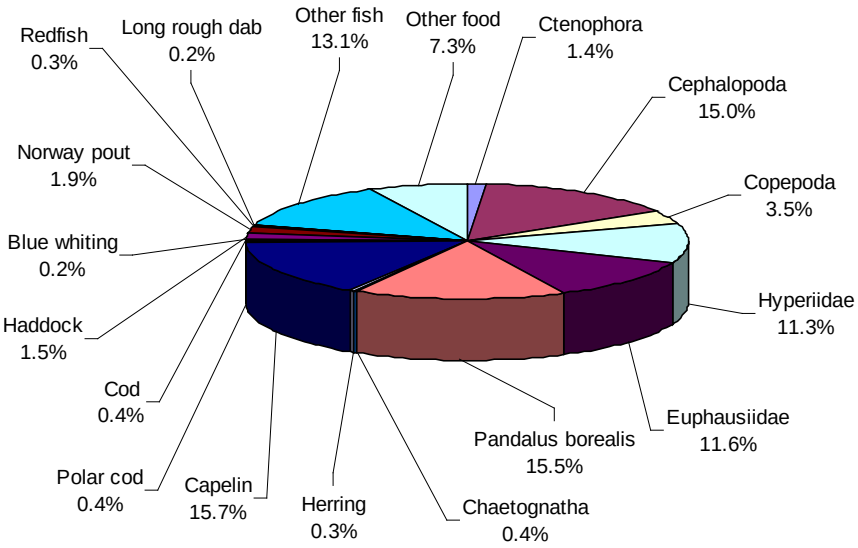
Mean fullness ball (MFB) and mean fullness index (MFI) were used as indicators of feeding intensity of redfish (Anon, 1974). Importance of prey items was estimated by frequency of occurrence %f (number of stomachs with given prey as percent of total number of stomachs with food) and weight percent %m (total weight of given prey as a percent of total food weight).

RESULTS AND DISCUSSION

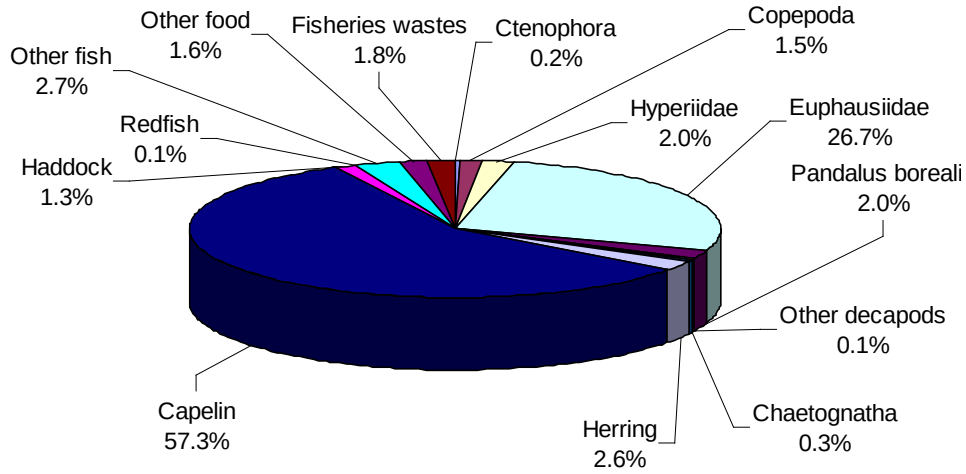
General food composition

Quantitative and qualitative data on general food composition of redfish in the Barents Sea have shown considerable differences between three species (Figure 1, Table 1).

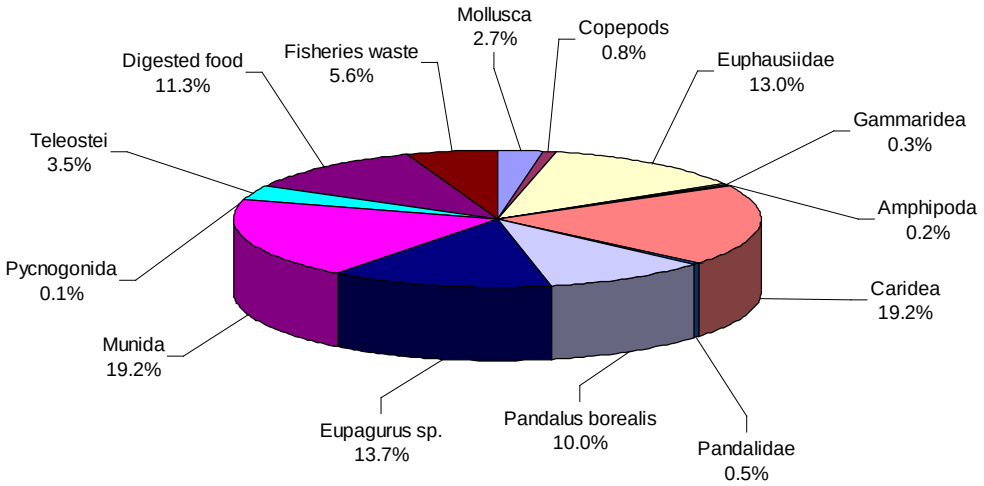
In terms of weight some prey taxons dominated in diet of deepwater redfish – fishes (totally 30 %m) and also decapods, plankton crustaceans and cephalopods (15-26 %m). Diet of golden redfish consisted of mostly fishes (totally 64 %m) and lesser plankton crustaceans (30 %). Importance of decapods in diet of this species was insignificant (2 %m). In contrast decapods were the dominant prey in diet of Norway redfish (totally 62 %m) – shrimps (including northern shrimp Pandalus borealis), hermit crabs Eupagurus spp, and munids. Portions of plankton crustaceans (euphuists, copepods) and fishes were much lower in diet of this species.



Sebastes mentella



Sebastes marinus



Sebastes viviparus

Figure 1. Diet composition of three redfish species based on quantitative data in 1988-2010 гг., %m

Data on frequency of occurrence of prey species also showed essential differences in diets of three redfish species (Table 1). For S.mentella and S.marinus approximately the same preys/groups were dominant in terms of both frequency of occurrence and weight – euphausiids, shrimps, hyperiids and capelin in deepwater redfish diet and capelin, euphausiids, arrow-worms and hyperiids in golden redfish diet. In contrast dominant prey in diet of Norway redfish based on quantitative and qualitative data were completely different.. Frequency of occurrence of arrow-worms (41 % f) a swell as shrimps, capelin and euphausiids (13-16 %f) was the highest in their diet, while decapods dominated by weight. Such distinctions in their diet are probably caused by a small number of investigated fishes and differences in seasons and areas of stomachs sampling.

Table 1. Food composition of redfishes in the Barents Sea in 1957-2010 based on qualitative data, %f

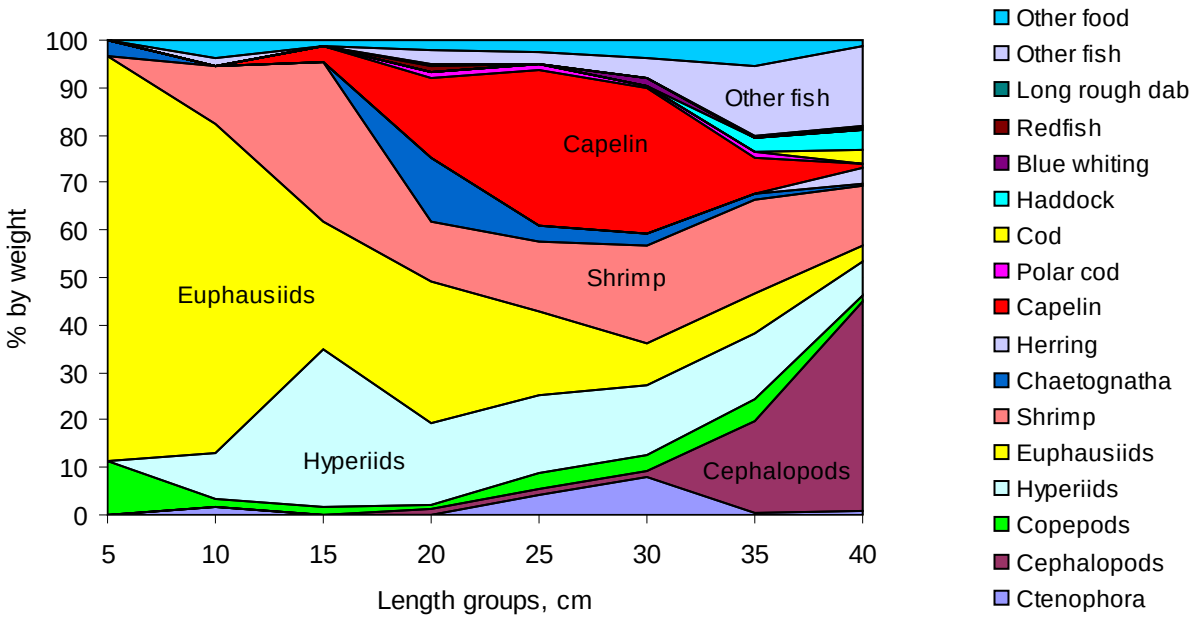
Prey	Sebastes mentella	Sebastes marinus	Sebastes viviparus
Ctenophora	4,76	4.22	
Annelida	0,62	0.60	
Polychaeta	0,04	0.11	
Gastropoda		0.02	
Pteropoda	0,05	0.08	
Cephalopoda	3,26	0.94	
Copepoda	6,76	7.42	9.84
Euphausiidae	52,12	41.72	13.11
Hyperiidae	12,74	8.70	
Gammaridea	1,99	2.36	3.28
Shrimp	18,15	7.17	16.39
Crabs	0,05	0.02	1.64
Bottom crustaceans	0,04	0.02	1.64
Chaetognatha	4,82	8.45	40.98
Echinodermata	0,12	0.09	
Herring	0,36	1.66	
Capelin	11,03	21.26	16.39
Polar cod	0,37	0.02	
Cod	0,68	1.45	
Haddock	0,06	0.37	
Blue whiting	0,31	1.03	
Norway pout		0.46	
Redfish	2,62	1.57	
Wolffish		0.02	
Cottidae	0,18	0.40	
Stichaeidae	0,06	0.09	
Sandeel	0,05	0.32	
Long rough dab	0,16	0.09	
Digested food	3,24	2.10	4.92
Number of stomachs	88429	27928	922
% of fish fed	22,6	22,6	6,6
Years	1957-2010	1957-2010	1969-2007

Onthogenetic food changes

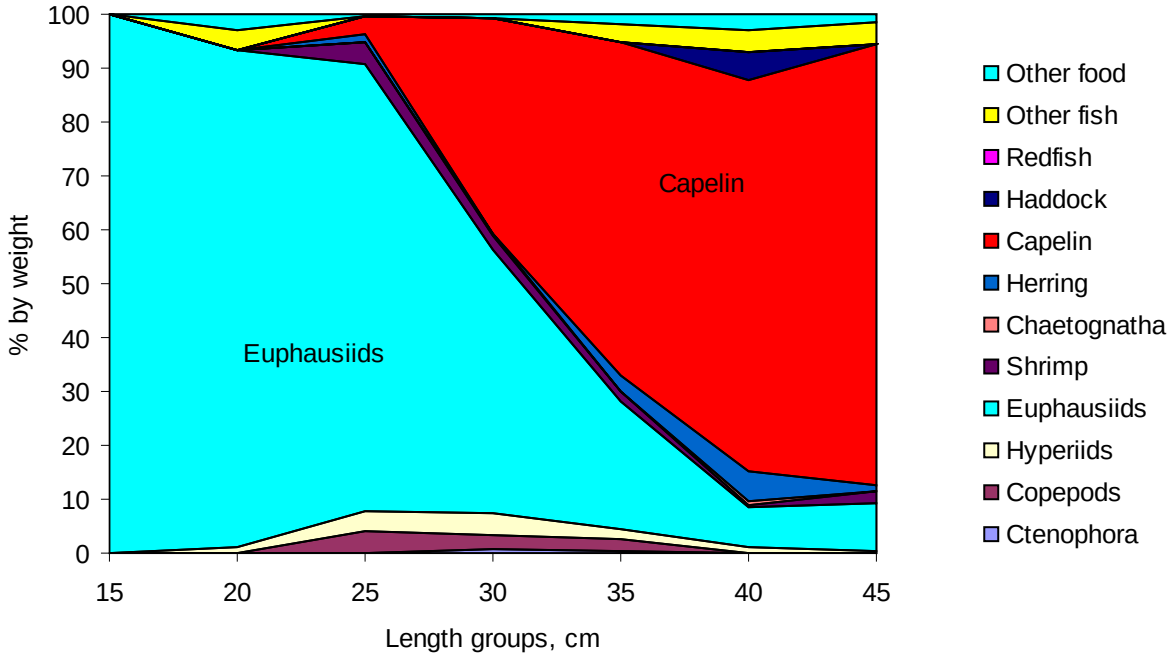
Dominance of small plankton organisms (copepods and euphausiids) was observed in the diet of deepwater redfish at length up to 10-15 cm (Figure 2). In the diet of larger fishes their importance decreased, while weight percent of larger prey (hyperiids in diet of fish at length 15-30 cm), shrimps and capelin in diet of fishes at length 25-35 cm) increased. The largest fishes (length > 35 cm) feed mainly on cephalopods and various fishes. In contrast, there were no obvious regularities in diet of different age groups of deepwater redfish (Figure 3) that confirms that diet of this species depend mostly on fish size than on their age.

Size changes in food of golden redfish have been expressed even more accurately (Figure 2). Fishes at length less 25 cm preyed mainly on euphausiids. Importance of fish sharply increased in the diet of larger individuals and fish was the dominant food in fishes at length >35 cm.

Some onthogenetic changes of food composition were observed in the diet of Norway redfish too. Frequency of occurrence of zooplankton (copepods and euphausiids) decreased from 35-50 %f in fish at of 21-22 cm to full disappearance in diet of fishes at length >29 cm. Frequency of occurrence of arrow-worms after maximum in fishes at length 23-24 cm (65 %f) decreased and was stable (29-33 %) in larger individuals. At the same time frequency of occurrence of shrimps and capelin increased from total absence in diet of small individuals (length < 23 cm) to 30-40 %f in fish at length > 27 cm.



Sebastes mentella



Sebastes marinus

Figure 2. Food composition of redfish from different length groups in 1988-2010 based on quantitative data, %m

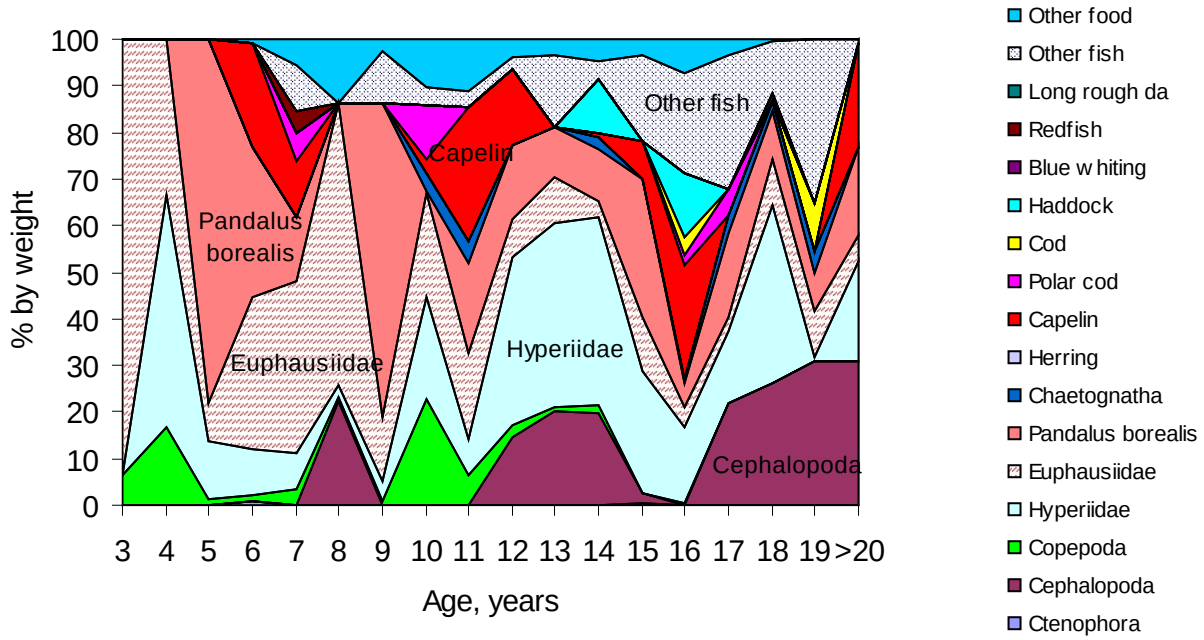


Figure 3. Food composition of deepwater redfish from different age groups in 1997-2010 based on quantitative data, %m

Seasonal changes

Distinct seasonal changes of feeding intensity and food composition were observed in deepwater redfish (Figure 4-5). During winter-spring period feeding intensity of this species was usually low, the values of mean fullness ball didn't exceed 0,2-0,3. Euphausiids, shrimps, copepods and hyperiids and also capelin in February-April occurred most often in their diet during this period. During summer-autumn feeding intensity of golden redfish sharply increased, mean fullness ball raise up to 1,-1,2. Thus euphausiids, shrimps and lesser hyperiids dominated in their diet in terms of frequency of occurrence. Herring, cod and haddock occurred in diet of this species only in autumn and winter (September-December), when frequency of occurrence of herring and juvenile cod were reached 8-10 %f.

Data on diets of golden redfish and Norwegian redfish doesn't allow to analyze seasonal changes in their feeding.

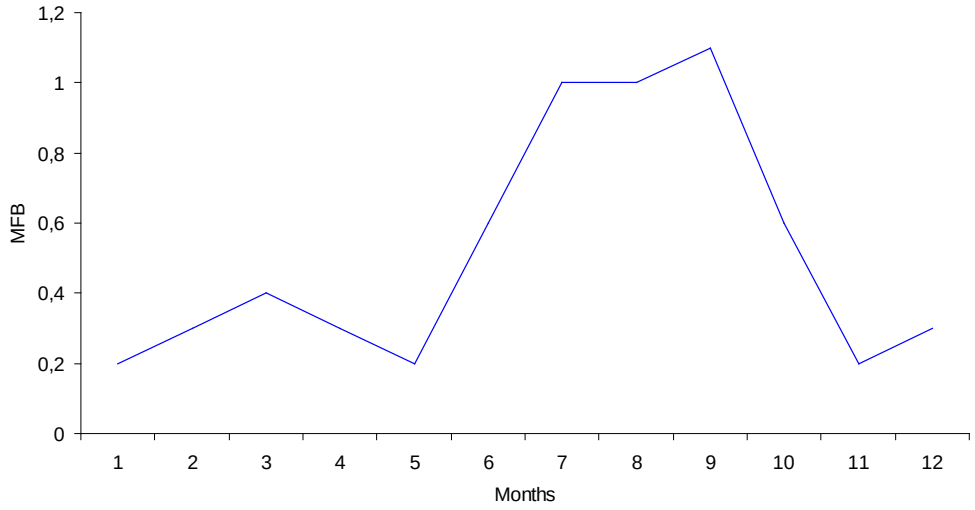


Figure 4. Seasonal dynamics of mean fullness ball of deepwater redfish in 2000-2010 based on qualitative data.

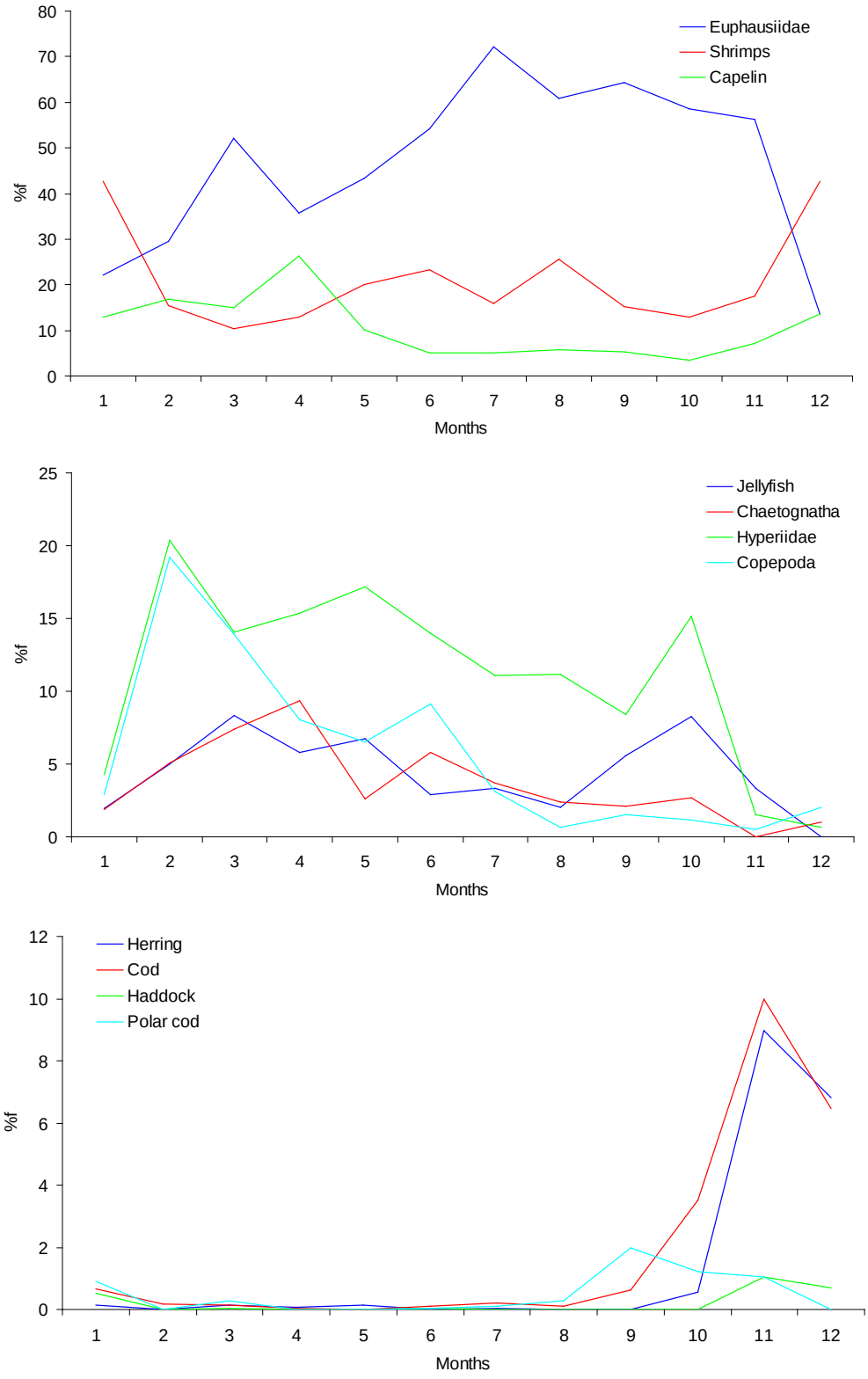


Figure 5. Seasonal dynamics of frequency of occurrence of various prey in diet of deepwater redfish in 2000-2010, %f

Interannual changes

In 2000-2010 accurately expressed dynamics of food composition of deepwater redfish were not observed (Figures 4-6). At the same time it is possible to note decreasing of frequency of occurrence of ctenophores and copepods from 9-13 and 9-24 %f accordingly in 2001-2002 to less than 1 %f in 2008-2010. Besides, in 2002-2003 and 2005 intensive consumption of blue whiting by this species was noticed that coincide with high importance of blue whiting in cod diet in the same years. Last years (2008-2010) own juveniles has appeared in diet of deepwater redfish (up to 5-18 %f), while cannibalism in this species were not observed in previous years.

In some cases rather good correspondence of dynamics of prey importance from quantitative and qualitative data was marked. So, frequency of occurrence and weight percent of cephalopods sharply increased 2005-2006 and 2008-2009.

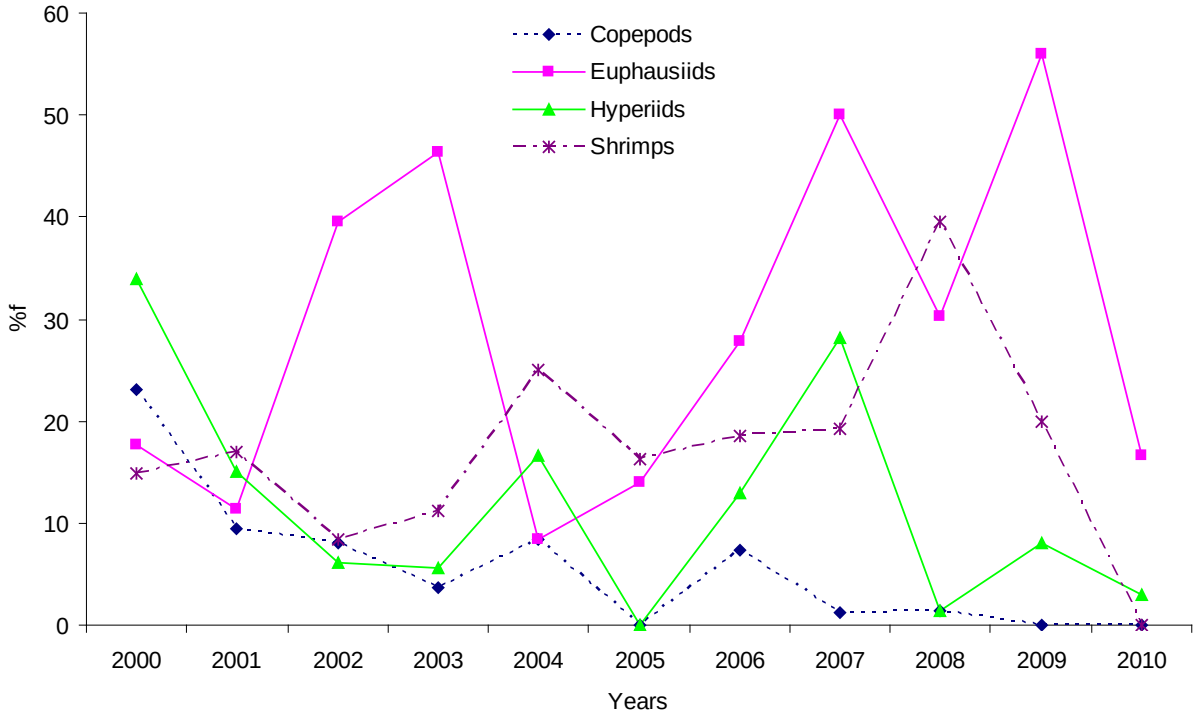


Figure 6. Interannual dynamics of frequency of occurrence of invertebrates in diet of deepwater redfish in 2000-2010., %f

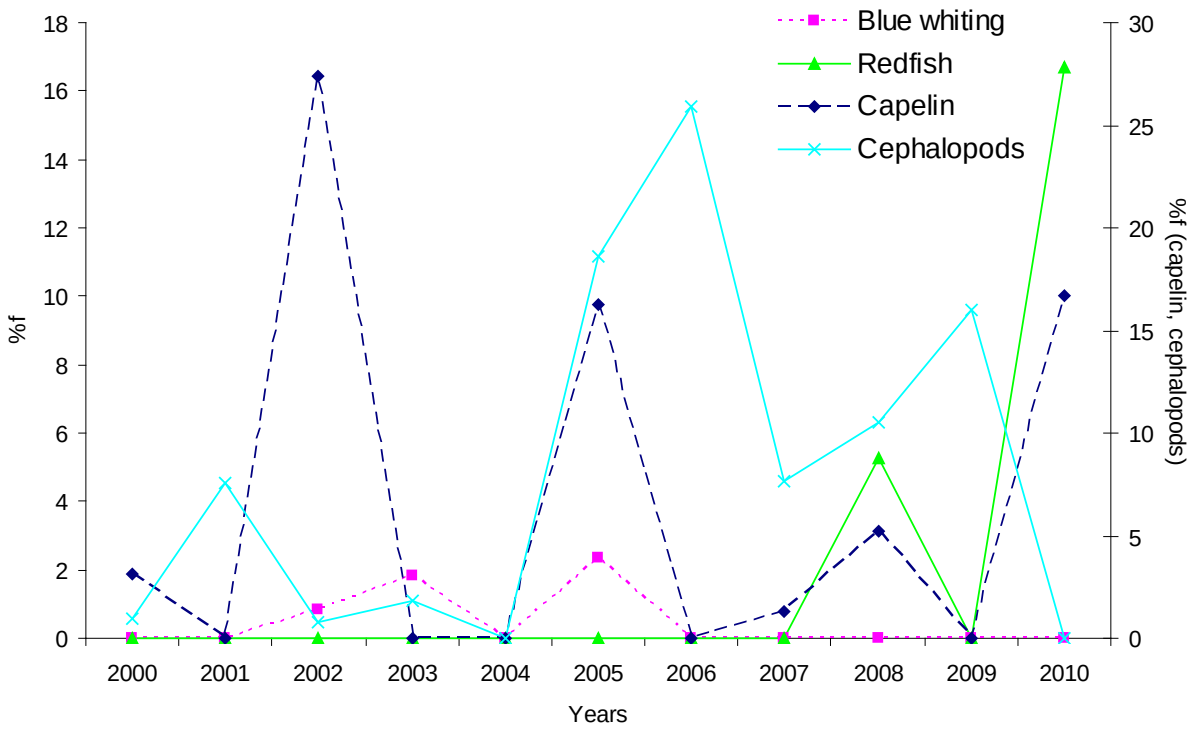


Figure 7. Interannual dynamics of frequency of occurrence of fishes and cephalopods in diet of deepwater redfish in 2000-2010., %f

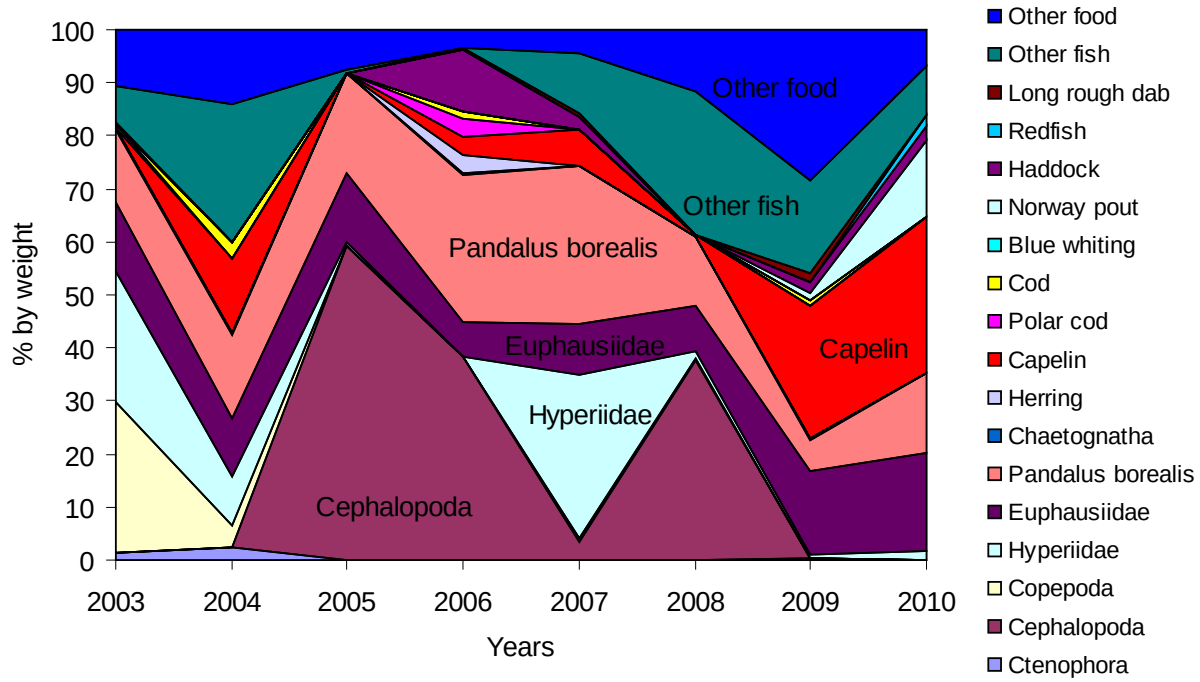


Figure 8. Interannual dynamics of food composition of deepwater redfish in 2003-2010., %m

Data on diet of golden redfish and Norwegian redfish don't allow to analyze interannual changes in heir feeding.

Spatial changes

Spatial changes in diet of deepwater redfish and golden redfish were observed in recent years (Figures 7-8).

Feeding intensity of deepwater redfish was rather similar throughout whole Barents Sea with some raising on their distribution area borders and especially in the northernmost areas. Capelin and lesser hyperiids dominated in their diet in northern Barents Sea, while euphausiids and shrimps prevailed in the diet in open areas of the central part of the sea. In the western Barents Sea and off Norwegian coast this species fed mostly on cephalopods and herring.

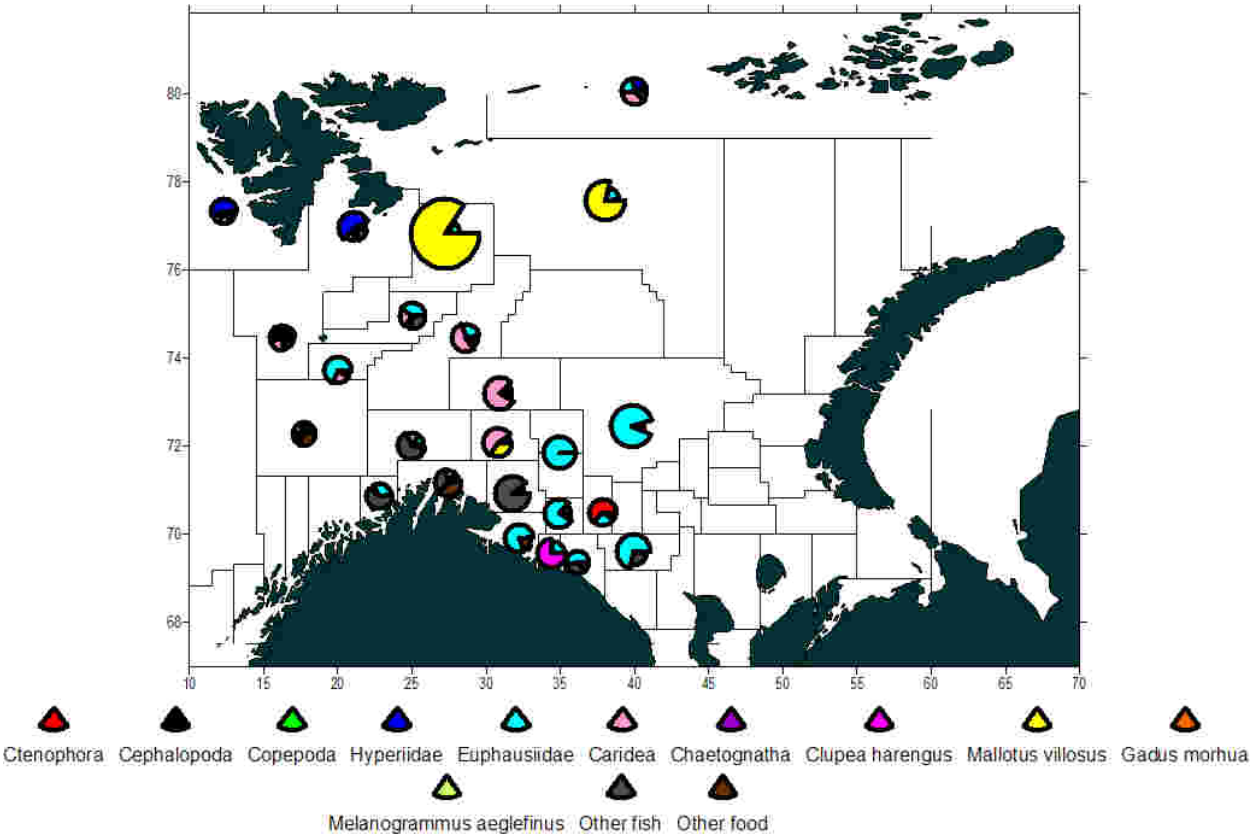


Figure 9. Food composition of deepwater redfish in various local areas of the Barents Sea in 2003-2010 ,% m (circles size corresponds to mean fullness indices)

Feeding of golden redfish was the most intensive near Norwegian and Murman coast during preying on capelin (what probably is caused by data sampling mainly in the spring on capelin spawning grounds). In other local areas euphausiids and shrimps as well as hyperiids (in northern areas) dominated in their diet, thus feeding intensity was at the average level.

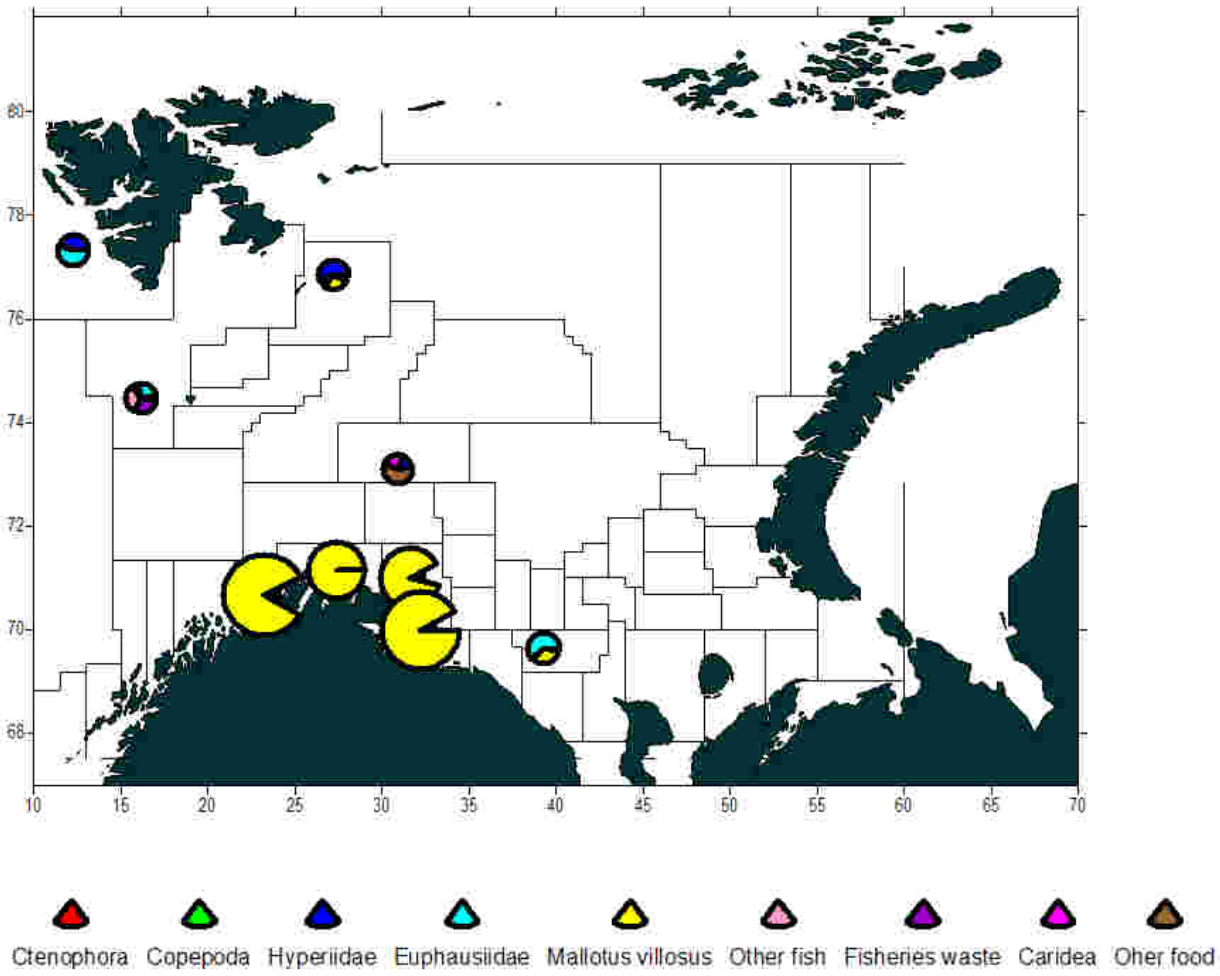


Рисунок 10. Food composition of golden redfish in various local areas of the Barents Sea in 2003-2010 ,% m (circles size corresponds to mean fullness indices)

Data on diet of Norwegian redfish don't allow to analyze spatial changes in feeding of this species.

Conclusions

Thus, despite rather high degree of coincidence of distribution areas of all three redfish species in Barents Sea, there was o considerable food competition between these species due to division of food resources among them. Deepwater redfish feed mainly on plankton and nekton invertebrates while golden redfish is more predatory species with dominance of various fish species in their diet, and large bottom decapods are dominant prey for Norwegian redfish.

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