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Feeding of *Cetroscyllium fabricci* (Reinhardt, 1825) and the Influence of the Fishery on its Diet in Flemish Pass (NAFO Divisions 3LM)

by

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Abstract

In 1992 151 stomachs containing food of Centroscyllium fabricci were analysed on board freezer vessels targeting the Greenland halibut (Reinhardtius hippoglossoides) fishery in NAFO Divisions 3LM. Three length groups were established to study variations in diet with length. The most important preys were waste products from fish processing of species caught by the fleet and fish. It was observed that diet varies with length, the smaller specimens feeding on crustaceans and molluscs, offal and fish appearing as prey more and more aslength increases, to become the main preys in larger predators.

Keywords

Feeding, North West Atlantic, *Cetroscyllium fabricci*, Offal

Introduction

Cetroscyllium fabricci, of the Squalidae family, is a species widely distributed throughout the Atlantic, in the West from Baffin Island to the Beagle Channel, and in the East Atlantic from Iceland to Namibia (Campagno, 1984; Lloris, D., 1986; Scott & Scott, 1988; Campagno et al., 1991; Roberto et al. 1993; Yano, 1995). It has been located from the surface down to depths of up to 1600 m (Campagno, 1984; Scott & Scott, 1988).

The gears which catch this species are bottom trawl and long-line (Templeman, 1963; Scott & Scott, 1988; Cardenas et al.,1996). The Spanish freezer trawl fleet has worked in NAFO Divisions 3LM since 1990 at between 800 and 2000 metres of depth (Rodriguez-Marin et al., 1995) the Greenland halibut

(*Reinhardtius hippoglossoides*) as the target species. The black dogfish is one of the accompanying species caught in this fishery and is always discarded, mainly because its catch is sporadic, but also due to its low commercial value (Pinhorn, 1976; Scott & Scott, 1988).

This species has been studied very little, although recently Robert et al. (1993) and Yano (1995) have carried out important studies on biometry and reproductive biology respectively. The species' feeding has been dealt with on numerous occasions (Bigelow and Schroeder, 1948; Clarke and Merret 1972; Sedberry and Musick, 1978; Mauchline and Gordon, 1983; Crabtree et al. 1991), although most of these articles are qualitative. In this study we analyse black dogfish feeding quantitatively, assessing variations with length, and the influence the fishery has on feeding.

Material and methods

The sampling area was NAFO Divisions 3LM, between March and June 1992. Sampling was carried out on board two commercial freezer vessels using trawl gear. Greenland halibut was the target species. A total of 96 hauls were analysed, the depths of which ranged from 737 to 1474 m, between 48° 30' N and 46°30' N and 47° 30' W and 46° W (figure 1).

The stomachs of 151 specimens were analysed, taking data of total length to the lower centimetre, sex and the the depth at which they had been caught. The stomach content analysis was performed on board the vessels, attempting to reach the lowest taxonomic classification of preys. Four prey categories were established: molluscs, fish, crustacea and offal. Within the category offal were considered, that is to say, those parts which were not included in freezing on board ship. In this fishery, heads, digestive tracts, and caudal fins of Greenland halibut and Macrurids would normally be the main components of this category (Saila, 1983; Rodriguez-Marin et al, 1995). Heads were measured to the lower centimetre and in their natural position.

Stomachs without food were not considered in obtaining an emptiness index, since, from what was observed on board, regurgitation is very common, similarly, specimens which had food remains in the mouth were rejected .

For the evaluation of stomach contents, frequency of occurrence was used, which characterises this species' feeding qualitatively (Hyslop, 1980):

$$FO=N_p/N_t *100$$

where N_p is the number of stomachs with a specific prey, and N_t is the total number of stomachs with food.

To see the variations of feeding with length, three length classes were created, < 60, 60 - 70, >70 cm. To observe whether the differences between the different length groups were significant with respect to the four prey groups, a Chi-squared test was performed with a 95% level of confidence.

Results

On carrying out the study of black dogfish feeding we must take a new component into consideration in addition to the large prey groups of crustacea, molluscs and fish. This component, offal from on board fish processing, has not to date been described in the diet of this species. This 'prey' is the main part of its diet (FO=41), the other two most important preys groups being crustacea (FO=30) and fish (FO=28). Molluscs are the least important prey with a FO of 9 (Table 1 and Figure 2).

The most important prey species are, within the crustacea, the ***Pasiphaea tarda*** (FO=11.41), and within fish, species of the Macruridae family with a frequency of occurrence of 7.38 (Table 1). With respect to molluscs the most important component is that of Cephalopoda Decapoda (FO=3.36).

In specimens <60 cm the main component is crustacea, with a frequency of occurrence of 59, the fish group being the least important (FO=10.35). Molluscs and offal appear in the diet with a frequency of occurrence of 20.69. In specimens of between 60 and 69 cm, offal is the main prey group (FO=40.98), together with crustacea (FO=29.5) and fish (FO=26.2). Meanwhile, in larger-sized specimens black dogfish feeding is fundamentally based on offal (FO=49.18) and fish (FO=40.98), with crustacea appearing to a lesser extent (FO=14.75)(Figure 3).

A Chi - square test was performed for the three length ranges with respect to the four large prey groups. In all cases the result was significant with $\alpha=0.95$: among the three length ranges $p<0.01$ (Chi-square=33,96022); among specimens of less than 60 cm and those of 60 - 69 cm, $p<0.01$ (Chi-square=12,78724); among these latter and specimens greater than 69 cm $p<0.05$ (Chi-square=7,96019).

Greenland halibut and Macruridae heads are the most important component of offal. A linear regression was performed between total predator length and Greenland halibut and Macruridae heads (Figure 4). The two components were dealt with separately, since the shape of the heads and their on board processing is different,. In the case of Greenland halibut this process is manual, while in that of Macrurids it is mechanical. Only in the case in which length was related to the Greenland halibut head was the result significant, although correlation is very low at R^2=0.201, with $p<0.05$ (N=26). When put against that of Macruridae, $p>0.1$ (R^2=0.051; N=26) (Figure 4).

Discussion

The role of discards in marine ecosystems is outstanding (Saila, 1983), but it is difficult to check this by direct observation, mainly because discarded species are discarded whole. For this reason, there is no external characteristic of the prey by which to differentiate between a discard prior to ingestion and a specimen consumed as live food unless a specific sampling (Olaso et al., 1996) is carried out. In our case at least part of the food on which the species feeds is easily identifiable as material previously discarded, since what appears is offal from the processing of the retained catch. That is to say, there are external indications that permit their identification as discarded material.

These offal are the most important component in the diet of black dogfish (Table 1). On considering this prey type, it must be taken into account that this is not a 'natural food'(Rodriguez-Marin et al, 1995), by which we refer to live prey, thus having escape and defensive resources. The energy consumed in catching the prey is probably much lower, and for this reason the presence of this prey type in the ecosystem may favour its consumption in detriment to the characteristic prey in the diet of this species. On the other hand it is a recognised fact that one of the main food sources in the Marine ecosystems is organic material from levels higher up the water column, of both a natural and an antrophic origin (George & Tyler, 1991; Kaiser & Spencer, 1995; Olaso et al. 1996). Sedberry and Musick (1978) have already described the possible carrion behaviour of this species.

Similar behaviour is observed by Rodriguez-Marín et al. (1995) in a simultaneous study using the same methodology as ours (NAFO Division 3LM) on Greenland halibut (*Reihardtius hippoglossoides*) feeding in which, though to a lesser extent (taking the diet in general into account), a considerable part of the diet comes from carrion behaviour (FO=9.6) revealing both how widespread this behaviour is in deep-water ecosystems and the outstanding role of fishing activities in this area.

With respect to the frequency of offal in relation to length we see an increase in the importance of offal in the diet of *C. fabricii* with increasing length. As we have already commented, there is a significant relationship, although correlation between this and the size of Greenland halibut heads is very low. This leads us to suppose that smaller specimens can only feed on the heads (the most important part of the offal found in stomachs) of smaller size, and so can only exploit the distribution tail-off, the smallest sizes, of retained catches of Greenland halibut, the limiting factor being predator mouth size. This would explain the lesser role of this prey type in smaller specimens. The non- existence of a statistical relationship between predator length and that of Macruridae heads may be due to heads having been measured in their natural position, as previously commented, and given that the shape in the species of this family is tubular, it would affect to a greater extent the probability of ingesting it at the maximum diameter of the head and not its total length.

If we do not take offal into account and we consider the rest of the preys as natural food, we observe that diet is fundamentally based on fish and crustacea with a small proportion of cephalopods, mainly decapods, which is in agreement with the results of Crabtree et al. (1981). A similar conclusion can be drawn from studies into the feeding of this species (Bigelow and Schroeder, 1948; Clarke and Merret 1972; Sedberry and Musick, 1978; Mauchline and Gordon, 1983), in which these two prey groups are the most important.

If we observe the changes in diet which come about with length, respecting the previous condition, we observe that the smaller specimens feed mainly on crustacea and cephalopods, these species or classified taxonomic groups being typical of areas far from the bottom (Rodriguez-Marin et al., 1995). Specimens greater than 69 cm are fundamentally ichthiofagous, Macruridae being the most important prey, and this seems to indicate a more direct relationship with the bottom (Cage, 1991) than that of smaller specimens. This capacity for displacement in the water column has been described by Biguelow and Shroeder (1948) and Sedberry and Musick (1978) The diet of the 60 to 69 cm group seems to be one of transition between these two types of feeding.

To sum up our results and from work carried out to date it seems clear that this is a generalist species with a carrion tendency, with the capability of displacement in the water column and in which smaller specimens exploit different resources than those of greater length. At the same time, we have been able to confirm the influence of the fishery on deep-water marine ecosystems.

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Figures

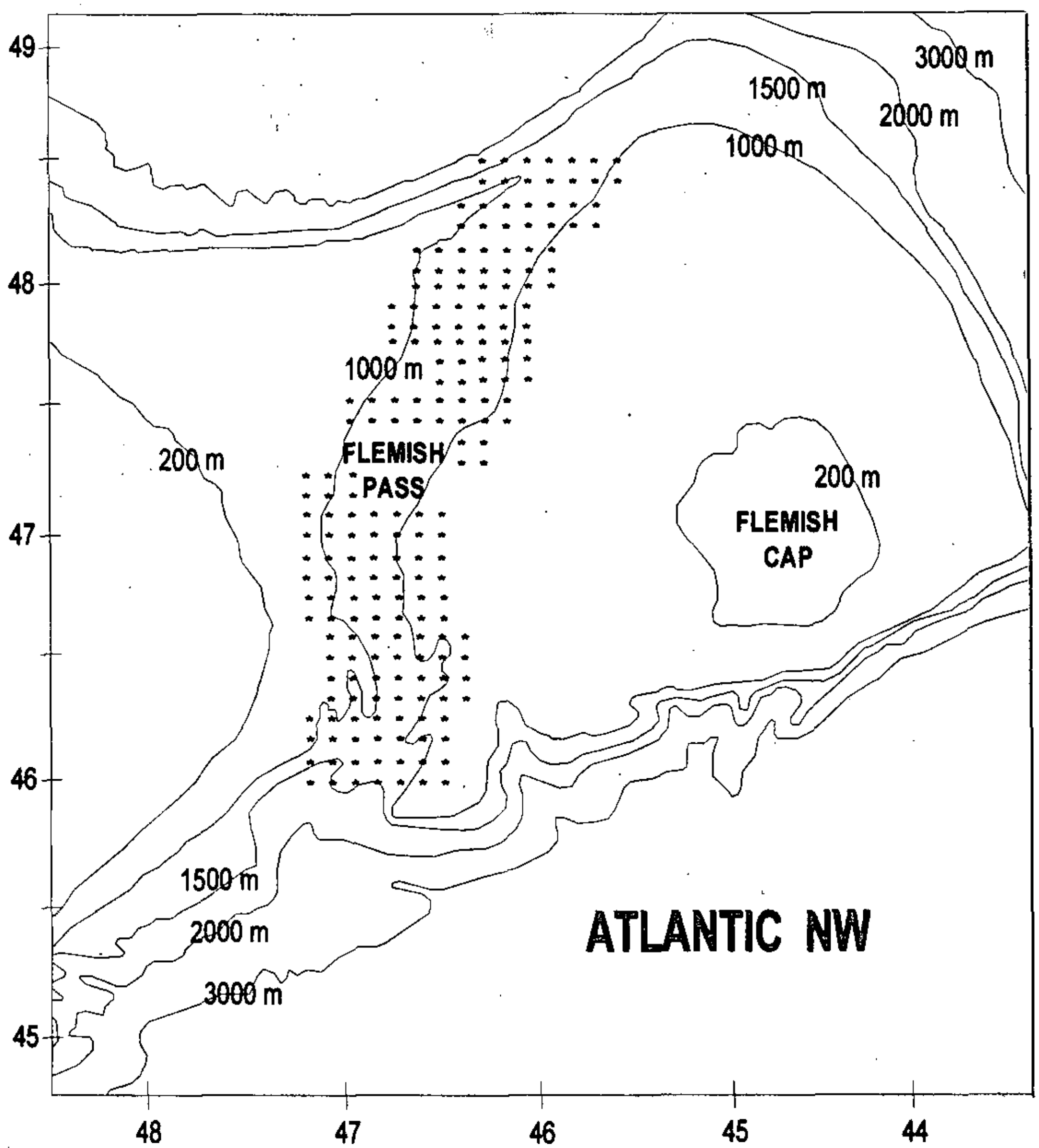


Figure 1. Sampling area in Flemish Pass.

Table 1. Centroscyllium fabricci main diet components by lengthgroup.

Prey	Size Range <60	Size Range 60-69	Size Range >70	Total
Crustacea	**58.62**	**29.51**	**14.75**	**29.53**
Decapoda				
Natantia				
Pasiphaea tarda	20.69	14.75	3.28	**11.41**
Pandalus borealis			1.64	**0.67**
Unidentified Natantia	37.93	14.76	9.83	**17.45**
Mollusca	**20.69**	**9.84**	**3.28**	**9.4**
Decapoda	20.69	6.56	1.64	**3.36**
Octopoda		1.64	1.64	**1.34**
Unidentified Mollusca		1.64		**4.7**
Others	**20.69**	**42.62**	**50.82**	**42.28**
Unidentified		1.64	1.64	**1.34**
Offal	20.69	40.98	49.18	**40.94**
Pisces	**10.35**	**26.23**	**40.98**	**28.86**
Serrivomeridae				
Serribomer beani	3.45			**0.67**
Macruridae	3.45	4.92	13.11	**7.38**
Coryphaenoides rupestris		3.28	8.2	**4.7**
Nezumia bairdii	3.45		1.64	**1.34**
Macrurus berglax		1.64	3.28	**2.01**
Moridae				
Antimora rostrata			1.64	**0.67**
Myctophidae		4.92	6.56	**4.7**
Scorpaenidae				
Sebastes sp.		1.64	1.64	**1.34**
Synapobranchidae				
Synapobranchus kaupi		1.64		**0.67**
Searsiidae				
Holbyrtnia sp.	3.45			**0.67**
Unidentified Pisces		13.11	19.67	**13.42**
No. Stomachs	29	61	61	**151**

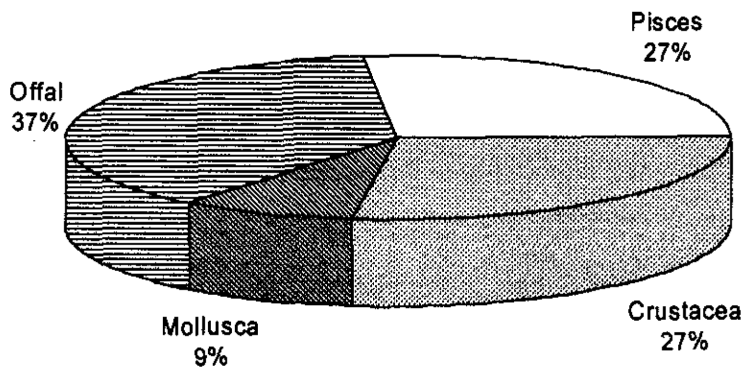


Figure 2. Centroscyllium fabricci main diet components.

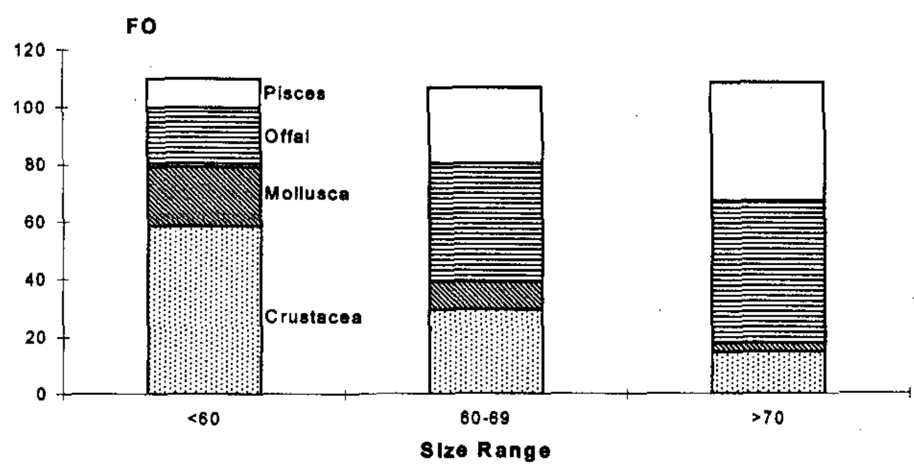
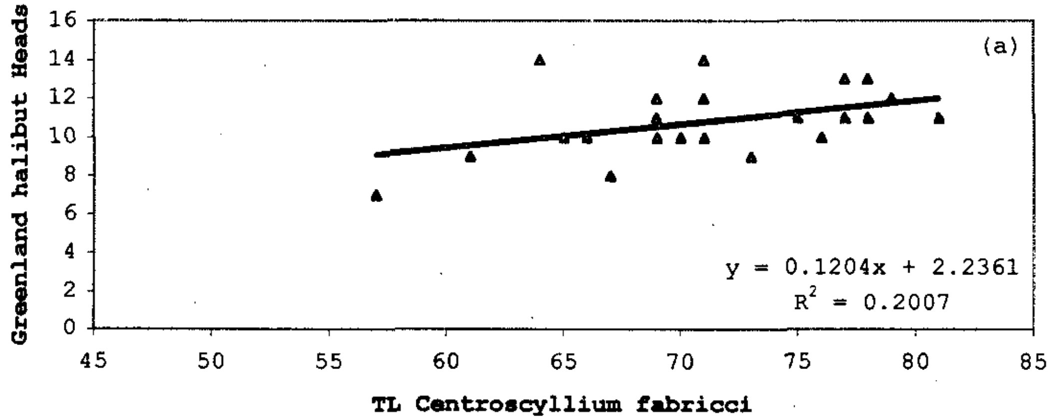


Figure 3. Centroscyllium fabricci main diet components by length group



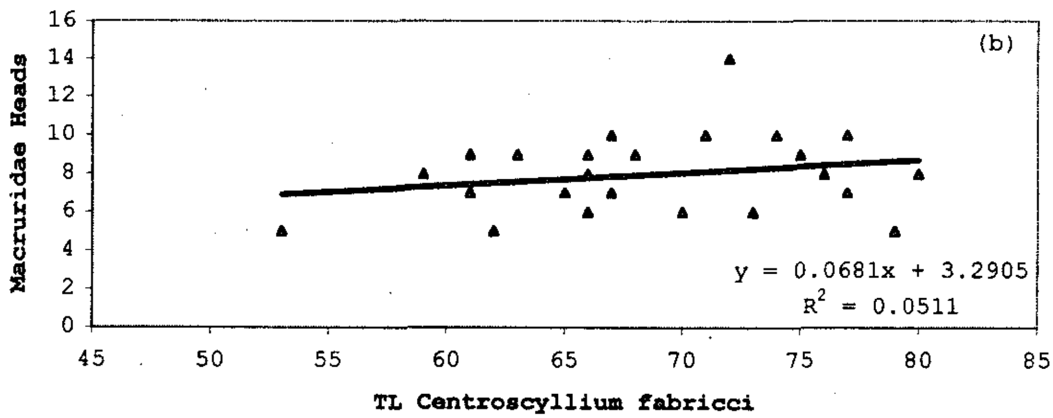


Figura 4. Linear Regression between total length of C. Fabriccii and the length of Greenland halibut heads (a) and macrurid heads (b)