OBSERVATIONS ON THE FEEDING HABITS OF THE NARROW MOUTHED CAT SHARK *SCHROEDERICHTHYS BIVIUS* (CHONDRICHTHYES, SCYLIORHINIDAE) IN THE BEAGLE CHANNEL

by

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ABSTRACT. - The study of the stomach contents of 97 specimens of the narrow mouthed cat shark *Schroederichthys bivius* shows that their basic food consists of crabs, mainly *Munida subrugosa*. No significant variations were observed between size classes. The strongly developed sexual dimorphism in tooth morphology and mouth shape was not correlated with the diet of males and females.

RÉSUMÉ. - L'étude des contenus stomacaux de 97 spécimens d'holbiche blanche, *Schroederichthys bivius*, montre que les proies préférentielles sont des crabes, principalement *Munida subrugosa*. Aucune différence significative n'apparaît entre les classes de tailles. Il n'y a pas de corrélation entre l'important dimorphisme sexuel (forme de la bouche et des dents) et le régime alimentaire des mâles et des femelles.

Key-words. - Chondrichthyes, Scyliorhinidae, *Schroederichthys bivius*, Beagle Channel, Feeding habits.

The narrow mouthed cat shark *Schroederichthys bivius* (Smith, 1838) is common on the continental shelf of the magellanic zoogeographical province (Norman, 1937) and, according to Krefft (1968), the centre of distribution is on the Pacific side of this province. Its northern limit appears to be about 35°S in the Argentine Sea (Cervigón and Cousseau, 1971) and is distributed, according to Menni *et al.* (1979) up to 55°S at depths from 28 to 179 m where the bottom temperature is between 3.5 and 12.5°C. According to Bellisio *et al.* (1979), *S. bivius* is a characteristic species from the Malvinas current and lives from the surface to approximately 150 m. Ojeda (1983) extends its bathymetrical distribution to 359 m. This species is common in the Beagle Channel between 12 and 110 m depth (Lloris and Rucabado, 1991).

According to Menni *et al.* (1979) and Menni (1986), this species shows some sexual segregation with depth: females are more numerous in the shallow stratum (below 100 m) while large numbers of males are found between 100 and 130 m. Gosztonyi (1973) and Menni *et al.* (1979) showed that *S. bivius* displays an unusual secondary sexual dimorphism, with the males being larger than females (total length (TL) of 820 mm versus 700 mm respectively). Gosztonyi (1973) shows also that both the mouth and teeth shape are sexually dimorphic in this species and that this change starts in both sexes at 300 mm TL. Teeth in adult males are unicuspidate and twice as high as the tricuspidate teeth of females of similar size. According to this author, females reach sexual maturity at 400 mm TL, while males mature at 530 mm TL. No substantive data are known about the reproduction of *S. bivius*.

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In relation with its feeding habits, the only reference is made by Menni *et al.* (1979): "*S. bivius* is an omnivorous species that feeds mainly on Fishes, Polychaeta and Crustacea".

The present paper gives some qualitative and quantitative data on the diet of *S. bivius*.

MATERIAL AND METHODS

The stomach contents of 97 specimens (67 males and 30 females) were analysed. The specimens were caught using trammel nets in the Beagle Channel in February and March 1988.

Total length of males varied from 37 to 73 cm, most of them (56.7% of total) were between 41 and 50 cm. Total length of females varied from 35 to 50 cm, 66.6% of them sized between 41 and 50 cm TL. In this sample, 32.7% of the males and 83.2% of the females are adult. All specimens were longer than 30 cm TL which is the size at maturity (Gosztonyi, 1973).

In the Laboratory of the CADIC (Centro Austral de Investigaciones Científicas) of Ushuaia, the specimens were measured, the sex was determined and the stomachs extracted and preserved in 10% formalin for later study. The stomachs were grouped by sex, in 10 cm size classes. The following indices have been used for a quantitative analysis of the diet of this species:

Coefficient of repletion (CR).- Percentage of stomachs containing food.

Frequency of occurrence index (F).- Percentage of stomachs with a specific species or food item, in relation to number of stomachs with food.

Numerical abundance index (N).- Percentage of specimens of a particular species, or food item, in relation to total number of specimens.

Weight index (W).- Percentage in weight of all specimens of a particular food item in relation to total weight of all the prey items.

Index of relative importance (IRI).- The IRI = F x (N+V). We have replaced volume (V) by weight (W). In the tables I and II, the IRI appears both as its absolute value and, also, according to Rosecchi and Nouaze (1985), transformed using the formula $\%IRI = IRI/\sum IRI \times 100$ in order to compare it with the other indices.

In the text, the term "prey groups" is referred to the total number of groups and the term "prey items" to the total number of individuals.

To calculate the diet-overlap between each two size classes, we have used the Schoener (1970) index: $PSxy = 1 - 0.5(pi-qi)$, where "pi" and "qi" are the values of the numerical index (N) in the groups being compared.

RESULTS

The sex-ratio (2.3) of the sample studied does not agree with the sexual segregation with depth observed by Menni *et al.* (1979) for this species in the shallow stratum.

Of the 97 stomachs analysed, 84 were found to contain food: a total of 203 prey items with a total weight of 186.78 g. The coefficient of repletion (CR) was 86.5% (88.0% in males and 71.4% in females). In the sample studied, the CR of the females increased with size from 60% in the specimens of the size class 1 (30-39 cm TL) to 100.0% in the size class 3 (50-59 cm TL). The values of the CR by size classes in males were respectively 57.1; 89.4; 100.0; 77.7 and 100.0%.

Table I shows both qualitative and quantitative importance of every food item in the diet of *S. bivius* for the total sample studied for both males and females.

Table I. - Quantitative and qualitative importance of items in the diet of *S. bivius* both global (total) and by sex (males and females). IRI = Index of Relative Importance; %IRI = Percentage of IRI.

	Total		Males		Females	
	IRI	**%IRI**	**IRI**	**%IRI**	**IRI**	**%IRI**
Algae	35.81	0.270	50.19	0.370	8.83	0.070
Porifera	0.73	0.006	1.36	0.010	-	-
Sipunculida	1.39	0.010	2.58	0.020	-	-
Priapulida	4.97	0.030	9.21	0.060	-	-
Priapulus sp.	4.97	0.040	9.21	0.070	-	-
Echiurida	1.65	0.010	3.06	0.020	-	-
Echiurus sp.	1.65	0.010	3.06	0.020	-	-
Polychaeta	71.45	0.480	95.03	0.640	-	-
Aphrodite sp.	1.07	0.008	2.00	0.010	-	-
Polychaeta unid.	54.76	0.410	69.17	0.510	-	-
Crustacea	16470.58	98.190	16030.18	97.720	17843.42	99.240
Cirripeda	0.74	0.006	1.38	1.020	-	-
Isopoda	31.78	0.220	43.09	0.290	9.19	0.060
Valvifera	14.74	0.110	16.89	0.120	9.19	0.070
Flabellifera	0.64	0.005	1.21	0.009	-	-
Sphaeromatidae	0.95	0.007	1.77	0.010	-	-
Amphipoda	2.58	0.020	4.82	0.040	-	-
Decapoda	14374.22	97.570	14361.96	97.100	14532.05	98.340
Munida subrugosa	12942.43	96.960	13149.60	96.820	12479.88	96.620
Brachyura	21.16	0.160	12.43	0.090	57.54	0.450
Decapoda unid.	72.36	0.540	55.10	0.410	133.26	1.030
Crustacea unid.	19.34	0.140	5.53	0.040	99.71	0.770
Teleostei	21.38	0.150	25.02	0.170	11.88	0.080
Champsocephalus esox	3.05	0.020	5.62	0.040	-	-
Patagonotothen sp.	0.81	0.006	1.51	0.010	-	-
Teleostei unid.	2.99	0.020	1.21	0.009	11.88	0.090
Unidentified tissues	166.53	1.250	187.40	1.380	115.94	0.900
Number of fish examined	97		60		37	
Coefficient of repletion (%)	86.5		88.0		71.4	
Number of prey items	203		151		52	
Total weight of prey (g)	186.8		142.9		43.9	

Figure I shows the relative importance of the different prey groups. The basic food of *S. bivius* using the Nikolsky (1963) classification, consists of Crustacea Decapoda with *Munida subrugosa* as the main species consumed by both sexes. The remaining groups listed in table I are incidental. *S. bivius* was found to be virtually monophagous in the Beagle Channel during summer. The presence of incidental prey items was higher in males than in females. Teleosts occurred in the stomach contents of specimens longer

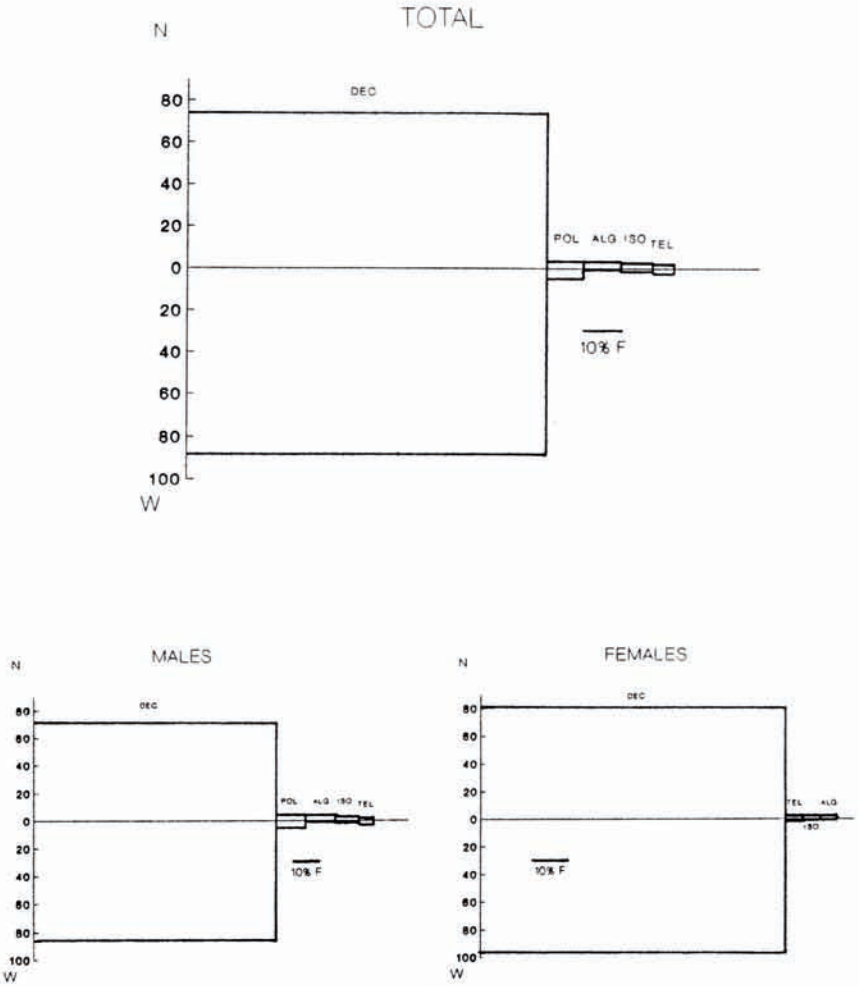

Fig. 1. - Relative importance of the prey groups. The square is proportioned to the IRI. F: Frequency of a prey group; N: Percentage of number of a prey group; W: Percentage of weight of a prey group. DEC: Decapoda; POL: Polychaeta; ALG: Algae; ISO: Isopoda; TEL: Teleostei. TOTAL: All the specimens.

than 40 cm and their frequency (F) was higher, but not significatively higher, in males than in females.

Table II shows the values of the IRI, both global and in%, by size classes: 30-39 cm (males and females); 40-49 cm (males and females); 50-59 cm (males and females); 60-69 cm (only males) and 70-79 cm (also only males). The higher diversity of prey items was found in the size class II (40-49 cm) which comprised 57.7% of the specimens studied.

Table III presents the diet-overlap, using the index of Schoener (1970), between pairs of size classes. We have used this index because, according to Wallace (1981), it is one of the more suitable indexes available to measure the overlap in diet among fish when resource-availability data are absent. The diet-overlap between size classes can be

Table II. - Values of the IRI in the 5 size classes. 30-39, 40-49 and 50-59 cm classes contain both males and females; 60-69 and 70-79 cm classes, only males.

TL	30-39 cm		40-49 cm		50-59 cm		60-69 cm		70-79 cm	
	IRI	%IRI	IRI	%IRI	IRI	%IRI	IRI	%IRI	IRI	%IRI
Algae	-	-	39.8	0.3	-	-	186.8	1.4	67.5	0.4
Porifera	-	-	2.8	0.0*	-	-	-	-	-	-
Sipunculida	-	-	6.0	0.0*	-	-	-	-	-	-
Priapulida	-	-	20.9	0.2	-	-	-	-	-	-
Priapulus sp.	-	-	20.9	0.2	-	-	-	-	-	-
Echiurida	-	-	7.2	0.1	-	-	-	-	-	-
Echiurus sp.	-	-	7.2	0.1	-	-	-	-	-	-
Polychaeta	-	-	35.1	0.3	-	-	1134.9	8.1	-	-
Aphrodite sp.	-	-	4.4	0.0*	-	-	-	-	-	-
Polychaeta unid.	-	-	14.6	0.1	-	-	1134.9	8.3	-	-
Crustacea	18166.0	97.2	15555.3	98.4	19074.0	99.2	15545.0	90.4	17339.4	97.5
Cirripeda	-	-	-	-	-	-	50.0	0.4	-	-
Isopoda	-	-	37.0	0.3	28.8	0.2	51.7	0.4	58.6	0.3
Valvifera	-	-	16.9	0.1	-	-	51.7	0.4	58.6	0.3
Flabellifera	-	-	-	-	28.8	0.2	-	-	-	-
Sphaeromatidae	-	-	3.8	0.0*	-	-	-	-	-	-
Amphipoda	-	-	-	-	-	-	43.4	0.3	48.2	0.3
Decapoda	16193.0	91.9	12914.3	97.7	18786.0	99.0	12175.1	86.8	16485.0	96.8
Munida subrugosa	9770.9	86.6	12261.4	97.3	15549.3	97.0	11798.8	86.1	16031.0	96.4
Brachyura	121.2	1.1	2.6	0.0*	161.2	1.0	-	-	56.7	0.3
Decapoda unid.	681.7	6.0	60.3	0.5	140.6	0.9	62.3	0.5	-	-
Crustacea unid.	179.0	1.6	27.0	0.2	-	-	46.3	0.3	-	-
Teleostei	-	-	11.5	0.1	33.7	0.2	-	-	163.6	1.0
Champsocephalus esox	-	-	-	-	-	-	-	-	163.6	1.0
Patagonotothen sp.	-	-	-	-	33.7	0.2	-	-	-	-
Teleostei unid.	-	-	11.5	0.1	-	-	-	-	-	-
Unidentified tissues	528.5	4.7	121.2	1.0	117.6	0.7	329.4	2.4	203.5	1.2
N. fish examined	12		58		10		9		8	
Coef. of repletion (%)	58.3		77.5		100		77.8		100	
N. of prey items	14		95		35		33		26	
Tot. weight of prey (g)	5.8		66.2		46.3		30.9		37.6	

considered as total in *S. bivius* because the values of the Schoener index are always higher than 0.7. The higher values of this index are found between the size classes 2 and 3, 2 and 5, and between 3 and 5.

Size classes	1	2	3	4	5
1	-	0.88	0.89	0.89	0.88
2	0.88	-	0.98	0.88	0.97
3	0.89	0.98	-	0.87	0.97
4	0.89	0.88	0.87	-	0.88
5	0.88	0.97	0.97	0.88	-

Table III. - Values of the Schoener index between each two size classes.

DISCUSSION

Higher values of the coefficient of repletion in males than in females have also been observed in other Chondrichthyes such as *Dalatias licha* (Matallanas,1982), a species in which females are longer than males, contrary to the size relations in *Schroederichthys bivius*.

The higher number of food items in the stomach contents of males was observed also by García (1984) in *Discopyge tschudii*, the only other known Chondrichthyan with an unusual secondary sexual dimorphism. We could suppose that males caught a higher diversity of prey items because of their larger size, but this is not probably the reason because the same phenomenon has been observed in other Chondrichthyes in which the males are smaller than the females, as observed in *Dalatias licha* (Matallanas, 1982).

The higher diversity of prey items found in the specimens of size class 2 (40-49 cm TL) can be due both that it includes the 57.7% of all the samples studied and that, in this size class, 66.0% of the specimens are males and, according to table I, males eat a higher diversity of prey items than females.

McEachran *et al.* (1976) says that difference in shape of the mouth and number of teeth rows may be related to food habits in skates. Du Buit (1978-79) described the changes in the diet in some species of skates correlated with the change of tooth morphology. The tooth sexual dimorphism has been interpreted by Feduccia and Slaughter (1974) as an adaptation in order to reduce intraspecific competition for food. In *S. bivius*, in spite of its sexual dimorphism in mouth and teeth, the diet of males and females is almost identical and the diet-overlap is practically total. This high overlap may have been due to the high abundance of *Munida subrugosa* at the times of capture. Indeed, if a prey is very abundant it is a nonlimiting resource for several predators (Zaret and Rand, 1971; McEachran, 1976; Targett, 1981). Besides, according to Capape (1975), the Chondrichthyes are opportunistic predators and capture mainly the prey that are more available to them. The higher diet-overlap observed between the size classes 2 and 3 and between 3 and 5, may have due that in this classes the IRI values of *Munida subrugosa* are the higher (Table II). In this circumstance, it is impossible to know whether the mouth and tooth sexual dimorphism of *S. bivius* is related to its feeding habits or if this dimorphism, and the higher size of males, could be explained by the reproductive behaviour of this species as was suggested by Mellinger (1989). The fact that the presence of Teleostei in the stomach content in males was not significatively higher than in females and that this also happens in other Chondrichthyes with a similar tooth sexual dimorphism, seems to support the latter hypothesis.

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