NAFO Sci. Coun. Studies, 6: 35-38

Feeding Characteristics of Wolffishes in the Labrador-Newfoundland Region

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Abstract

Qualitative and quantitative analyses of the stomach contents of *Anarhichas lupus* (Atlantic wolffish), *A. minor* (spotted wolffish) and *A. denticulatus* (northern wolffish) from the Labrador-Newfoundland region revealed similarity in the diets of Atlantic and spotted wolffishes which feed almost entirely on bottom organisms, whereas part of the food spectrum of northern wolffish consists of bathypelagic organisms. Considerable differences in the food components of each species were evident among areas. Average indices of stomach fullness indicate that Atlantic and spotted wolffishes feed more intensely than northern wolffish.

Introduction

In the Northwest Atlantic, studies on the food and feeding of marine fishes have generally focussed on species which have been exploited traditionally, such as Atlantic cod, *Gadus morhua*; beaked redfish, *Sebastes mentella*; roundnose grenadier, *Coryphaenoides rupestris*; Greenland halibut, *Reinhardtius hippoglossoides* and haddock, *Melanogrammus aeglefinus* (Zheltenkova, 1961, 1972; Yanulov, 1963; Konstantinov and Turuk, 1968; Podrozhanskaya, 1971; Konstantinov and Podrazhanskaya, 1972; Turuk, 1973; Podrazhanskaya and Shestov, 1981). However, there is little published information on the feeding characteristics of wolffishes, although some papers on feeding of Barents Sea and Northwest Atlantic fishes contain brief descriptions of the food spectra of wolffishes in conjunction with studies on other species. Similarity in feeding of Atlantic wolffish, *A. lupus*, and spotted wolffish, *A. minor*, has been noted, especially in connection with the dominance of echinoderms, molluscs and crustaceans in their diets, whereas northern wolffish, *A. denticulatus*, often feed intensively on ctenophores and medusae in addition to bottom invertebrates (Barsukov, 1959, 1961; Baranenkova *et al.*, 1960; Barsukov and Nizovtsev, 1960; Turuk and Postolaky, MS 1980). The present paper considers the feeding characteristics of three species of wolffishes commonly found in the Labrador-Newfoundland region (Fig. 1), based on the qualitative and quantitative analyses of data collected during 1977-81.

Materials and Methods

Field analysis of the stomach contents of wolffishes was made during four spring-summer and three autumn-winter cruises in 1977-80 by the research vessels *Persey III*, *Suloy* and *N. Kononov* (Table 1). The field analysis involved recording the incidence of different food items in each stomach, and estimating the degree of stomach fullness by the 5-point scale: 0, 1, 2, 3 and 4 for stomachs that were empty, one-quarter full, half-full, three-quarters full and completely full respectively. The average degree of stomach fullness was calculated as the arithmetic mean of the values for individual fish. The coefficient of food similarity (CFS) was calculated by Yanulov's (1963) formula

$$CFS = \frac{-n}{N} \times 100\%$$

where N is the sum of maximum and n is the sum of minimum values of frequency of food components in

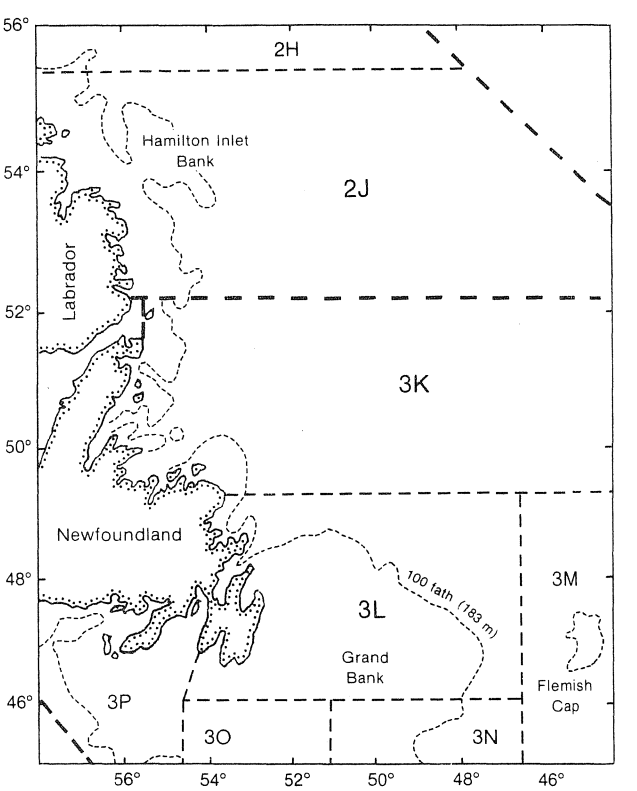

Fig. 1. Map of Labrador-Newfoundland region showing NAFO divisions mentioned in the tables.

TABLE 1. Number of wolffish stomachs examined during research vessel cruises to the Labrador-Newfoundland area in 1977–80.

	Atlantic wolffish				Spotted wolffish				Northern wolffish			
Year	2J	3K	3L	3M	2J	3K	3L	3M	2J	3K	3L	3M
1977	—	703	367	302	—	15	87	43	—	129	86	18
1978	620	362	57	211	40	6	2	21	248	12	4	51
1979	—	88	107	54	—	—	—	—	15	8	—	36
1980	339	351	99	111	36	30	22	12	252	90	20	5
Total	959	1,504	630	678	76	51	111	76	515	239	110	110

the fishes compared. CFS is 0% for complete difference of food and 100% for complete similarity of food in the species compared.

During the *N. Kononov* cruise in May–August 1981, samples of wolffish stomachs were fixed in 4% formalin and many wolffish specimens were frozen for detailed examination in the laboratory. Analysis of the fixed and frozen material involved separating the stomach contents into various food components, which were then weighed to determine the relative composition of the food mass of each stomach. The feeding indices derived from these samples were calculated as the ratio of the weight of food to the weight of fish, multiplied by 10,000.

Length and weight measurements were recorded for all wolffishes involved in the feeding study.

Results and Discussion

The laboratory analysis of stomach contents of specimens collected in 1981 indicates the great variety of organisms on which the three species feed (Table 2), including hydroids, crustaceans, molluscs, echinoderms, polychaetes and fish, with bivalve molluscs a dominant component of the food in Atlantic wolffish from the Flemish Cap (Div. 3M). External skeletons of bottom organisms were almost always crushed, and non-organic material (stone, silt and sand) was frequently found in the stomachs of Atlantic and spotted

TABLE 2. Food composition and partial feeding indices (°/₀₀₀) for wolffishes collected off southern Labrador and eastern Newfoundland in June–July 1981, as determined from stomachs preserved in formalin and frozen specimens. (AW = Atlantic wolffish, SW = spotted wolffish, and NW = northern wolffish.)

	Fixed material									Frozen material					
	Div. 2J	Div. 3K			Div. 3L		Div. 3M			Div. 2J		Div. 3K	Div. 3L		
Food components	AW	AW	SW	NW	AW	NW	AW	SW	NW	AW	SW	AW	AW	SW	NW
Hydroida	1	1	3	—	1	—	—	—	—	23	—	—	3	2	—
Gammaridea	—	3	—	—	--	—	—	—	—	—	—	—	—	—	—
Calathura brachiata	—	3	—	—	—	—	—	—	—	—	—	2	—	—	—
Hyas sp.	—	—	—	—	—	—	—	—	—	—	280	—	—	—	—
Brachyura sp.	+	+	2	4	—	—	—	—	—	16	377	+	20	—	—
Ilyas sp.	—	—	—	—	7	—	—	—	—	—	—	—	—	—	—
Pagurus pubescens	+	5	—	11	—	—	92	—	—	—	—	—	—	—	—
Pandalus borealis	—	13	5	3	—	—	—	7	—	44	—	—	—	—	—
Solariella obscura	—	2	—	—	—	—	—	—	—	—	—	3	1	—	—
Buccinum sp.	—	109	9	—	36	—	—	—	—	—	—	—	67	—	—
Gastropoda	—	7	—	—	15	—	5	27	—	15	5	7	16	1	—
Bivalvia	—	27	—	6	2	—	2,083	2	—	+	—	—	2	—	—
Cephalopoda	—	—	—	—	—	—	—	—	—	—	—	—	220	—	—
Strongylocentrotus sp.	2	—	5	19	10	—	7	—	—	34	—	434	—	—	—
Clypestroidea	—	—	1	—	—	—	105	396	—	—	—	—	114	445	—
Ctenodiscus crispatus	—	8	125	12	—	—	—	—	—	55	—	47	—	—	—
Ophiopholis aculeata	11	—	4	—	—	—	—	—	—	49	—	—	219	—	—
Ophiura sarsi	+	3	26	+	—	—	1	—	—	1	—	—	—	15	1
Ophiura sp.	37	2	3	8	121	—	—	339	—	—	56	—	32	—	10
Ophiocantha bidentata	—	—	—	—	12	4	—	—	—	—	—	—	—	—	—
Gorgonocephalus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27
Polychaeta	+	1	—	1	2	—	—	—	+	7	9	+	1	2	1
Sebastes marinus	—	—	—	—	—	—	—	423	—	—	—	—	367	—	—
Gadus morhua	—	—	—	—	—	—		511	—	—	—	—	—	—	—
Raja sp.	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—
Digested fish	—	—	4	—	—	—	3	49	—	—	—	—	54	—	—
Digested food	2	86	211	21	118	13	229	17	139	213	95	26	72	—	12
Stone, silt, sand	1	1	3	—	15	—	—	4	—	48	—	—	5	2	—

wolffishes. The average feeding indices, based on analysis of the material collected in the summer of 1981, indicate considerable variation among areas (Table 3), but the values for Atlantic and spotted wolffishes are consistently higher than those for northern wolffish.

The field analysis of stomachs during 1977–80 (Table 4) also showed a great variety of food organisms, although only some of them were the main components. The most widely-distributed groups of organisms in the stomachs were crabs, starfish, brittle stars, sea urchins, bivalve molluscs and gastropods. It is evident that hard-shelled organisms are less important in the diet of northern wolffish than in the diets of Atlantic and spotted wolffishes, and that pelagic organisms (medusae and ctenophores) occur frequently in the stomachs of northern wolffish, thus indicating a lesser connection of this species with the bottom. The average indices of stomach fullness (Table 5) indicate that Atlantic and spotted wolffishes feed more intensely in the summer-autumn than in the autumn-winter period, and that these two species feed more intensely than the northern wolffish, at least in the spring-summer period.

TABLE 3. Average feeding indices from fixed (4% formalin) and frozen samples of wolffishes collected in June–July 1981.

Wolffish species	Feeding indices (‰)			
	Div. 2J	Div. 3K	Div. 3L	Div. 3M
Fixed specimens				
Atlantic	—	115	185	867
Spotted	—	341	—	728
Northern	31	37	17	139
Frozen specimens				
Atlantic	261	329	182	—
Spotted	372	—	451	—
Northern	—	—	12	—

A peculiar characteristic of wolffishes is the specific construction of the dental system. All three species have well-developed teeth on the intermaxillae, mandibles, palate bones and vomer. Hook-shaped teeth on the frontal part of the maxillae and mandibles are used to tear food organisms from the bottom. Conic and round teeth on the vomer and palate bones of Atlantic and spotted wolffishes, that are used to crush hard skeletons of bottom organisms, wear down rather quickly and are replaced by new ones annually. The fangs of northern wolffish are smaller and sharper than those of the other two species and do not wear down as quickly. The northern wolffish, therefore, is apparently not accustomed to tearing organisms off the bottom but feed on pelagic and demersal animals not attached to the bottom (Barsukov, 1959, 1961; Barsukov and Nizovtsev, 1960).

The results of this investigation agree with the observations of other researchers in other areas that Atlantic and spotted wolffishes are typical benthophages which have a considerable coincidence of feeding spectra. The coefficient of food similarity (CFS) for these species is rather high (70%). The greatest difference in feeding is evident between Atlantic and northern wolffishes (CFS = 33%), whereas the degree of similarity for spotted and northern wolffishes is somewhat higher (CFS = 43%). There were slight differences in food composition of each species in different areas.

TABLE 4. Frequency of occurrence (%) of different food components in stomachs of Atlantic wolffish (AW), spotted wolffish (SW), and northern wolffish (NW) in the Newfoundland area, 1977–80.

Food components	Div. 2J			Div. 3K			Div. 3L			Div. 3M		
	AW	SW	NW	AW	SW	NW	AW	SW	NW	AW	SW	NW
Ctenophora	—	—	7.2	—	—	28.1	—	—	13.6	0.2	3.9	8.1
Medusae	—	—	—	—	—	3.0	—	—	0.9	—	1.3	5.4
Copepoda	—	—	—	—	—	—	0.2	—	—	—	—	—
Isopoda	0.6	—	—	1.7	—	—	—	—	—	—	—	—
Amphipoda	0.1	1.3	—	1.4	—	1.7	0.6	0.9	—	0.3	1.3	—
Decapoda (crabs)	16.8	31.6	11.6	13.6	9.8	9.1	11.1	7.2	4.5	8.6	—	8.1
Asteroidea	20.9	24.8	6.4	34.0	49.0	14.7	0.8	2.7	1.8	—	—	—
Ophiura	47.3	33.9	30.2	45.6	33.3	26.8	51.2	67.6	33.6	—	—	—
Echinoidea	31.9	17.0	12.0	20.1	7.8	2.2	37.5	37.8	5.4	—	—	—
Bivalvia	15.1	—	0.8	27.8	5.9	—	13.2	9.9	2.7	15.2	5.3	1.3
Gastropoda	29.2	6.6	0.6	44.9	7.8	1.3	38.1	13.5	—	10.1	3.9	2.7
Cephalopoda	0.8	—	0.8	1.8	2.0	1.7	0.4	—	—	1.8	1.3	—
Worms	6.2	11.8	1.6	10.0	5.9	0.4	2.9	2.7	0.9	6.4	5.3	1.3
Fish	0.7	1.3	1.6	1.0	2.0	—	1.9	11.7	0.9	3.8	1.3	20.3
Other organisms	4.0	7.9	1.6	2.6	—	9.1	4.4	5.4	1.8	6.3	—	1.3
Digested food	0.2	—	1.0	0.1	—	3.0	0.6	—	3.6	0.5	—	2.7
Stomachs examined	999	76	515	1,504	51	239	630	111	110	678	76	110
% empty stomachs	30.4	11.8	39.0	11.2	2.0	38.5	22.2	5.4	42.7	8.4	14.5	25.4

TABLE 5. Average indices of stomach fullness by area in the spring-summer and autumn-winter periods for the three wolffishes sampled during 1977-80.

	Atlantic		Spotted		Northern	
Div.	Spr. Sum.	Aut. Win.	Spr. Sum.	Aut. Win.	Spr. Sum.	Aut. Win.
2J	2.0	1.1	2.6	1.1	1.3	1.2
3K	2.2	0.4	2.7	—	1.4	0.5
3L	2.3	—	2.6	—	1.5	—
3M	2.2	0.5	2.1	0.6	1.0	1.8

References

BARANENKOVA, A. S., V. V. BARSUKOV, I. J. PONOMARENKO, T. K. SYSSOEVA, and N. S. KHOKHLINA. 1960. Morphological peculiarities, distribution and feeding of the young of *Anarhichas lupus* L., *A. minor* Olafsen, and *A. latifrons* Steenstrup et Hallgrimsson. *Zool. Zh.*, **39**(8): 1186-1200.

BARSUKOV, V. V. 1959. Fauna of the U.S.S.R.: family Anarhichadidae. *Zool. Inst. Akad. Nauk SSSR*, Vol. 5, 173 p.

1961. Some observations on *Anarhichas latifrons* Steenstrup et Hallgrimsson. *Vopr. Ikhtiol.*, **1**(1): 19-28.

BARSUKOV, V. V., and G. P. NIZOVTSEV. 1960. On feeding of Barents Sea wolffishes. *Tr. Murman. Morsk. Biol. Inst.*, **2**(6): 203-206.

KONSTANTINOV, K. G., and S. G. PODRAZHANSKAYA. 1972. Feeding and food competition between rock grenadier (*Macrourus rupestris*) and other deep-water fishes in the Northwest Atlantic. *Tr. PINRO*, **28**: 96-106 (Fish. Res. Bd. Canada Transl. Ser. No. 2537.)

KONSTANTINOV, K. G., and M. N. TURUK. 1968. Two types of cod daily vertical migrations. *Mater. Rybokhoz. Issled. Ser. Bass.*, XI: 105-110.

PODRAZHANSKAYA, S. G. 1971. Feeding of roundnose grenadier (*Macrourus rupestris*) in the Northwest Atlantic and Iceland waters. *ICNAF Redbook* 1971, Part III: 115-123.

PODRAZHANSKAYA, S. G., and V. P. SHESTOV. 1981. Some aspects of haddock feeding in the Newfoundland area. *NAFO Sci. Coun. Studies*, **1**: 51-56.

TURUK, T. N. 1973. Diurnal periodicity of feeding and vertical migrations of cod (*Gadus morhua* L.) in the Labrador and Newfoundland waters. *Vopr. Ikhtiol.*, **13**: 328-343.

TURUK, T. N., and A. I. POSTOLAKY. MS 1980. Feeding and food relations of some fish species in the Labrador and Newfoundland areas. *NAFO SCR Doc.*, No. 70, Serial No. N118, 9 p.

YANULOV, K. P. 1963. Feeding of beaked redfish (*Sebastes mentella* Travin) in waters of Newfoundland and Labrador. *Vopr. Ikhtiol.*, **3**(4): 708-726.

ZHELTENKOVA, M. V. 1961. Shorygin's works on studying of feeding and food relations in fishes: development of these studies. *Tr. VNIRO*,XV: 26-37.

1972. Some data on feeding of North Atlantic fishes. *Tr. VNIRO*, XXXVII(2): 204-224.