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Some Aspects of Haddock Feeding in the Newfoundland Area

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Abstract

The qualitative and quantitative characteristics of the feeding of haddock in the Newfoundland area were investigated from 452 stomachs collected during 1963-75. The composition of the food organisms comprised 118 names, mainly bottom-living fauna. There was an apparent increase in feeding activity from spring to autumn as indicated by trends in the feeding index. The highest level of satiation of haddock was observed on St. Pierre Bank and the lowest on Flemish Cap. Fish was the main component of the food on Grand Bank and St. Pierre Bank, whereas the entire food mass consisted of invertebrates on Flemish Cap. Analysis of the data by depth indicated that optimum feeding conditions occurred at 101-150 m, where fish and echinoderms constituted more than 80% of the food mass.

Introduction

The only major study of the qualitative and quantitative aspects of haddock feeding in the Northwest Atlantic is that by Wigley (1956) who listed 172 organisms found in the stomachs of haddock from Georges Bank. He pointed out the predominance of benthic and epibenthic fauna in the food, distinguished differences in feeding on three parts of the bank, noted variation in feeding by season and by age of haddock, and observed a decrease in stomach fullness during the spawning period. Maurer (MS 1975) mentioned haddock in his description of some important feeding relationships in the Georges Bank area.

Observations on the feeding of haddock in the Newfoundland region are either very general or deal with specific instances during certain times (Noskov, MS 1962; Templeman, 1966), but the data reflect only the qualitative aspect of feeding from field studies. The present study deals with both the qualitative and quantitative characteristics of haddock feeding in various parts of the Newfoundland area.

Materials and Methods

The materials for this study were collected during research cruises in 1963-75 on Flemish Cap, Grand Bank and St. Pierre Bank (Fig. 1). The 452 stomachs were taken from haddock caught in 33 trawl hauls at depths ranging from 50 to 238 m and preserved in 4% formalin for laboratory analysis. The haddock ranged from 15 to 97 cm in length and from 1 to 15+ years old.

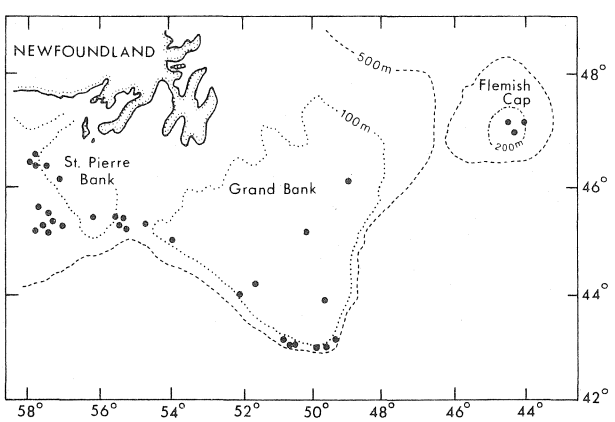

Fig. 1. Location of samples for study of haddock feeding in the Newfoundland area, 1963-75.

In the laboratory, each stomach was weighed and the state of repletion estimated visually using the 5-point scale: 0, 1, 2, 3 and 4 for stomachs that were empty, quarter-full, half-full, three-quarters-full and completely full respectively. After dissection, the food items were separated into groups and weighed. For analysis by area, season and depth, the weights of the various food components are expressed as percentages of the total weight of all items found in the stomachs. The feeding index was calculated as the ratio of weight of food to the weight of fish, multiplied by 10,000 (Zenkevich and Brotskaya, 1931).

The food of haddock

The list of food organisms found in the stomachs of haddock from the Newfoundland area (see Appendix) indicates that this species is extremely omnivorous. Represented in the food were five species of fish and many marine invertebrates, mainly sedentary or slow-moving benthic species. The impression is that haddock eat everything which may be accessible, including organisms dug out of the sand and gravel. Judging by the food composition, one can readily agree with Needler (1931) that haddock prefer not to chase for food.

In the Newfoundland area as a whole (Table 1), invertebrates comprised 42% of the food mass of the haddock stomachs examined, crustaceans (17.8%) and echinoderms (16.1%) being the dominant groups (Table 1). Crustaceans were represented mainly by crabs (4.5%), euphausiids (4.4%) and gammarids (3.8%), and echinoderms mostly by brittle stars (11.2%) and sea urchins (4.1%). Polychaetes and molluscs constituted 5.4% and 1.3% of the food mass respectively. Fish comprised 37.3% of the food mass, the species found most often being capelin (16.7%) and redfish (11.8%).

Geographical and seasonal variation in feeding

The major haddock stocks in the Newfoundland area are those of Grand Bank and St. Pierre Bank (Templeman, 1953), and small numbers have been taken on Flemish Cap. The results of the investigation on feeding by season for these three areas are given in Table 1 and summarized in Fig. 2. The periods taken to represent the seasons are as follows: spring (March–May) is the period of rapid environmental and biological changes, particularly in the upper layers of the ocean with the development of phytoplankton blooms; summer (June–August) is the period when the

TABLE 1. Food composition of haddock by season in the Newfoundland area (% by weight).

	All areas	Flemish Cap		Grand Bank				St. Pierre Bank		
Stomach contents	and seasons	Spring	Summer	Winter	Spring	Summer	Autumn	Winter	Spring	Summer
Polychaeta	5.4	20.9	12.7	—	0.3	4.4	0.4	1.3	0.3	1.8
Mollusca	1.3	5.3	0.3	—	0.6	0.2	—	5.1	1.3	1.5
Bivalvia	1.1	4.9	0.1	—	0.3	0.1	—	3.7	0.9	0.9
Gastropoda	0.2	—	0.2	—	0.2	0.1	—	1.4	0.1	0.6
Not identified	—	0.4	—	—	0.1	—	—	—	0.3	—
Crustacea	17.8	26.4	2.6	—	14.2	8.9	97.8	8.1	7.7	9.5
Amphipoda	3.8	5.3	0.3	—	2.4	8.5	68.7	0.4	3.8	0.1
Cumacea	2.3	—	—	—	1.2	0.1	—	7.6	0.3	0.1
Decapoda	4.5	0.3	2.3	—	0.3	—	13.1	—	1.3	—
Euphausiacea	4.4	—	—	—	9.5	—	—	—	0.5	9.2
Isopoda	0.2	—	—	—	0.1	0.1	—	—	—	0.1
Mysidacea	0.1	—	—	—	0.1	—	—	—	—	—
Not identified	2.5	20.8	—	—	0.6	0.2	16.0	0.1	1.8	—
Echinodermata	16.1	42.7	34.8	—	9.6	2.3	—	34.4	47.1	3.6
Echinoidea	4.1	11.5	19.4	—	0.9	0.1	—	0.1	8.6	1.8
Holothuroidea	0.8	—	—	—	0.8	0.2	—	1.6	2.2	—
Ophiuroidea	11.2	31.2	15.4	—	7.9	2.0	—	32.7	36.3	1.8
Other invertebrates	1.3	1.6	—	—	0.5	0.1	—	0.7	3.4	0.1
Pisces	37.3	—	—	—	63.7	69.6	—	49.8	21.6	58.1
Anarhichas sp.	2.1	—	—	—	11.6	—	—	—	—	—
Lycodes sp.	—	—	—	—	0.1	—	—	—	—	—
Mallotus villosus	16.7	—	—	—	29.0	59.8	—	—	—	—
Paralepis sp.	2.4	—	—	—	11.9	—	—	—	—	—
Sebastes sp.	11.8	—	—	—	—	—	—	—	19.8	—
Not identified	4.3	—	—	—	11.1	9.8	—	49.8	1.8	58.1
Digested food	19.6	1.4	49.6	—	10.6	11.3	1.8	—	17.5	25.0
Sand and gravel	1.1	1.7	—	—	0.5	3.2	—	0.6	1.1	1.6
Stomachs examined	452	21	10	15	113	32	27	9	210	15
Percent with food	78.3	71.5	100.0	0.0	85.9	84.4	88.9	100.0	71.5	100.0
Feeding index	31.3	10.0	20.3	0.0	39.3	78.2	106.6	63.5	57.9	70.4
Mean stomach fullness	...	1.7	1.9	0.0	2.0	2.8	...	2.2	1.2	1.9

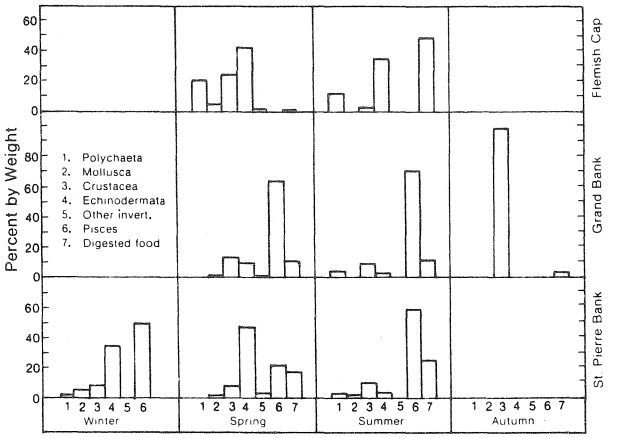

Fig. 2. Seasonal and geographical composition of food types in the stomachs of haddock from the Newfoundland area.

biomass of plankton is highest and may reach 500 mg/m³ (Vladimirskaya, 1965); in August the plankton starts to change to its autumn phase and this continues during September–November when the plankton biomass declines steeply; the biological winter lasts until March and is characterized by the minimum development of zooplankton and phytoplankton (Movchan, 1962). These seasonal periods, used for this analysis of haddock feeding, may vary somewhat from area to area and almost certainly from year to year. However, some obvious differences in the components of haddock food were evident.

On Flemish Cap, echinoderms (brittle stars and sea urchins) constituted the major part of the diet of haddock in spring (42.7%) and summer (34.8%) (Table 1). Crustaceans (amphipods and unidentified species) were next in order of importance in spring (26.4%) but much lower in summer (only 2.6%). Polychaetes were also significant in the diet in both spring (20.9%) and summer (12.7%). Fish were not evident in spring or summer. However, nearly 50% of the stomach contents taken in summer consisted of digested food, which could not be identified even by major type. Some food was found in all of the stomachs taken in the summer and 71.5% of those taken in the spring. However, the stomachs were, on the average, less than half full in both seasons, and the general feeding index was rather low (10.0 and 20.3).

On Grand Bank, no food was found in the 15 specimens taken in winter (Table 1). In spring and summer, fish (63.7 and 69.6%) was by far the most important food component, followed by crustaceans (14.2 and 8.9%) and echinoderms (9.6 and 2.3%). The fish food consisted almost entirely of capelin in summer, and capelin also dominated in spring together with small barracudina and wolffish. The crustaceans were mainly euphausiids in spring and amphipods in summer, and the echinoderms were mainly brittle stars in both seasons. In the autumn, crustaceans (97.8%), mainly amphipods, *Parathemisto compressa*, *P. lebellula*, and some shrimp, *Pandalus annulicornis*, constituted nearly all of the food items. Some food was found in more than 84% of the stomachs taken in the spring, summer and autumn. The stomachs were, on the average, half full or more, and the general feeding index increased from 39.3 in the spring to 78.4 in the summer and to 106.6 in the autumn, all three values being considerably higher than those for Flemish Cap.

On St. Pierre Bank in winter, in contrast to the absence of food in 15 specimens from Grand Bank, unidentified fish species (49.8%) and echinoderms (34.4%), mainly brittle stars, constituted the major components of food in the nine stomachs examined. Smaller quantities of crustaceans (8.1%) and molluscs (5.1%) were also present. In the spring, echinoderms (47.1%), mainly brittle stars, and fish (21.6%), mainly redfish, were the dominant food items, followed by crustaceans (7.7%). In the summer, however, fish (58.1%) again constituted the bulk of the food mass, with small quantities of crustaceans (9.5%) and echinoderms (3.6%). Some food was found in all the stomachs taken in winter and summer and in 71.5% of those taken in spring. The stomachs were, on the average, about half-full in winter and summer and only slightly more than quarter-full in spring, but the data for the small numbers of specimens for the winter and summer periods may not be representative of the population. The general feeding index in the three seasons on St. Pierre Bank varied from 57.9 to 70.4.

There are significant geographic differences in the feeding characteristics of haddock in the Newfoundland region. Invertebrates constituted the diet on Flemish Cap, there being no evidence of fish in the small number of stomachs examined. Fish was the major type of food on both Grand Bank and St. Pierre Bank, with capelin being the major component in the former and redfish in the latter area. Invertebrates also play a major role as food on St. Pierre Bank, with echinoderms being the major contributor, whereas crustaceans were next in importance after fish on Grand Bank. Except in winter on Grand Bank, more than 70% of the specimens from each area had some food in their stomachs. The general feeding index in spring, for which the numbers of specimens was greatest for each area, was higher for haddock on St. Pierre Bank (57.9) than on Grand Bank (39.3) and Flemish Cap (10.0). However, in summer the feeding index was higher on Grand Bank (78.2) than on St. Pierre Bank (70.4).

Variation in feeding by depth

There is considerable variation in the composition of haddock food by depth (Table 2). The general

TABLE 2. Food composition (% by weight) of haddock by depth in the Newfoundland area.

Food groups	Food composition by depth range (m)			
	50–100	101–150	151–200	>200
Polychaeta	3.2	3.9	2.5	23.7
Mollusca	0.1	0.9	1.8	8.9
Crustacea	36.2	4.5	13.6	35.1
Ophiurae	2.7	22.3	10.4	7.2
Other Echinodermata	0.3	7.3	3.1	17.7
Other invertebrates	0.1	1.1	0.3	2.7
Pisces	41.4	50.4	36.2	—
Digested food	14.1	8.7	30.7	3.1
Sand and gravel	1.9	0.7	1.4	1.6
Stomachs examined	83	224	117	28
Percent with food	89.2	77.9	68.4	67.9
Feeding index	53.7	70.0	40.0	11.7

feeding index was quite high at 50–100 m, where fish (41.4%) and crustaceans (36.2%) constituted the main food types. The feeding index was highest (70.0) at 101–150 m, where fish (50.4%) and echinoderms (29.6%) were the major food types, ophiurans (22.3%) being the major constituent of the latter. Other echinoderms (7.3%), crustaceans (4.5%) and polychaetes (3.9%) were frequently found. The feeding index declined to 40.0 at 151–200 m, where fish (36.2%), crustaceans (13.6%) and echinoderms (13.5%), mainly ophiurans (10.4%), were the major food types. However, the amount of digested food was quite large (30.7%) at this depth range. At depths greater than 200 m, the feeding index declined steeply to 11.7. Unlike the shallower depths, fish was completely absent, and the major components were crustaceans (35.1%), echinoderms (24.9%) and polychaetes (23.7%). There was a significant increase in the abundance of polychaetes and molluscs at the greatest depth, and brittle stars, which were the dominant echinoderms at shallower depths, were to some extent replaced by other echinoderms (mainly sea urchins) in the food mass.

The results of the analysis by depth indicate that feeding conditions appear to be optimum at 101–150 m, where the feeding index was highest and where fish and echinoderms constituted 80% of the food organisms. Feeding conditions appear to deteriorate at greater depths as indicated by a steep decline in the feeding index and an increase in the number of empty stomachs.

Conclusions

The composition of organisms found in haddock stomachs from the Newfoundland region comprised 118 names. Important components of the food were bottom-living crustaceans, echinoderms (mainly brittle stars and sea urchins) and polychaetes. Fish also was rather important, mainly capelin and redfish, with juvenile wolffish and barracudina occurring occasionally.

Feeding activity of haddock was highest on St. Pierre Bank, where the bulk of the food consisted of fish (mainly redfish) and echinoderms (mainly brittle stars). Fish (mainly capelin) constituted the bulk of the food on Grand Bank, whereas echinoderms, crustaceans and polychaetes were the major components on Flemish Cap.

The analysis of haddock feeding by depth indicates that feeding conditions were better at shallower than at greater depths, the optimum appearing to be in the 100–150 m depth range.

Seasonal changes in feeding indices indicate that feeding activity was highest during the summer-autumn period. Except on Flemish Cap where echinoderms and polychaetes were main components of the food in both spring and summer, fish was the major constituent in summer on the other two banks, with an indication that haddock feed intensively on crustaceans (mainly amphiods) in the autumn on Grand Bank.

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APPENDIX

List of Organisms Found in Haddock Stomachs From the Newfoundland Area

Annelida

Polychaeta

Ammotrypane aulogaster Rathke
Ampharetidae
Anaitides groenlandica (Oersted)
Aphrodite aculeata (L.)
Arenicola marina (L.)
Brada villosa (H. Rathke)
Cirratulidae
Goniada maculata (Oersted)
Lumbricus gragilis (O. F. Müller)
Maldanidae
Nephtys sp.
Nereis zonata Malmgren
Onophis couchylega Sars
Ophelia limacina (H. Rathke)
Oweniidae
Pectinaria hyperborea (Malmgren)
Pectinaria koreni (Malmgren)
Sabellidae
Scalibregmidae
Styloroides plumosus (O. F. Müller)
Syllis fasciata Malmgren
Travisia forbessi Johnston

Sipunculoidea

Phascolion strombi (Montagu)
Phascolosoma sp.

Mollusca

Bivalvia

Astarte crenata (Grey)
Cardium elegantulum (Beck) Müller
Crenella decussata (Montagu)
Cyrpidaria glacialis Sars
Cyrtodaria kurriana Dunber
Dacridium vitreum (Holloll) Müller
Diplodonta torelli Jeffreys
Joldia hyperborea (Loven) Torell
Leda pernula (Muller)
Lima hyperborea (Jensen)
Macoma calcarea (Chemnitz)
Macoma moesta (Deschanes)
Musculus sp.
Mya trunicata L.
Nucula tenius (Montagu)
Serripes sp.
Thyasira flexuosa (Montagu)

Gastropoda

Bela sp.
Cyclihna alba (Brown)
Margarites groenlandicus (Chemnitz)
Natica clausa Broderip et Sewerly
Philine sp.
Sipho lachaesis

Crustacea

Amphipoda

Ampelisca eschrichti Krøyer
Anonyx nugax (Phipps)
Caprella septentrionalis Krøyer
Corophiidae
Gammarus locusta (L.)
Hyperia medusarum (O. F. Müller)
Lembos arcticus (Nansen)
Lysianassidae
Melita dentata
Monoculodes pallidus Sars
Oediceros sp.
Parathemisto abyssorum Boeck
Parathemisto compressa (Goes)
Parathemisto libellula (Lichtenstein)
Photis sp.
Siphonoecetes sp.
Unicola irrorata

Cumacea

Campilaspis sp.
Diastylis rathkei (Krøyer)

Cirripedia

Balanus sp.
Nibelia bipes (Fabricius)

Decapoda

Anomura
Brachyura
Chionoecetes opilio (Fabricius)
Hyas areneus (L.)
Macrura natantia
Pagurus capillatus (Benedict)
Pagurus pubescens Krøyer
Pandalus annulicornis Leach
Pandalus borealis Krøyer
Sergestidae

Euphausiacea

Meganyctiphanes norvegica (Sars)
Nyctiphanes couchi (Bell)

Isopoda

Aega sp.
Mesidothea entomon (L.)
Synidothea nodulosa (Krøyer)

Mysidacea

Ostracoda

Philomedes globosus (Lilljeborg)

Echinodermata

Asteroidea

Ctenodiscus crispatus Retzius

Echinoidea

Olypeastroidae
Strongylocentrotus drobachiensis (Müller)

Holothuroidea

Chiridota irrirata
Chiridota tufti
Cucumaria sp.
Psolus plantapus Strussenfelt
Thyonidium commune Forbes

Ophiuroidea

Ophiocanthidae
Ophiopholis aculeata L.
Ophiura albida Forbes
Ophiura borealis (Dan et Koren)
Ophiura robusta Ayres
Ophiura sarsi Lutken
Stegochiura nodosa Lutken

Other Invertebrates

Anthozoa

Ascidiacea

Pelonaria corrugata (Forb and Goods)

Bryozoa

Nematoda

Nemertina

Pantopoda

Priapuloidea

Halicriptus sp.
Priapulus caudatus Lamarck

Pisces

Teleostei

Anarhichas sp.
Lycodes sp.
Mallotus villosus (Müller)
Paralepis sp.
Sebastes sp.