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# Cannabalism in Atlantic cod (Gadus morhua L.) on Flemish Cap in winter, 1978-82

by

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## INTRODUCTION

Predation by cod on small cod was postulated to be potentially an important factor influencing year-class strength of cod on Flemish Cap (Akenhead MS 1978). Popova (1962) did not mention cannibalism in a report of stomach content examinations in July-August 1959-60, but Templeman (1976) found that adult cod were feeding heavily on young cod in the shallower parts of the bank in late March 1961. Turuk (MS 1981) stated that cannibalism was not considerable in samples taken at various times from 1970 to 1980, and Lilly (MS 1979) reported a low level of cannibalism in January-February of 1978 and 1979.

This paper summarizes the observations of cannibalism in January-February of 1978-82 and discusses the possibility that the intensity of cannibalism on a year-class may be useful as an indicator of year-class strength.

## METHODS

Stomachs were examined from cod caught during stratified-random bottom trawl surveys of Flemish Cap by the research vessel A. T. CAMERON in February 1977 and by the chartered Canadian research trawler GADUS ATLANTICA during January-February of 1978-82 (Table 1). The stomach examinations were in conjunction with other sampling which included measurement of fish length and collection of otoliths for ageing.

Two methods of stomach examination were used: a gross examination of fresh stomachs at sea and a detailed examination in the laboratory of stomachs preserved in 10% formalin. The gross examination at sea included noting what appeared to be the major food item in terms of mass. The detailed examination in the laboratory involved separating food items into taxonomic categories. Fish prey were counted and measured to the nearest millimeter total length.

## RESULTS

A very low ($\leq$1%) incidence of cannibalism was found during observations at sea from 1977 to 1981 (Table 1). However, many fish prey could not be identified and some of these may have been cod. The incidence of cannibalism in stomachs examined in the laboratory was low ($\leq$0.6%) in 1978-81 but rose in 1982 to 3.3% (Table 1). Many additional prey in 1982 could be identified as Order Gadiformes, so the incidence of cannibalism was probably greater than 3%.

The number and size of cod prey increased with increasing predator size (Table 2), but the number of observations to date are insufficient to determine the relationship between predator size and maximum prey size. The majority of cod recovered from cod stomachs were approximately 10 cm in length and were probably 1 yr olds. There were no 1 yr olds recovered in 1978-80 but one was taken in 1981. The other two prey taken in 1981 came from small cod (36-40 cm) so these too were probably 1 yr olds. In 1982 many more 1 yr olds were recovered than in previous years. Two larger cod (26 and 31 cm) were also found.

In 1982 cannibalism was recorded in 14 of the 92 sets (15%) in which at least one cod ($\geq$28 cm) was caught and examined for stomach contents (Fig. 1). Incidences of cannibalism were widely scattered in depths less than 300 m.

## DISCUSSION

The spatial distribution and size relationships of predation by cod on younger cod in January-February 1982 were similar to those found in March 1961 (Templeman 1965; 1976). During the earlier period cod comprised 29%, 80%, and 85% (by volume) of the stomach contents of the cod in sets at 145 m, 183 m, and 234 m respectively on the southern part of the bank. In deeper sets the major prey was juvenile redfish. The intensity of cannibalism seems to have been higher in 1961 than in 1982 but the depth ranges in which cod preyed on juvenile cod and juvenile redfish were similar in the two surveys. The tendency for cannibalism to occur in the shallow parts of the bank is consistent with the distribution of young cod which, according to Bulatova (MS 1973), are found at depths of 150-350 m, with greatest catches at 150-250 m. Templeman (loc. cit.) found that stomachs of medium size cod contained 10-15 cm cod (1 yr olds) and the stomachs of large cod more often contained 20-25 cm cod (2 yr olds). In the present study 2-yr-old cod were large enough to prey on 1 yr olds, and 2 yr olds were preyed upon by much larger cod.

It is somewhat surprising that cannibalism was more frequent in 1982 than in 1978-81, for the number of alternate prey (juvenile redfish) was apparently greater in 1982 than in previous years (Lilly and Gavaris MS 1982). In other fish species the intensity of cannibalism is often inversely related to the density of other prey (Forney 1976). However, the intensity of cannibalism is probably also directly proportional to the frequency of encounters between potential predators and vulnerable prey, so the intensity of cannibalism on a size-class (year-class) may provide an index of its abundance.

The derivation of an index of year-class strength from recoveries from predator stomachs would probably be complex, for the intensity of cannibalism will vary with relative sizes and numbers of predators and prey, degree of spatial overlap between potential predators and prey, availability of alternate prey, and the predator's preference for each type of potential prey. That is, the shape of the functional response of the predator to changes in density of the prey being monitored is uncertain. If pelagic fish (e.g. young cod, young redfish, myctophids) are preferred prey of cod, and cod do not discriminate between different species of pelagic fish of the same size, then there may be a rapid initial increase in number of prey taken with increasing density of pelagic fish, followed by a slow increase to the satiation level. In this situation the degree of cannibalism may be highly sensitive to changes in year-class strength at low year-class sizes, somewhat insensitive at higher year-class sizes, and highly dependent on availability of alternate prey.

Despite the problems with formulating an appropriate index, it would appear from Table 2 that the 1981 year-class is stronger as 1 yr olds than the 1977-80 year-classes, and that the 1980 year-class may have been stronger than the previous three. The 1981 year-class may be relatively strong because (1) greater numbers survived to the early post-larval stage or (2) the mortality rate from the early post-larval stage to the time of sampling in January-February 1982 was lower than in the earlier years. Lower juvenile mortality could arise from reduced predation mortality, which could be due to a reduced predator population or the presence of abundant alternate prey. Without an estimate (or an index) of population size at the early juvenile stage (perhaps in October-November of the first year) it is not possible to distinguish between events at the larval stage and events at the early juvenile stage.

## ACKNOWLEDGEMENTS

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Table 1. The occurrence of cannibalism in cod on Flemish Cap in samples taken in January-February 1978-82.

| | Observations at sea | | Detailed laboratory examination | |
|---|---|---|---|---|
| Year | No. stomachs | Cannibalism (%)a | No. stomachs | Cannibalism (%)[a] |
| 1977 | 506 | 1.0 | | |
| 1978 | 1398 | 0.2 | 403 | 0.5 |
| 1979 | 858 | 0.0 | 95 | 0.0 |
| 1980 | 650 | 0.3 | 447 | 0.0 |
| 1981 | 714 | 0.0 | 485 | 0.6 |
| 1982 | | | 516 | 3.3 |

[a]Number of stomachs containing cod as a percentage of the total number of stomachs examined, including empty stomachs.

Table 2. Numbers and sizes of cod recovered during laboratory examination of stomachs of cod captured on Flemish Cap in January-February 1978-82.

| | | Prey | |
|---|---|---|---|
| Year | Pedator length (cm) | Number | Length (cm)[a] |
| 1978 | 68 | 1 | 40.0 |
| | 86 | 2 | 27.0 |
| 1979 | nil | | |
| 1980 | nil | | |
| 1981 | 36 | 1 | |
| | 40 | 1 | |
| | 51 | 1 | 11.5 |
| 1982 | 28 | 1 | |
| | 30 | 2 | |
| | 31 | 1 | 10.1 |
| | 31 | 2 | 9.3 |
| | 33 | 2 | |
| | 33 | 1 | 10.3 |
| | 33 | 1 | |
| | 42 | 1 | |
| | 44 | 3 | 11.5, 11.3 |
| | 50 | 2 | |
| | 52 | 2 | 12.5 |
| | 56 | 4 | 9.2 |
| | 58 | 1 | 9.7 |
| | 74 | 1 | 10.0 |
| | 78 | 2 | 31.0 |
| | 81 | 1 | |
| | 82 | 1 | 26.0 |

[a]Some prey were too digested to be measured.

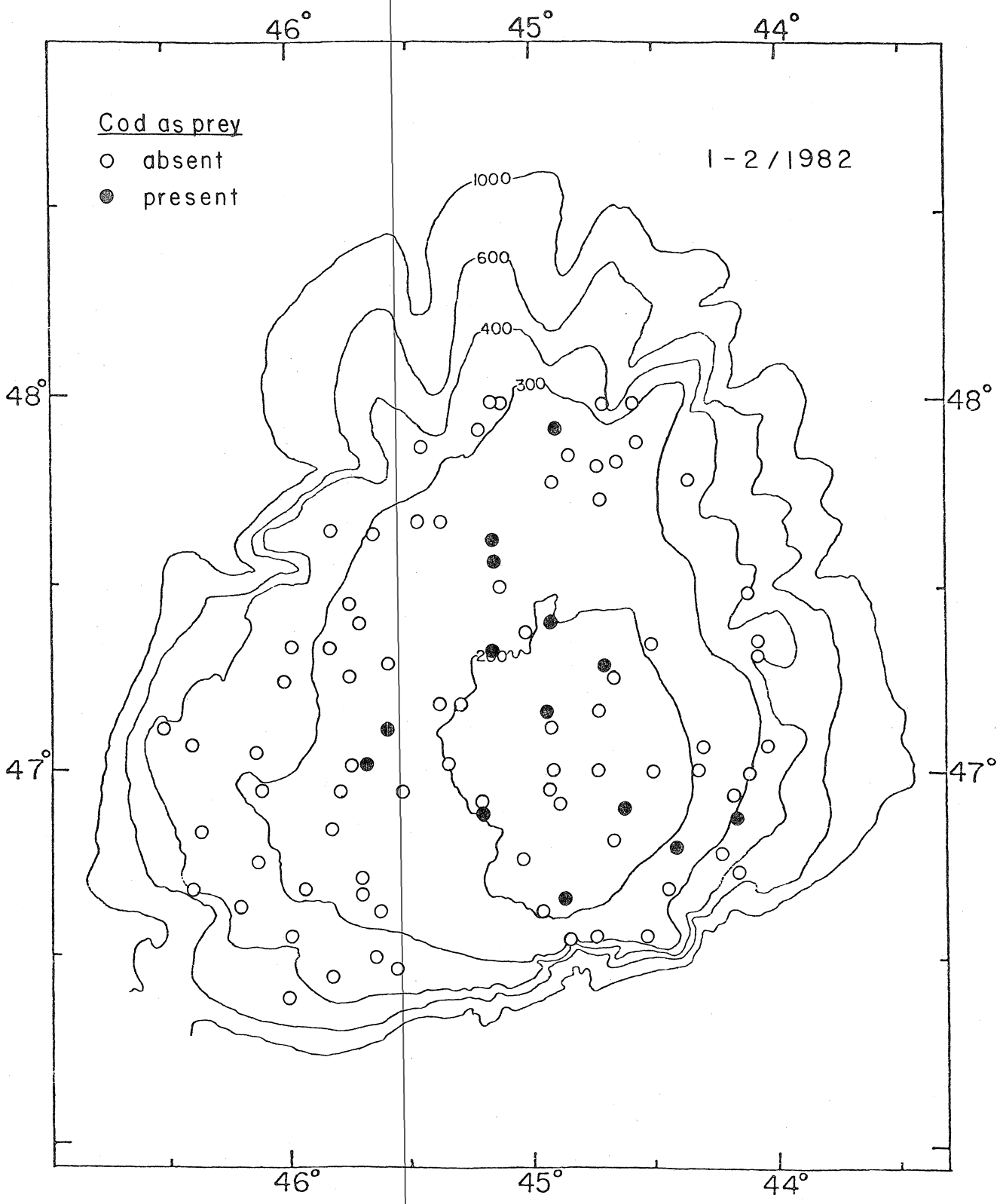


Fig. 1. Distribution of bottom trawl sets in which cod were found in cod stomachs, January-February 1982. All sets in which at least one cod (≥28 cm) was caught and examined for stomach contents are shown.