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Cannibalism as a factor regulating year class strength in the Norwegian spring-spawning herring stock.

by

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Abstract

The feeding area of the Norwegian spring-spawning herring stock is at present situated in the north-eastern parts of the Norwegian Sea. The eastern parts of the feeding area overlaps with the distribution of drifting larvae and 0-group of the same stock. This study presents preliminary results of a stomach sampling program on adult herring feeding off Vesteraalen, confirming that cannibalism are taking place in the area. The size range of the cannibals was 24 to 36 cm, and the mean size of the 0-group eaten was 6 cm (range 4-8). The maximum number of 0-group found in one stomach was 7. These findings support the hypothesis that cannibalism may be a regulating factor for yearclass strength in Norwegian spring-spawning herring under the present migratory regime.

Introduction

In 1970 the Norwegian spring-spawning herring stock was almost depleted as a combined effect of overfishing and climate changes leading to recruitment failure (Dragesund and Ulltang, 1975; Jacobsson, 1980). The process of rebuilding the stock has been tedious, and by 1991 the spawning stock had not yet reached the preferred minimum level at 2.5 million tons (Anon., 1991). Following the stock collapse an eastward shift was observed in the migration pattern, and as a consequence the feeding area of the adult stock and the drift area of the larvae and 0-group have been observed to coincide in periods. This led to the hypothesis that cannibalism could be a regulating factor for yearclass strength under the new migration regime (Bjørke et al., 1989; Anon.,1990). This hypothesis has met general accept, although being poorly documented. The present study presents data which confirm that cannibalism take place in this stock and supports the hypothesis that cannibalism could be a factor regulating yearclass strength in Norwegian spring-spawning herring.

Material and methods

The Institute of Marine Research, Norway, organized a pelagic trawl survey in the Norwegian Sea during a 35 day period starting on July 23, 1991. A total of 75 hauls were carried out in the area from 66° to 74° north and 7° west to 23° east (Fig. 1). The main target species of the survey were herring, mackerel and salmon.

The trawl sampling was carried out with a commercial pelagic trawl ("Boretårn"), which was hauled by two boats in the surface (pairtrawling). The trawl was fitted with bouys and the maximum sampling depth was measured to be about 17 m by a Scanmar depth sensor. The distance between the boats were 150

m and the wirelength 500 m. The wing spread of the trawl was estimated at 30 m based on experiments conducted with similar trawls. The trawling speed was 4.0 knots and each haul lasted for 45 min. Hence, an effective trawling distance of approximately 3 nautical miles.

The catch was sorted within minutes after the haul, and up to 100 herring were picked out by chance for analysis. After observing cannibalism at station 24, an additional 60 specimens, all larger than 30 cm, were picked out by chance at that station. Standard parameters as sex, maturation stage etc. were observed, and a scale sample were collected for age determination. The stomachs were single frozen in plastic bags at -20 C.

During the survey an epidemic caused by the fungus *Ichthyophonus hoferi* was detected in the herring stock. Samples of herring were frozen for later examination to assess the epidemic status in the stock during the period of the survey.

A total of 1350 herring stomachs were analyzed with respect to food content. This study presents the results of 31 stomachs in which cannibalism was observed. The total material will be included in a comprehensive study on the feeding habits of herring in the Norwegian Sea.

Results

0-group herring in the catches

0-group herring were caught at 19 stations distributed in two separated areas of the eastern part of the surveyed area (Fig 2). The 0-group herring of the southern area was significantly smaller the those of the northern area (Fig 3).

Young and adult herring in the catches

Young herring were caught in the area off Vesterålen and Troms, while adult herring were caught throughout most surveyed parts of the Norwegian Sea (Fig. 4). The largest catches were made within 200 n. m. off Vesterålen and Troms. The 1983 yearclass still dominated the stock, but the 1988 and 1989 year class contributed significantly to the stock in the feeding area (Fig. 5).

Diseased herring.

A mean prevalence at 44% of *Ichthyophonus hoferi* was observed in 24 catches throughout the Norwegian Sea. The prevalence was in the range from 0 to 8 % within the stations where cannibalism was observed, while prevalences up to 100% was observed within the area where 0-group herring was caught.

0-group herring as prey for herring

0-group herring were observed in the stomachs of young and adult herring in 5 out of 75 stations. These stations were situated in the eastern part of the surveyed area, southeast of the Bear Island and off Vesterålen (Fig. 1). In the northern area 3 out of 60 herring examined (5%) had eaten a total of 4 0-group herring, while in the southern area 28 out of 219 herring examined (12.8%) had eaten a total of 46 0-group herring. The maximum number of 0-group herring in one stomach was 7, but the majority of the predators had eaten one 0-group herring only (Fig. 6).

Due to digestion only 33 0-group herring could be measured within an accuracy of 5 mm (Fig. 7). The mean length of 0-group herring in the stomachs was 6.0 cm (range 4-8 cm). Based on the remaining bone, one herring was estimated at just above

10 cm when eaten.

Only 12 of the cannibals were measured, ranging from 24 to 36 cm (Fig. 8). The size distribution of young and adult herring (1+) caught within the two areas where cannibalism occurred is shown in figure 9.

Other food

Apart from 0-group herring the observed prey item groups were Polychaeta, Calanoidea, Hyperidae (Amphipoda) and redfish (*Sebastes* sp.) (Figure 10). Fish dominated the stomach content of herring which had eaten herring.

Discussion

Cannibalism has been observed in several clupeoids including alewife, anchovy, anchoveta, pilchard, herring and sardine (Blaxter and Hunter,1982). In herring, cannibalism on larvae has been reported from laboratory and mesocosm experiments (Hourston et. al, 1981; Fuiman and Gamble, 1988; Fuiman, 1989; Wespestad and Moksness, 1989). Bjørke et. al. (1989, 1991) observed post-larvae at 40 to 50 mm of the Norwegian spring-spawning herring stock in the stomachs of adult herring of the same stock.

The size distribution of the herring prey in this study indicates that 0-group herring of the Norwegian spring-spawning herring stock is vulnerable to cannibalism, with respect to size, throughout its first year of living. It is, however, reasonable to expect that the vulnerability to predation in general is size-specific as demonstrated in northern anchovy by Folkvord and Hunter (1986). Vulnerability to cannibalism may also be connected to major changes in

behaviour like the onset of schooling.

The mean size in august of immature 3-group herring in the Norwegian Sea having left the Barents sea the same year is close to 24 cm (Røttingen 1989; Holst and Iversen, 1992) and herring from this stock matures at about 29 cm. The size range of the predators observed in this study was from 24 to 35 cm, which indicates that the majority of the herring stock in the Norwegian sea, including young and adult specimens are potential predators on 0-group herring.

The cannibalistic potential for any young or adult herring size-group must vary with the degree of overlap with larvae and 0-group distribution. During 1976 to 1991 the observed geographic distribution of larvae/0-group (Bjørke, 1980; Nedreaas, K. and Smedstad, O.M., 1987; Bjørke et. al., 1989, 1991) indicates a near coastal distribution from Møre to Troms in the period March - July. This leads to the general hypothesis that any coastal migratory pattern of juvenile and adult herring will favour cannibalism in this stock.

Coastal migratory patterns is known through historical records. During the period 1866 to 1874 a fishery for unripe adult herring took place along the coasts off Nordland and Troms in the autumn. This situation resembles the geographic distribution of adult herring in the autumn observed from 1973 until present. Parts of the 1959 yearclass exhibited a coastal distribution in the period 1963 - 1966 (Devold, 1968) which may have favoured cannibalism compared to the main component of the same yearclass which fed of Iceland in that period.

By early autumn most of the 0-group herring has entered the Barents Sea, and spread north and eastwards throughout the area (Hamre,1989). During the eastward drift through the southern Barents Sea the 0-group herring passes 2,3 and 4-group herring migrating westwards into the Norwegian sea. This overlapping distribution of 0-group and young herring may

represent another period of cannibalistic potential.

An average of 44 percent of the herring sampled in 24 stations during this survey was infected by the fungus *Ichthyophonus hoferi*. Although not thoroughly analyzed yet, it appears that diseased herring reduces or stops feeding. It has been shown that diseased individuals are overrepresented in trawlcatches (Holst et al., 1992). This may have biased our results, making cannibalism appear less widespread than what was actually the case during the period of this survey.

It seems fair to claim that cannibalism may influence recruitment in Norwegian spring-spawning herring in periods. One must, however, assume a close correlation between the potential of cannibalism as a factor regulating yearclass strength and the migratory pattern of both young and adult herring. Future work to assess the impact of cannibalism on year class strenght in this stock will have to concentrate on two major issues; the degree of overlap between prey and predator in time and space, and the estimation of feeding and digestion rates.

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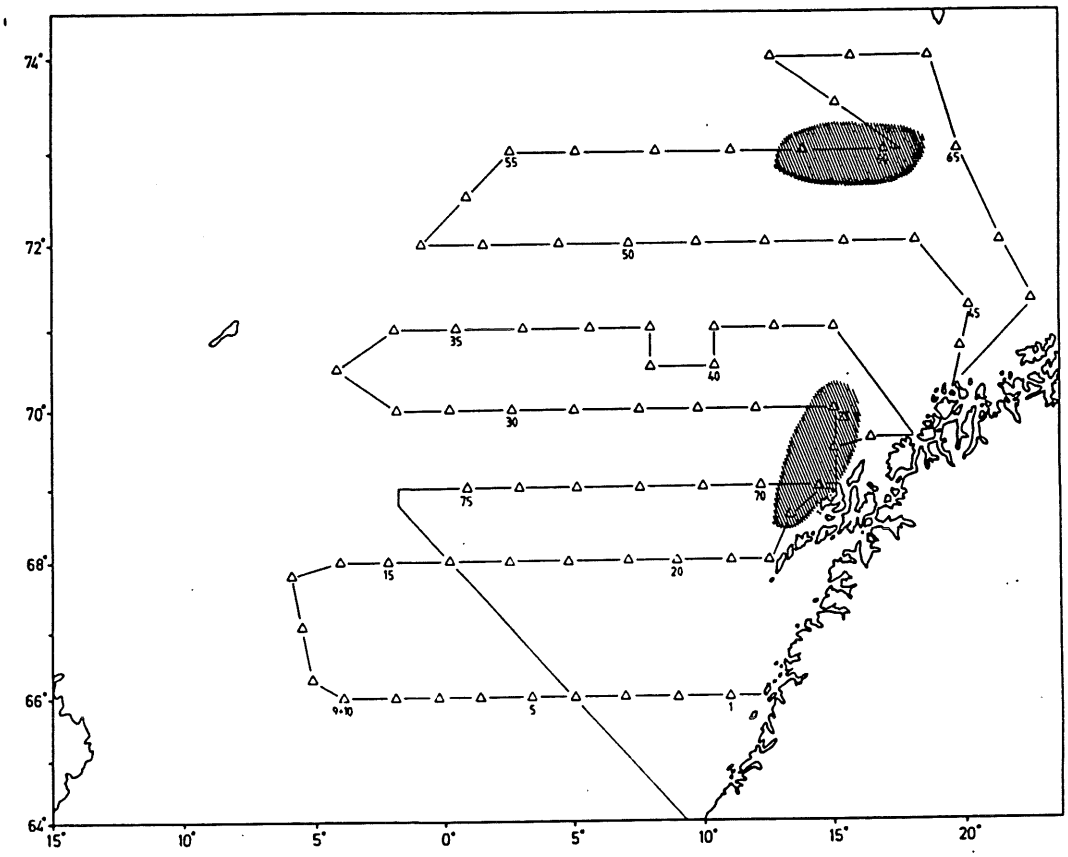

Fig. 1. Survey grid and trawlstations. Hatched areas indicate stations where cannibalism was observed.

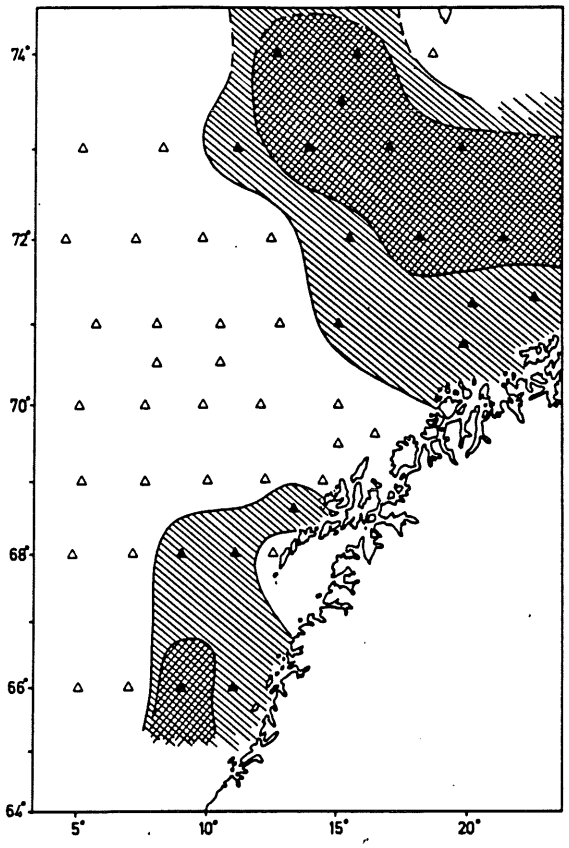

Fig. 2. Catches of 0-group herring.
Hatched: < 1000 per haul.
Double hatched: > 1000 per haul.

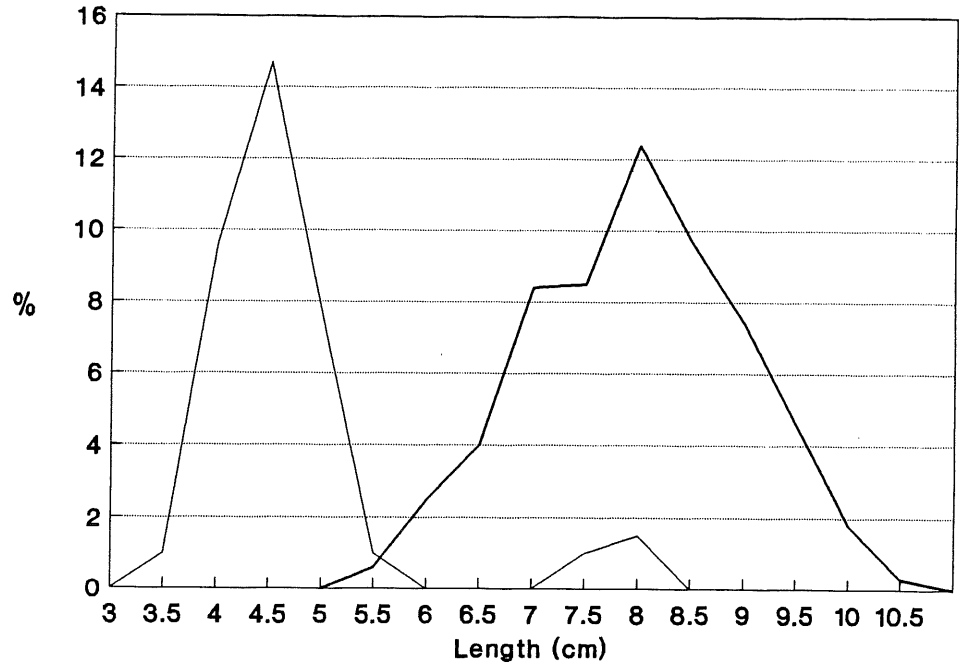

Fig. 3. Length distribution of 0-group herring in the catches. Southern and northern area according to figure 2. Thin line: Southern area. Thick line: Northern area.

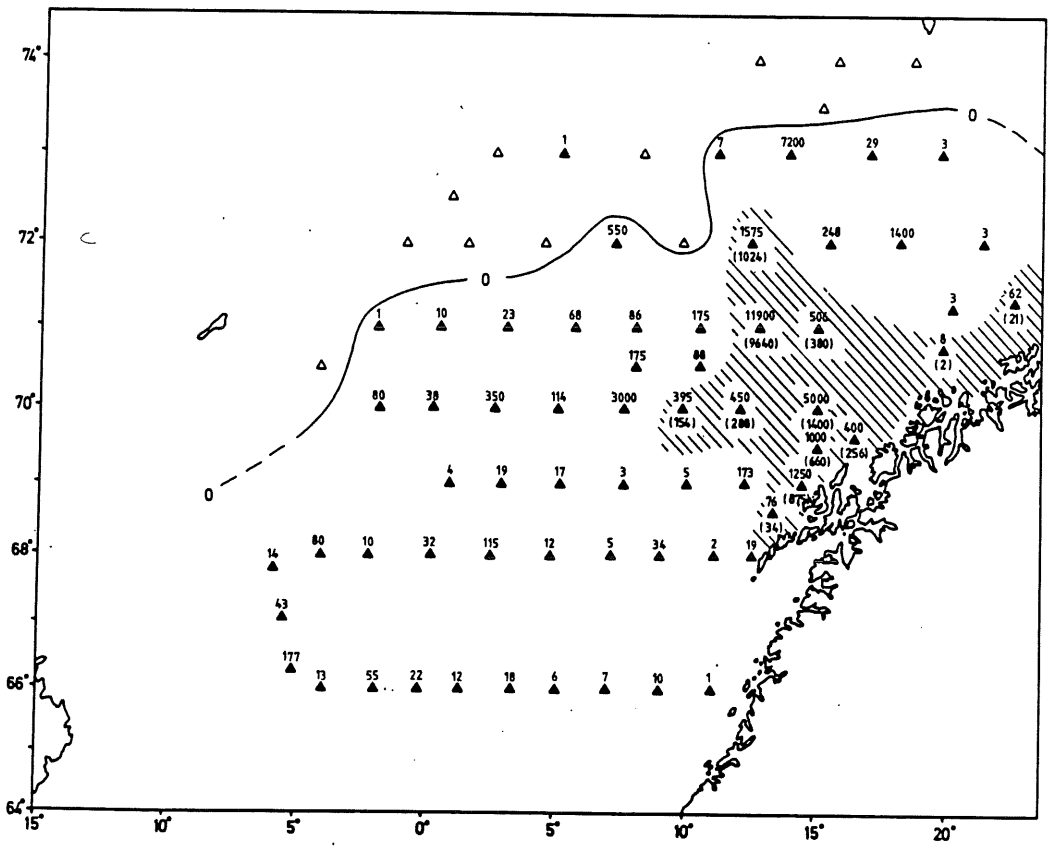

Fig. 4. Distribution of herring (numbers per trawl haul).
Number above triangle: adult herring (> 30 cm).
Number bellow triangle: young herring (< 30 cm).
Hatched area: distribution of young herring.

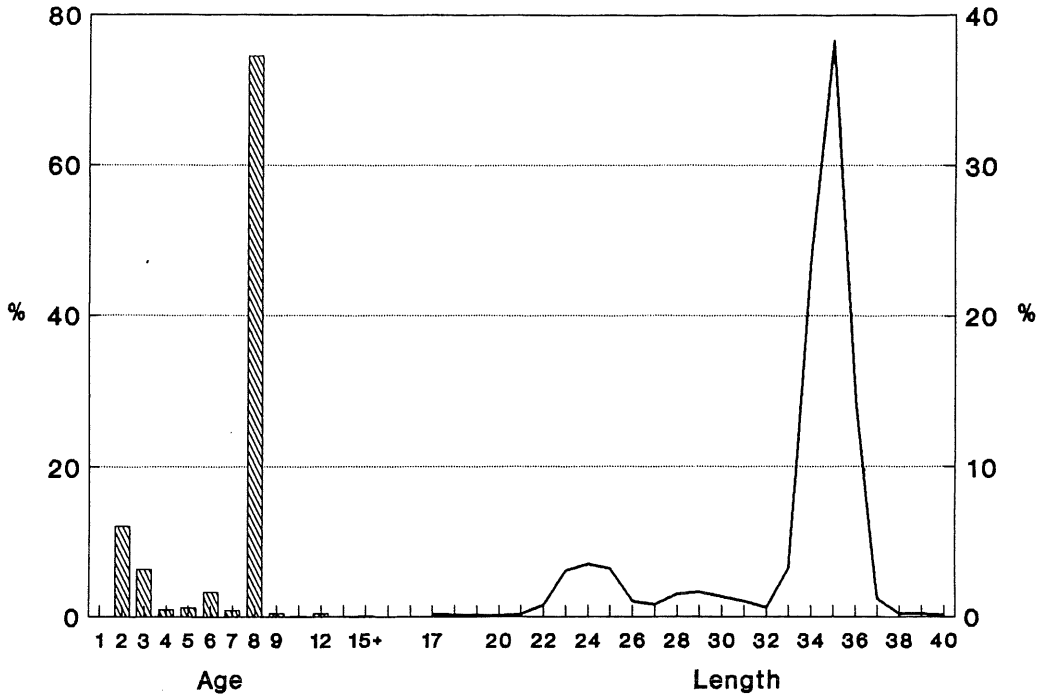

Fig. 5. Age and length distribution of herring caught in the Norwegian Sea during July - August 1991.

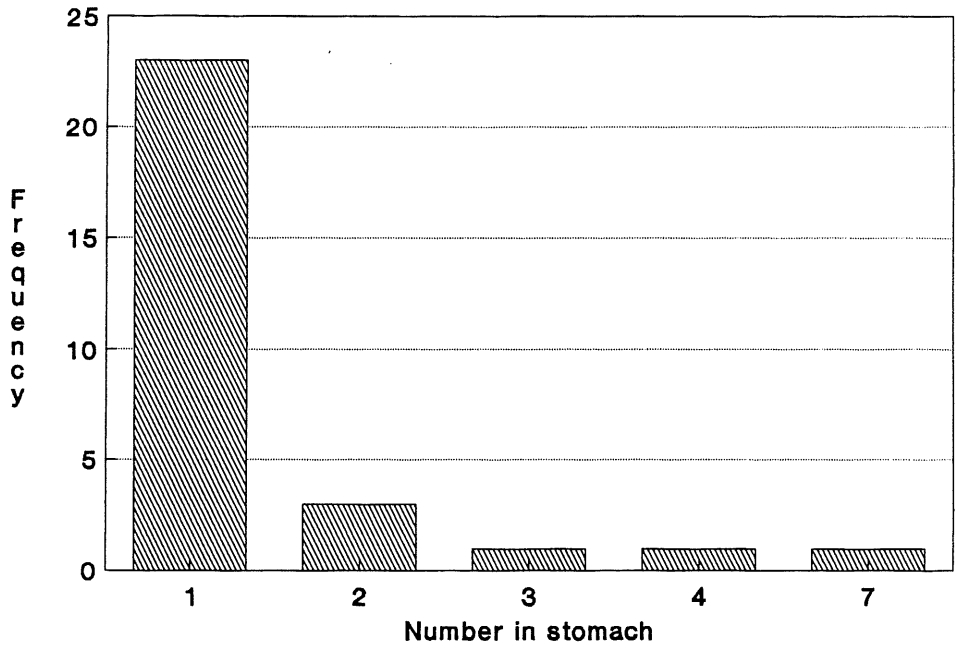

Fig. 6. Numbers of 0-group herring found in herring stomachs.

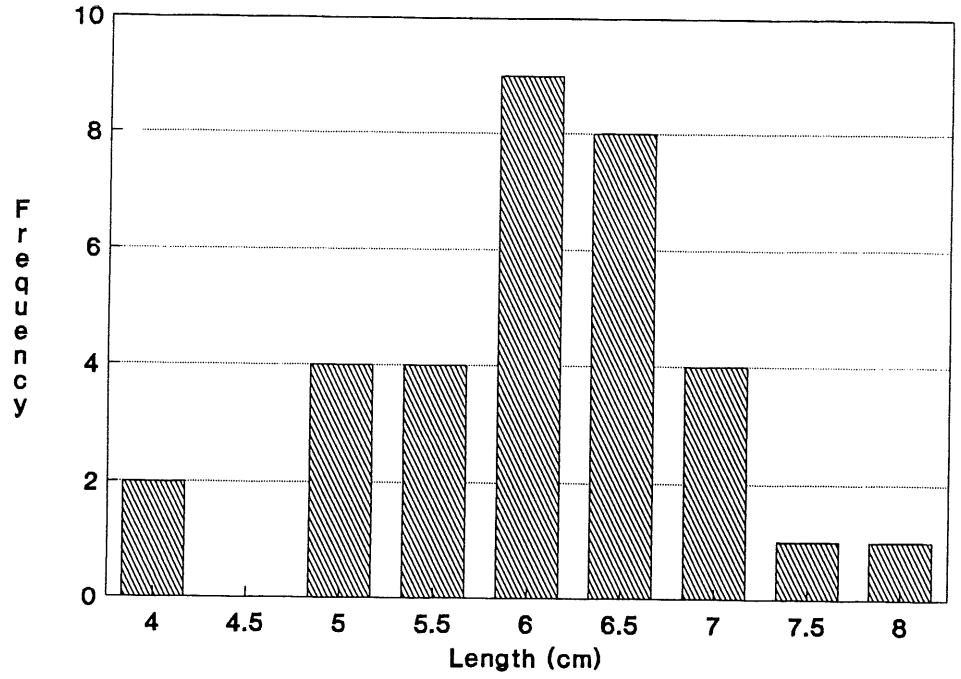

Fig. 7. Length distribution of 0-group herring in herring stomachs.

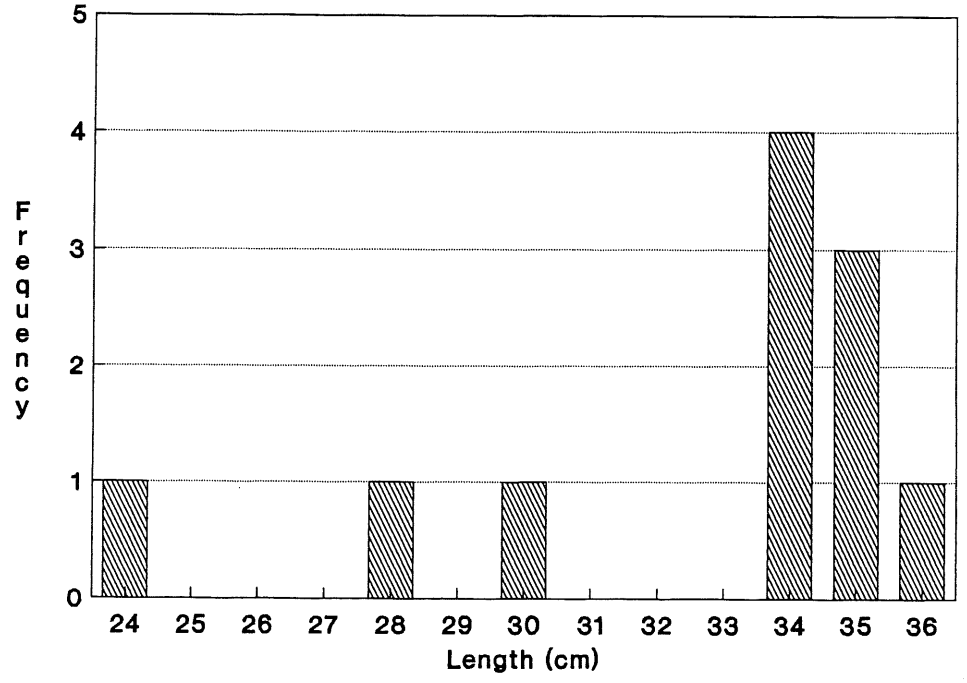

Fig. 8. Length distribution of 12 cannibalistic herring.

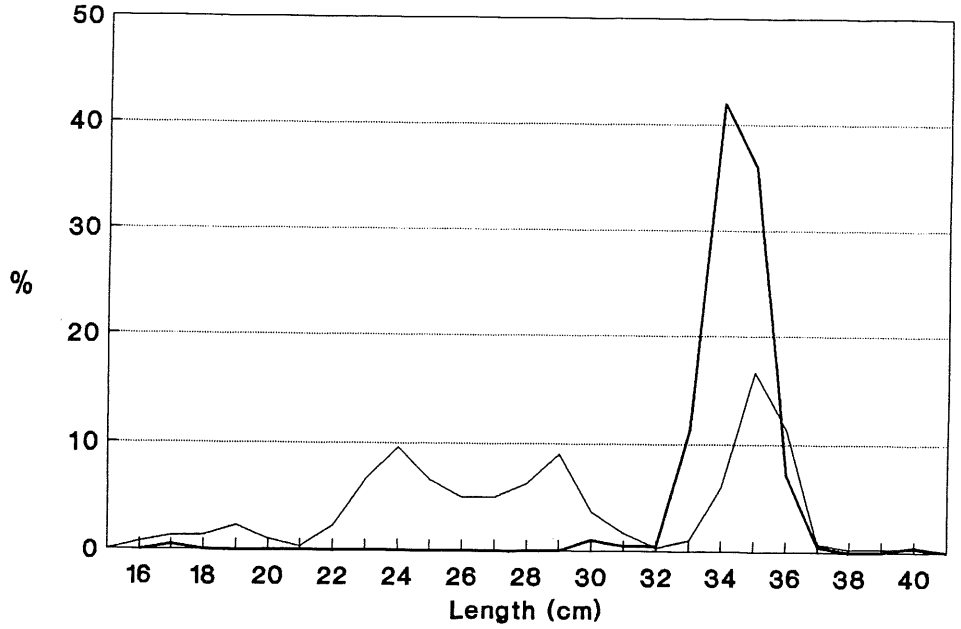

Fig. 9. Length distribution of young and adult herring in the catches within stations where cannibalism was observed. Southern and northern area according to figure 1. Thin line: Southern area. Thick line: Northern area.

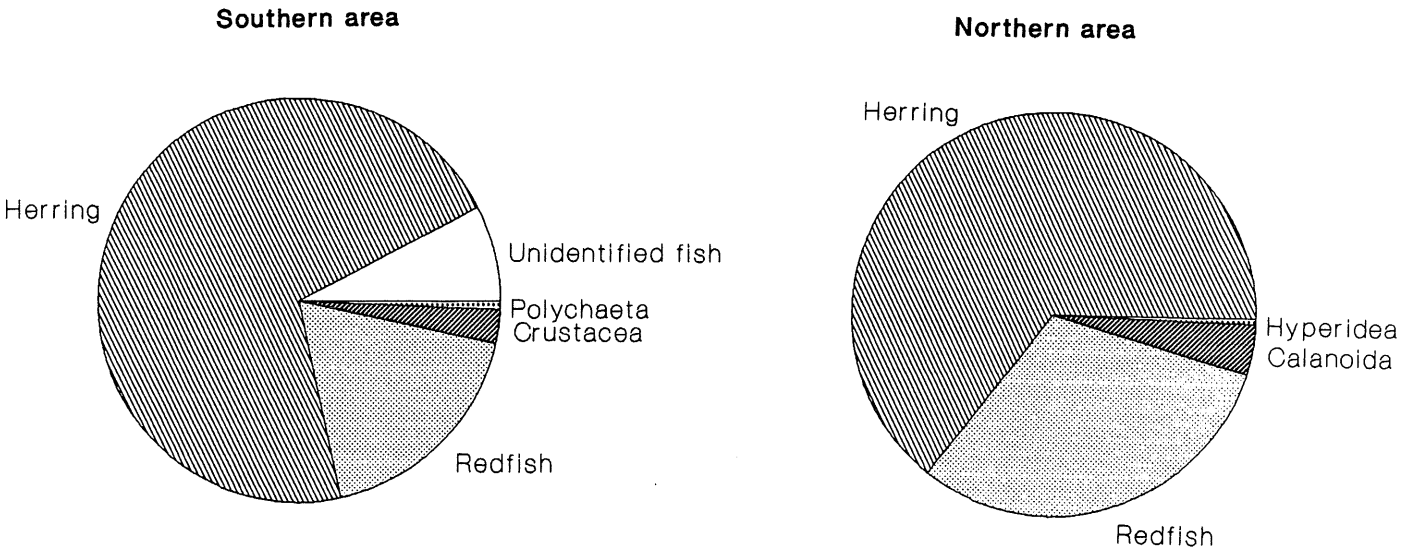

Fig. 10. Stomach content, wet weight percentage of preyitem groups. Crustacea includes Hyperidea and Calanoida.