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Influence of Latitude on the Catchability of Greenland Halibut.

by

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Abstract.

The present paper compares the proportions of females by length in the catch of the NAFO Regulatory Area and Svalbard. An increase in the catchability of males of over 5 years is detected in Svalbard which does not appear in the NAFO fishery. This difference gives rise to different sex ratios in the catch of both areas. A trend for the catchability of males to increase with latitude seems to exist, the causes of which remain unexplained.

1.- Introduction.

The proportion of sexes in the catch of Greenland halibut differs slightly throughout its area of distribution. While in Newfoundland (at around 48°N) the catch is dominated by females and presents a sex ratio (males/females) which varies between 0.51 and 0.58 (**de Cárdenas, 1996**), in the Davis Strait (at around 64° N) a co-dominance of sexes is detected in the catch, implying that the sex-ratio is situated at about 1 (**Chumakov *et al.*, 1978**). Nevertheless, in the Barents Sea (74° N) the catch is clearly dominated by males, since the sex-ratio in the area varies between 2.18 and 2.39 (**Nizovsev, 1969; Kovtsova, 1985**). These data seem to indicate a trend for the percentage of males in the catch to increase with latitude (**de Cárdenas, 1996**).

Between 1991 and 1994, Spain developed a project of observers on board commercial vessels in the NAFO Regulatory Area, Divisions 3L, M, N and O. Data collected by these observers has been used to study how the percentage of females evolves with length in the catch of these areas (**de Cárdenas, 1996**). In summer 1995, 6 units of the Spanish fleet habitually working in this fishery went out to Svalbard (ICES Subarea IIb) with an on board observer to perform experimental fishing targeting American Plaice. This permitted data collection on the proportion of sexes of Greenland halibut in this area (***Fig. 1***).

The aim of this paper is to compare the evolution of the percentage of females by length, mean length at age and percentage of females at age in Newfoundland, an area situated in the south of the area of distribution of the species and Svalbard, which is to the north. These two areas present the greatest contrasts in sex-ratio, which is important to find the cause of these differences.

2.- Materials and methods.

The data used were collected on board 6 commercial vessels fishing in waters near Svalbard (***Fig. 1***) in the months of June and July 1995. In total 5.589 specimens of Greenland halibut were sampled from the catch coming from 677 hauls, which covered a depth range of between 60 and 1382 m.

The female ratio (females/(males+females)) by 1 cm length group was made smoother through the use of a three point moving average, and was represented together with the three curves obtained for 1992, 1993 and 1994 in the Newfoundland area (**de Cárdenas, 1996**).

Using the length distribution of the catch by sex and the age-length keys by sex obtained from the otoliths of 607 males and 782 females caught in this area in August 1995, kindly provided by **Dr. K. Nedreaas** (Institute of Marine Research, Nordnesgaten 50, N-5024 Bergen

Norway), mean lengths at age in the catch were obtained and represented with the corresponding figures obtained for 1993 in Newfoundland (**de Cárdenas, 1996**). The number at age by sex was also calculated to obtain the female ratio at age, which was represented together with the figure obtained for Newfoundland in 1993 (**de Cárdenas, 1996**).

3.- Results.

The sex-ratio observed in Svalbard in summer 1995 is 1.51. The female ratio by length decreases drastically between 35 and 40 cm, a trend which is not seen at all in the Newfoundland samplings of 1992, 1993, or 1994. Between 40 and 52 cm the percentage of females grows in both areas, but this growth is much more pronounced in Svalbard. At 60 cm the percentage of females in Svalbard reaches over 90%, while this figure is only reached in Newfoundland at 65 cm (**Fig. 2**).

Specimens younger than 7 years present mean lengths at age around 7 cm higher in Svalbard than in NAFO, and from this age differences fall, disappearing completely from age 9. Sexual differences in growth are not observed in any of the areas (**Fig. 3**).

The proportion of females at age in the catch in Svalbard at 4 years is situated at around 0.5, before decreasing to below 0.3 at age 6. From this age, females tend to dominate the catch and reach a value of 0.99 at age 11. In NAFO, the proportion of females by length is also around 0.5 at 4 years, but remains at this level to age 6, from which point the proportion of females tends to increase drastically, although with a lesser slope than that found in Svalbard, and at 11 years the proportion of females is approximately 0.95 (***Fig. 4***).

4.- Discussion.

Although the sex ratio found in Svalbard in June-July 1995 was lower than the values obtained by **Nizovsev (1969)** and **Kovtsova and Nizovsev (1985)**, it is nevertheless higher than that obtained by **Chumakov *et al.* (1978)** for the Davis Strait, and very much greater than those obtained in the NAFO Regulatory Area (**de Cárdenas, 1996**).

When the behavior of the proportions of females by length are analyzed, it is observed that the main difference between the two areas is found in the accumulation of males in the 35-55 cm length range, given by the catch in Svalbard, and not in the catch of the NAFO Regulatory Area. This accumulation may be due to there being sexual differences in growth in Svalbard but not in NAFO. Slower growth of males would accumulate more ages in this length range than female ages, which would explain the increase in the proportion of males at these lengths as well as the fact that males do not reach greater lengths. However, this is not the explanation. When mean lengths at age are observed, it is seen that in Svalbard there are practically no differences between the sexes. On studying the evolution of the proportion of females at age, we see that males begin to be more vulnerable to fishing activity than females at age 5 in Svalbard, and this does not occur in NAFO. The results obtained in the Russian survey **Chumakov and Serebryakov (1982)** show a trend towards the north in the appearance of this phenomena, while Division 3K, which is the nearest to our fishery, shows highly similar behavior to that found in the Regulatory Area. As sampling becomes more northern, the phenomena becomes more pronounced.

Thus, we can conclude that in the areas studied, differences in the sex-ratio of the catch are due to increases in the catchability of males, increases which come about from age 5, and which become more pronounced as latitude increases. In the future it would be interesting to find out whether this trend is repeated in other areas, such as the area to the east of Greenland, Iceland or the Faeroe Islands.

One explanation of this increase in the catchability of males may be found in the formation of concentrations of fishes about to reach sexual maturity, and of mature specimens awaiting females in spawning grounds. This is not rare in other species of flatfishes. **Beverton (1964)** finds a different catchability of males and females in North Sea plaice, which he specifically puts down to this behavior.

If this were the case, the spawning grounds of this species should be situated in the north, and a migration of nearly mature males would come about in a northern direction. This does not seem to be the case of Greenland halibut since, as we are speaking of at least two independent stocks (that of NAFO and that of Norwegian Arctic) and possibly some sub-stocks, each must have its own spawning grounds and thus, the increasing phenomena of the sex-ratio in the catch should not present a trend towards the north, but rather, areas where the phenomenon were more or less pronounced should appear towards the north, coinciding with the greater or lesser proximity to the spawning grounds of each stock. Looking at Figure 2, we see that the length

range in which the large increase in the concentration of males in Svalbard comes about does not seem to coincide with a great fall in the percentage of males in NAFO, since this fall comes about a little later, at around 45 cm. Nor do migrations towards the north seem to be observed in the graphs in **Chumakov and Serebryakov (1982)**. With respect to spawning grounds, if some of them are situated in Davis Strait (**Jensen, 1935; Smidt, 1969; Templeman, 1973; Bowering, 1983**), spawning also appears in the north of Flemish Pass and in Division 3N (**Junquera, 1994; Junquera and Zamarro, 1994**), areas in which the increase in the catchability of males is not detected at all. It would therefore be necessary to continue studying this phenomena with the aim of finding a suitable interpretation.

Lastly, the behaviour of the proportions of females by length in Svalbard remains consistent with a differential mortality in the sexes from age 7 such as that postulated by **de Cárdenas (1996)**, since the speed of disappearance of males of over 50 cm is much greater in Svalbard than in NAFO due to the fact that the differential mortality already described for the NAFO area would be coupled with the effect brought about by the increase in catchability registered in this area, and very possibly with an increase in natural mortality owing to prey concentrations attracting the interest of predators.

As a purely illustrative exercise, the catch curve shows that the difference between the Z's of Svalbard are 1.1, whereas in NAFO they are 0.9 (***Fig. 5*** and ***6***).

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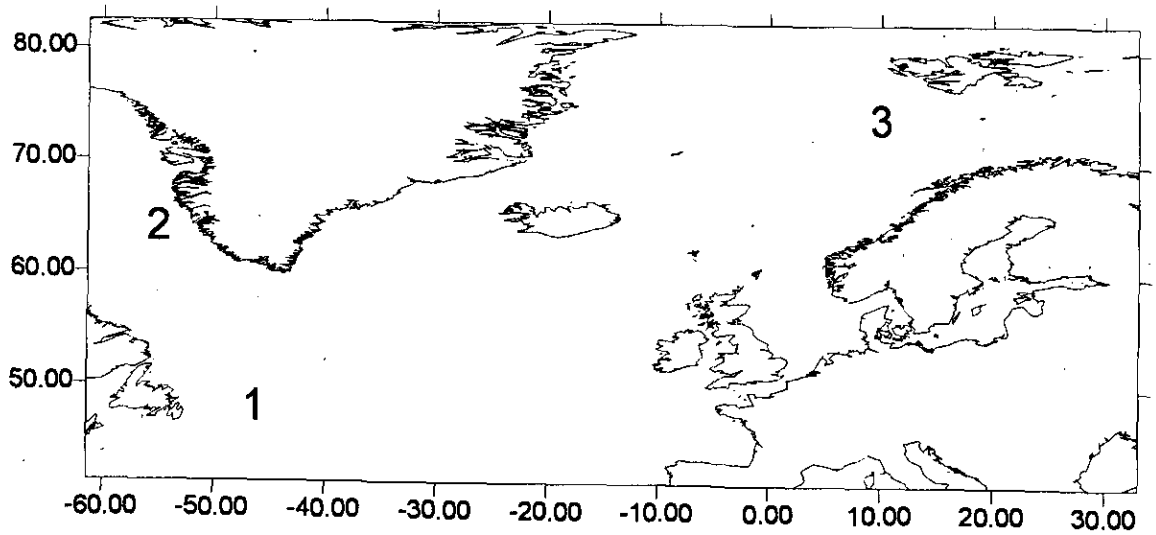

Fig. 1.- Map showing the fishing zone at the NAFO Regulatory Area (1), Davis Strait (2) and Svalbard (3).

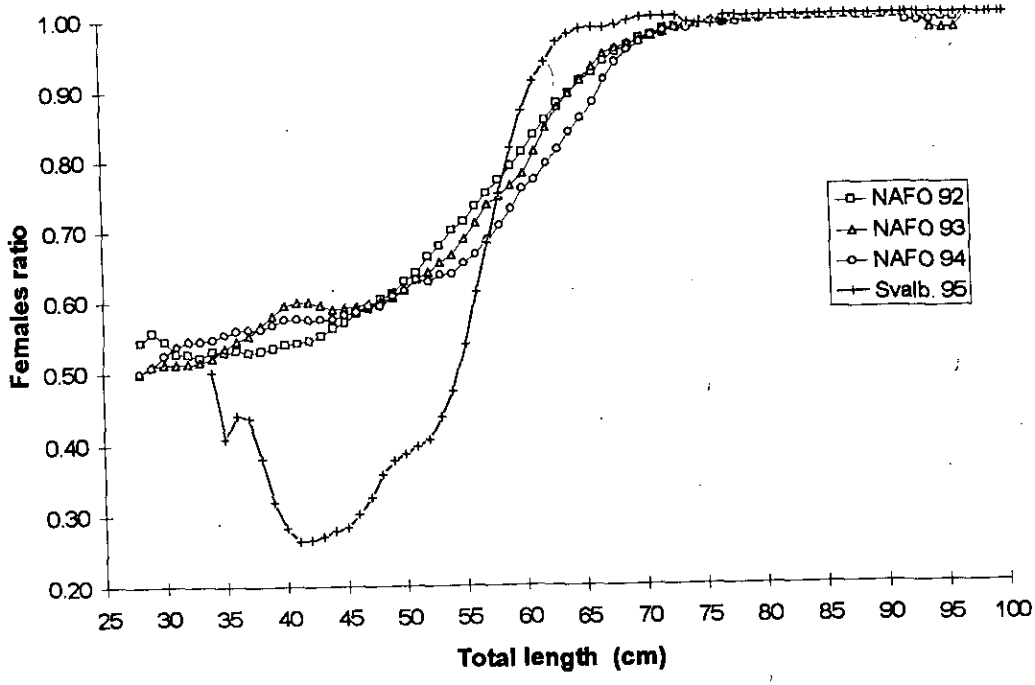

Fig. 2.- Females ratio by length in the NAFO Regulatory Area catch (period 1992-94) and Svalbard catch (!995).

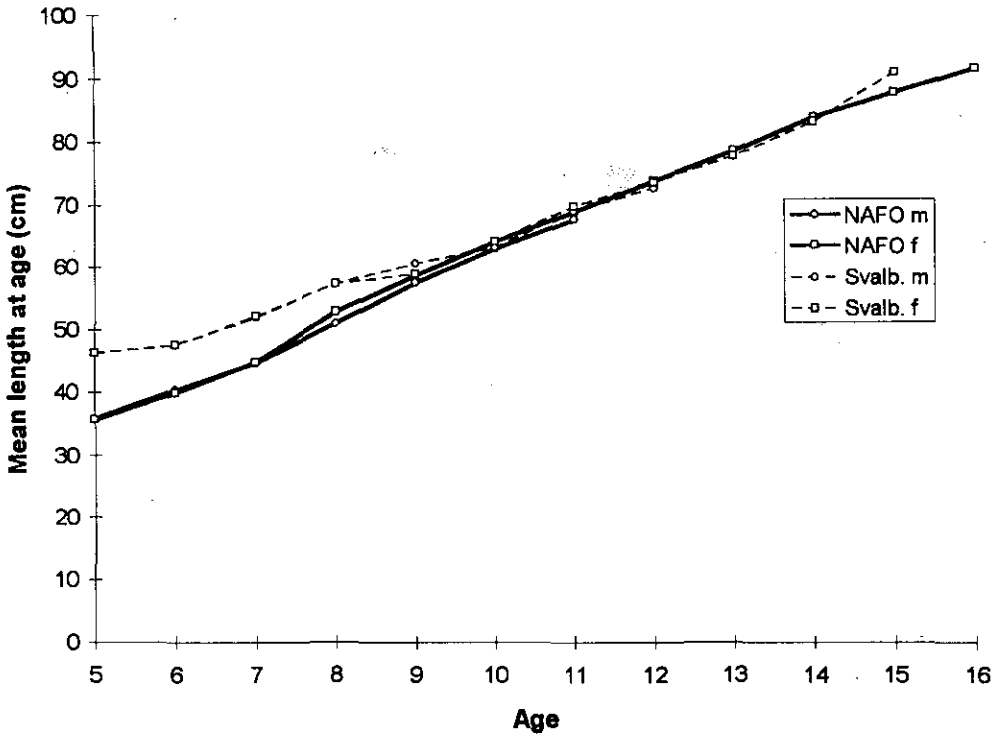

Fig. 3.- Mean length at age for males (m) and females (f) in NAFO (1993) and Svalbard (1995).

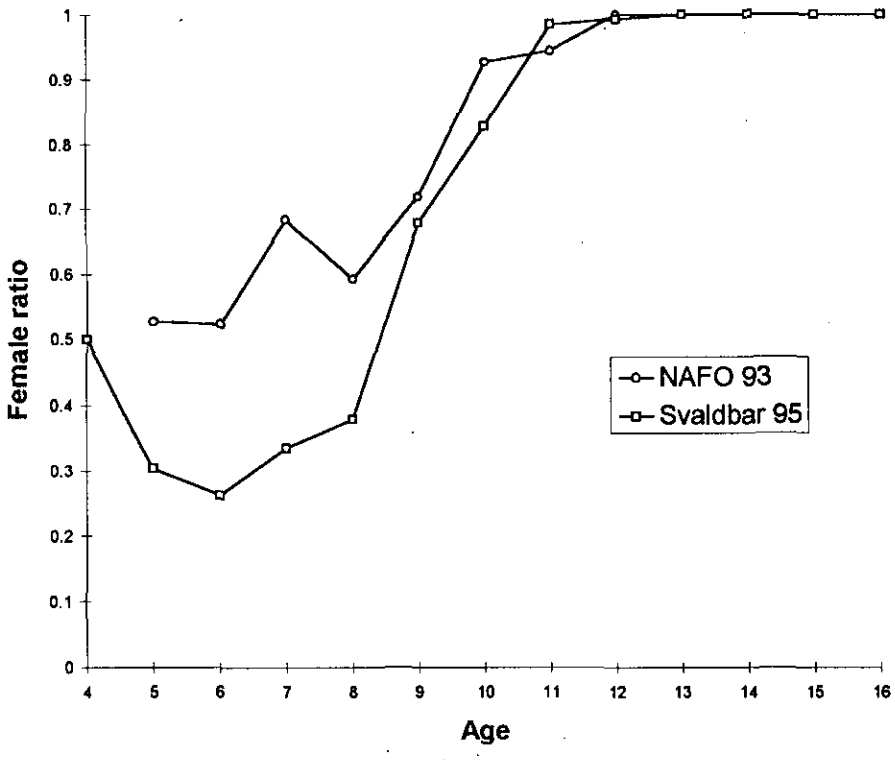

Fig. 4.- Female ratio by age in the NAFO Regulatory Area (1993) and Svalbard (1995).

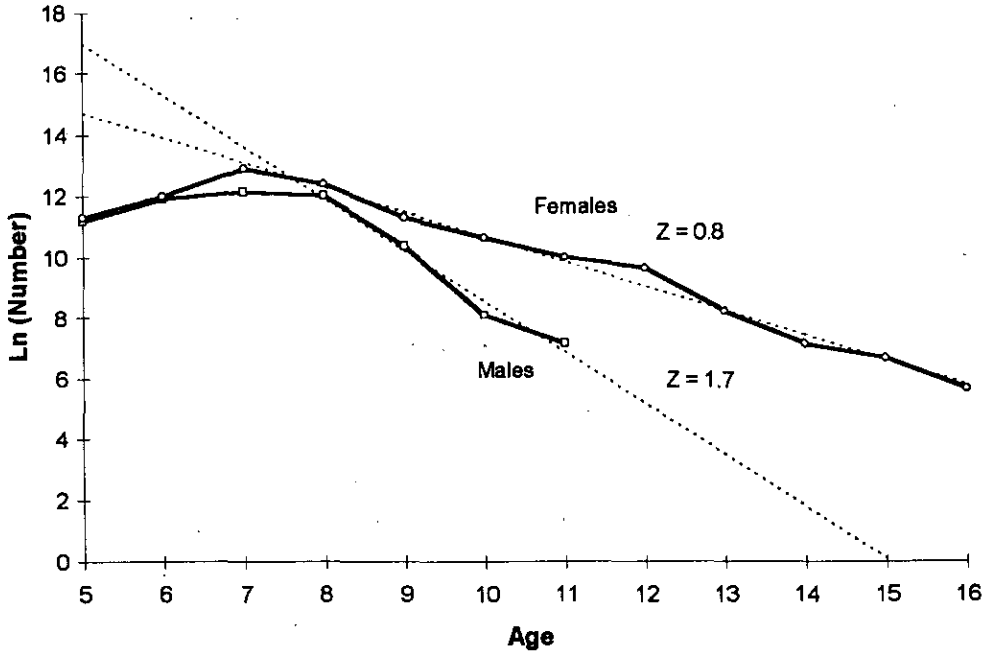

Fig. 5.- Catch curves by sexes comming from the NAFO Regulatory Area (1993).

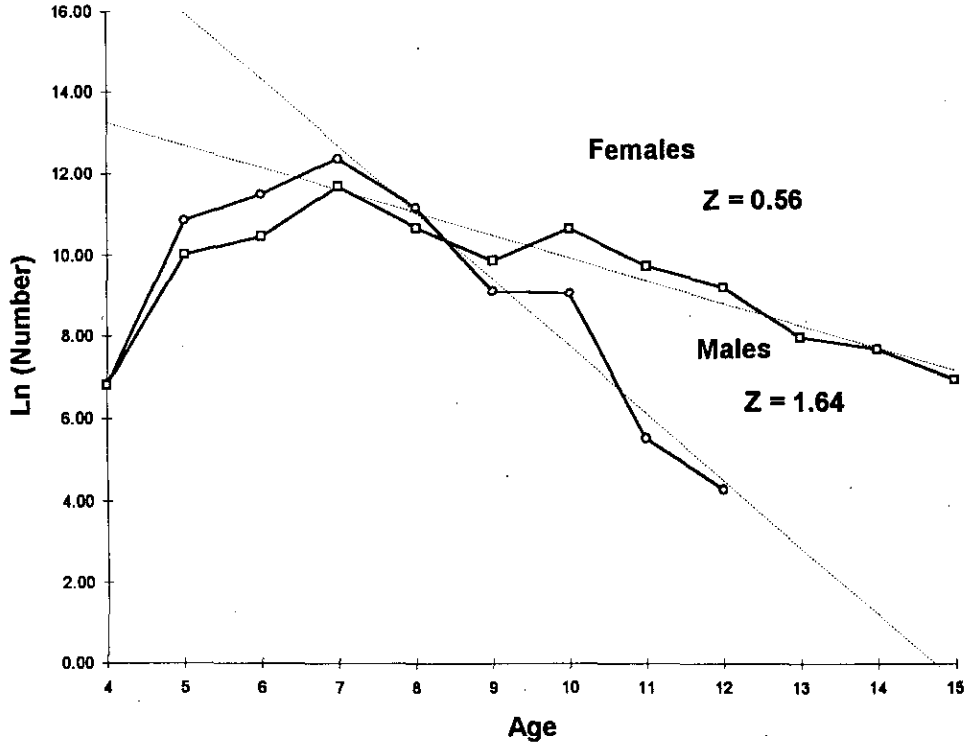

Fig. 6.- Catch curves by sexes comming from Svalbard (1995).