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Distribution, Abundance, Size, Age, Gonad Index and Stomach Contents of Greenland halibut (Reinhardtius hippoglossoides) off West Greenland in September/October 1988

by

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Introduction

Greenland halibut, Reinhardtius hippoglossoides, is one of the most important fishery resources at deep waters in Davis Strait (NAFO Subareas 0 and 1). Recent surveys on groundfish stocks have revealed the abundance of Greenland halibut off West Greenland (Atkinson and Bowering, 1987; Yamada et al., 1988). However, these two surveys did not include waters deeper than 1250 m (this species is known to be distributed as deep as 2000 m (Nielsen, 1986)).

A stratified random trawl survey was carried out off West Greenland (NAFO Divisions 1A-1D) at the depths between 200 and 1500 m in September and October, 1988 by the Japanese stern trawler, Shinkai Maru (Yatsu and Jørgensen, 1989 MS). This paper presents a part of the results from the survey jointly conducted by the Japan Marine Fishery Resource Research Center (JAMARC) and the Greenland Fisheries Research Institute as a part of a joint program between JAMARC and the Greenland Trawling Company of the Greenland Home Rule.

Materials and Method

Stratification scheme and basic data on survey methods are given by Yatsu and Jorgensen (1989 MS). The survey area included NAFO Divisions 1A (south of 73° N) to 1D outside the 3 nautical miles from the base line, at the depths between 401 m (201 m, north of 70°N) and 1500 m. The area swept at each trawl station was calculated as the product of the width between tips of net wings and the distance towed. The catchability coefficient was taken as 1.0.

At each trawl station, total length by sex was measured to cm-below for all fish caught except four stations where subsamples were taken due to large catches. The size

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composition in each stratum was calculated as the mean of the size composition of the hauls, in number per km^2 swept area. Overall size composition was calculated as a weighted mean of the size composition at each stratum, using the stratum area as a weighting factor.

Usually 20 specimens from all stations with catch of Greenland halibut were sampled to cover most of the length range in order to collect the following biological parameters: total length in mm, body weight in g, sex, gonad weight in 0.1 g, gonad maturation stage (visual examination), wet weight of stomach contents by major groups (fish, squid, shrimp, krill, etc.) in 0.1 g. Gonad index is the percentage of gonad weight to body weight including gonad. Feeding rate is the percentage of stomachs with any food to all stomachs examined. Composition of stomach contents was expressed in the average percentage of wet weight of stomach contents to body weight of all specimens examined. The age-length key used for calculating number at age per km^2 is based on otoliths from fish taken in Divisions 1A-1D (N=907). The otoliths were examined in alcohol in transparent light under a microscope.

Results

Fig. 1 shows the distribution (catch per km^2 swept area) of Greenland halibut. This species was caught from all stations except two (one in Division 1A and the other in Division 1C).

Estimated biomasses by stratum appears in Table 1. These estimates may to some extent be underestimated because an unknown part of this species might be pelagic and thus not available to bottom trawl (Alton et al., 1987). A comparison between the biomass estimates from 1987 and 1988 surveys for six strata (depth zone 401-600 m in Divisions 1A-S to 1C and depth zone 601-1000 m in Divisions 1B to 1D), which are common to both surveys (the 1987 survey was carried out in July/August 1987 (Yamada et al., 1988)), shows that all biomass estimates from 1988 survey are less than those from 1987 survey. This fact could represent seasonal migration from shallower to deeper area within the year's cycle as reported by Ernst (1987).

The size composition by stratum appears in Fig. 2. There is an obvious transition of the size of the fish with depth zone in each Division: smaller fish dominated in shallower strata, whereas larger fish were found in deeper strata. On the other hand, size of fish increased when strata proceeded from north to south. The transition of size with depth has been reported by Chumakov and Serebryakov (1982), Atkinson and Bowering (1987), and Ernst (1987). The direction of geographic cline in size presented here is opposite to that along Subareas 0 to 3 (Chumakov and Serebryakov, 1982; however, see below). Overall size composition (Fig. 3) shows the length ranged from 5 cm (unsexed and semitransparent) to 78 cm for males and to 115 cm for females with peaks at 12, 19, 27, and 47 cm.

The age compositions for each Division and for total survey area are shown in Figs. 4 and 5 respectively. Young fish first of all come from Divisions 1A and 1B and older fish come from Divisions 1C and 1D. The overall age composition is dominated by fish at age of 3, 4, 7, and 8 years.

The sex ratio (ratio of females to both sexes, excluding unsexed) by 1 cm group (Fig. 6) was calculated from the overall size composition. Sex ratio was around 0.5 between 15 and about 35 cm (as most of fish smaller than 15 cm was not sexed, the ratio was not considered). The sex ratio was about 0.2 to 0.4 between 35 to 65 cm, then increased abruptly to 1.0 at 79 cm. This pattern can be primarily attributed to the different maximum length by sex. However, the ratio of females of 40-70 cm was much lower than that reported by Riget and Boje (1987) who examined the catches from the fjords of West Greenland. This fact may suggest a different migration pattern by sex and, hence, leaves a clue for the relationship between fjord and offshore populations.

The relationship between total length and gonad index is shown by Division in Fig. 7. The smallest size to mature seems to be about 40 cm for males, about 55 cm for females. There is an apparent north-south cline in this relationship in both sexes, which is in contradiction to Chumakov and Serebryakov (1982) who found the reverse relationship in Subareas 0-3.

Feeding rate and composition of stomach contents are expressed by Division and 10 cm length group in Fig. 8. Feeding rate seems to be higher in smaller fish, but lower in larger fish within Divisions 1A and 1C (Kendall's rank correlation factor, τ , were 0.81 ($P>0.05$) and 0.71 ($P>0.05$; excluding 10-20 cm group) respectively). Feeding rate in Divisions 1A and 1B was higher than that of Divisions 1C and 1D. The average weight of stomach contents to body weight also showed the same tendency among Divisions. Fish was dominant in all size groups in all Divisions except for the 10-20 cm group in Division 1A and 20-30 cm group in Division 1C. The following fish species (or families) were found in stomachs: black dogfish (Centrocyllium fabricii), the rajidae, bathylagidae, paralepididae, myctophidae, synaphobranchidae, roundnose grenadier (Coryphaenoides rupestris), roughhead grenadier (Macrourus berglax), Atlantic cod (Gadus morhua), moridae (Onogadus ensis, etc.), zoarcidae, stichaeidae, redfish (Sebastes), cottidae, liparidae and Greenland halibut. Capelin and Arctic cod (Boreogadus saida) were not found although they are known as major food items for Greenland halibut in some localities (Atkinson et al., 1982; Haug and Gulliksen, 1982). Food items here combined as Crustacea includes shrimp (Pandalus borealis and other unidentified species), krill (Euphausiacea), and Amphipoda.

Ernst (1987) presented a scheme of spawning ground, larval drift, and migrations for Greenland halibut stock off Canada and West Greenland in his Fig. 12 and 13. The transitions found in the present results of size composition and gonad index are in correspondence to Ernst (1987) in that off West Greenland larvae are drifted northward by the West Greenland Current and the fish migrate to deeper and southern area for spawning. The reversed direction of spawning migration is explained by the oceanic current system and the location of spawning ground in Davis Strait.

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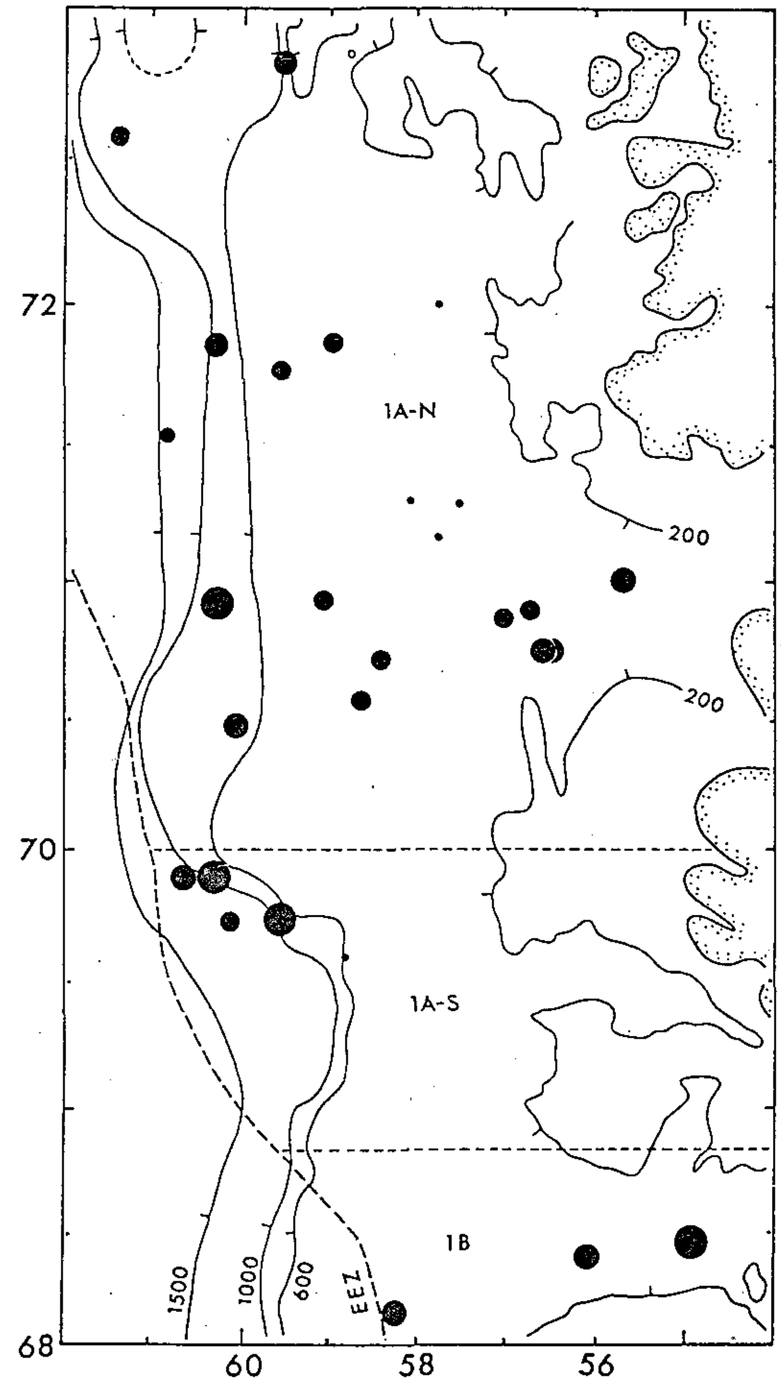
Page 3, line 11 to 14 should read:

for females at the West coast, $BW=8.377\ FL^{3.379}\ 10^{-7}$, N=103
for males at the West coast, $BW=2.285\ FL^{3.235}\ 10^{-6}$, N=126
for females at the East coast, $BW=2.097\ TL^{3.247}\ 10^{-6}$, N=122
for males at the East coast, $BW=2.285\ TL^{3.224}\ 10^{-6}$, N=127

Table 1. Bioamss estimates (tonnes) for *Greenland halibut* by stratum.

Division	Depth Zone (m) 401-600*	601-1,000	1,001-1,500	Total
1A-N	3,000	2,000	800	5,800
1A-S	300	2,900	700	3,900
1B	2,900	2,500	-	5,400
1C	100	15,800	1,100	17,000
1D	-	8,000	22,800	30,800
Total	6,300	31,200	25,400	62,900

* Division 1A-N includes depth zone 201-600 m.



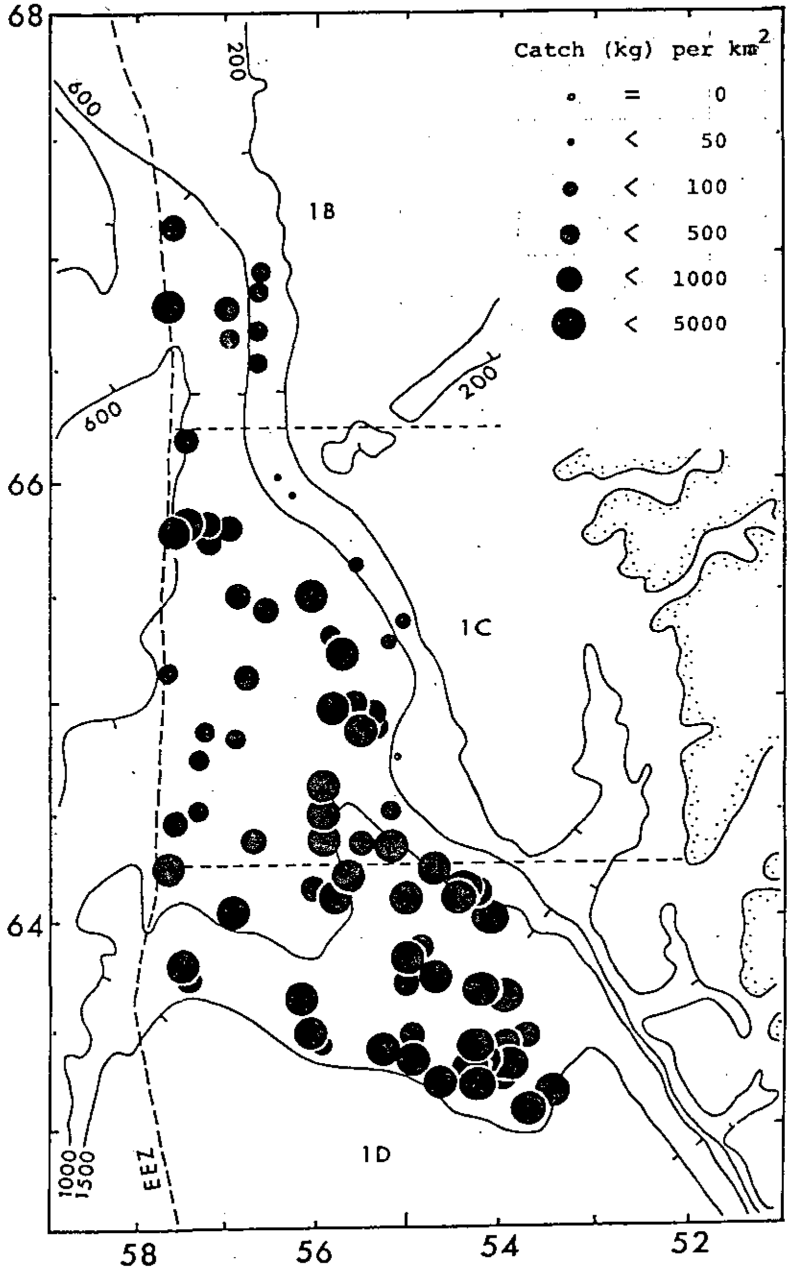


Fig. 1. Distribution of Greenland halibut off West Greenland in September/October 1988.

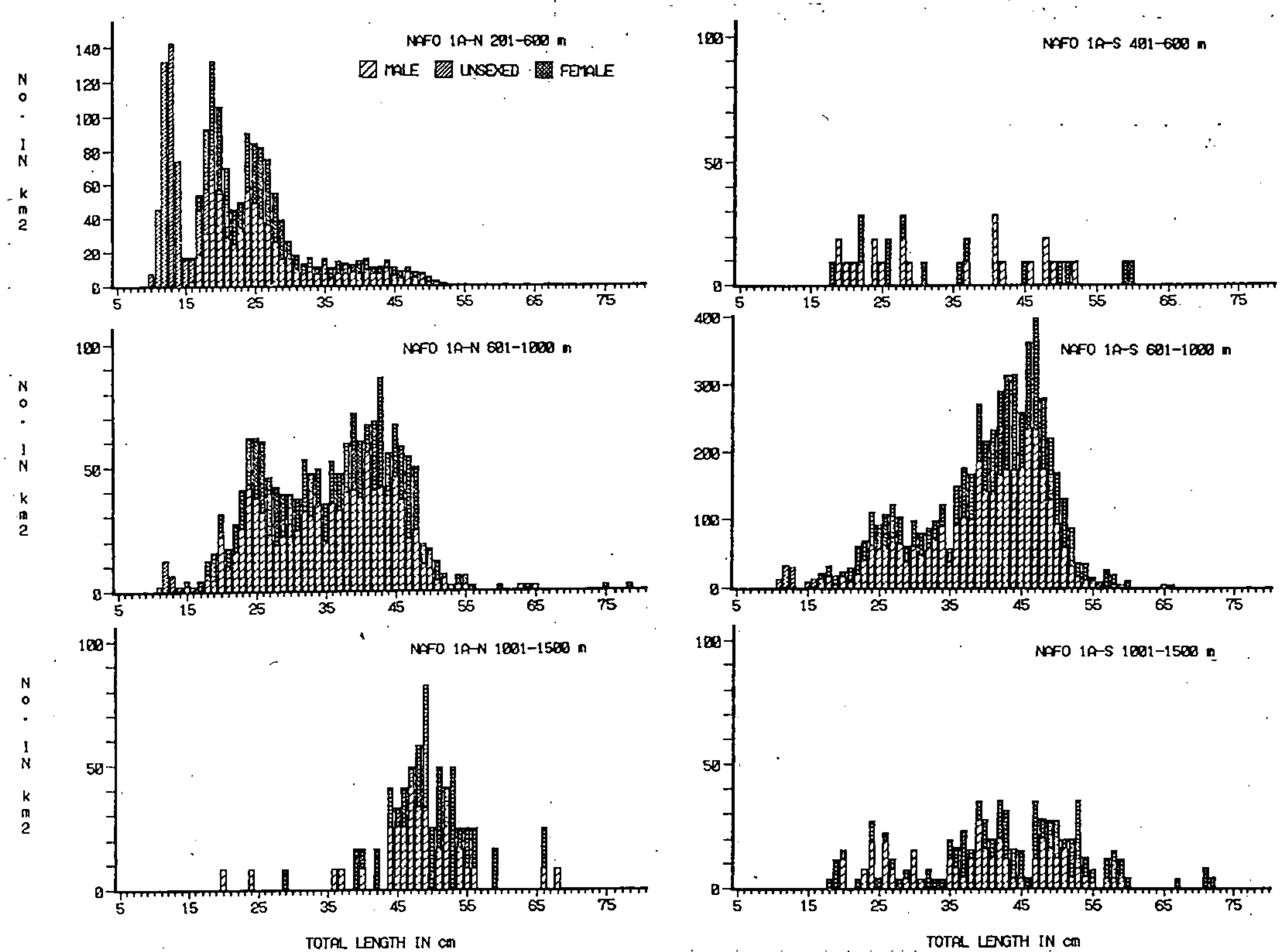


Fig. 2. Size composition of Greenland halibut by NAFO Division and depth zone. N.B.: different scales on y-axis in NAFO 1A-N (201-600 m), 1A-S (601-1000 m) and 1B (401-600 m).

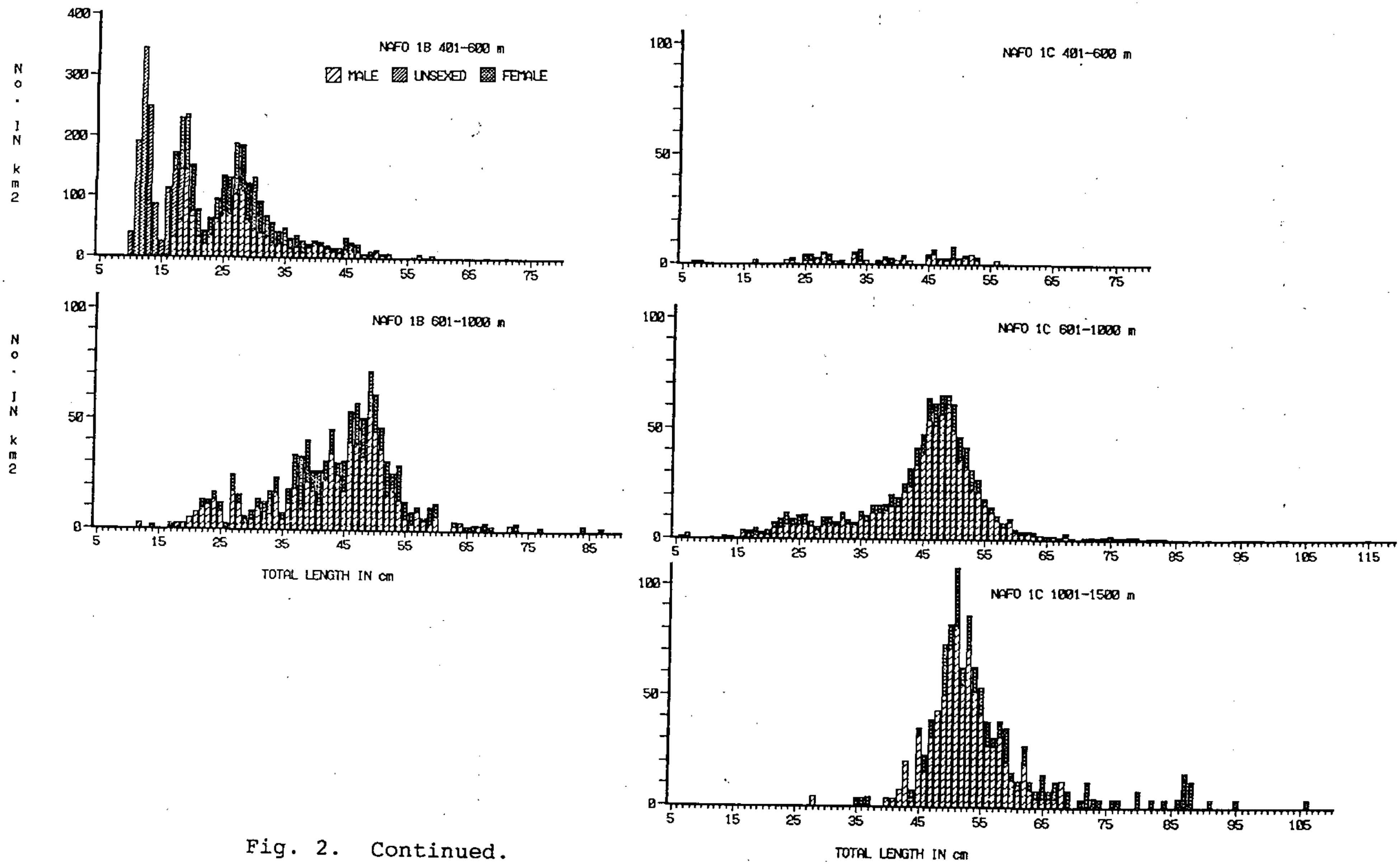


Fig. 2. Continued.

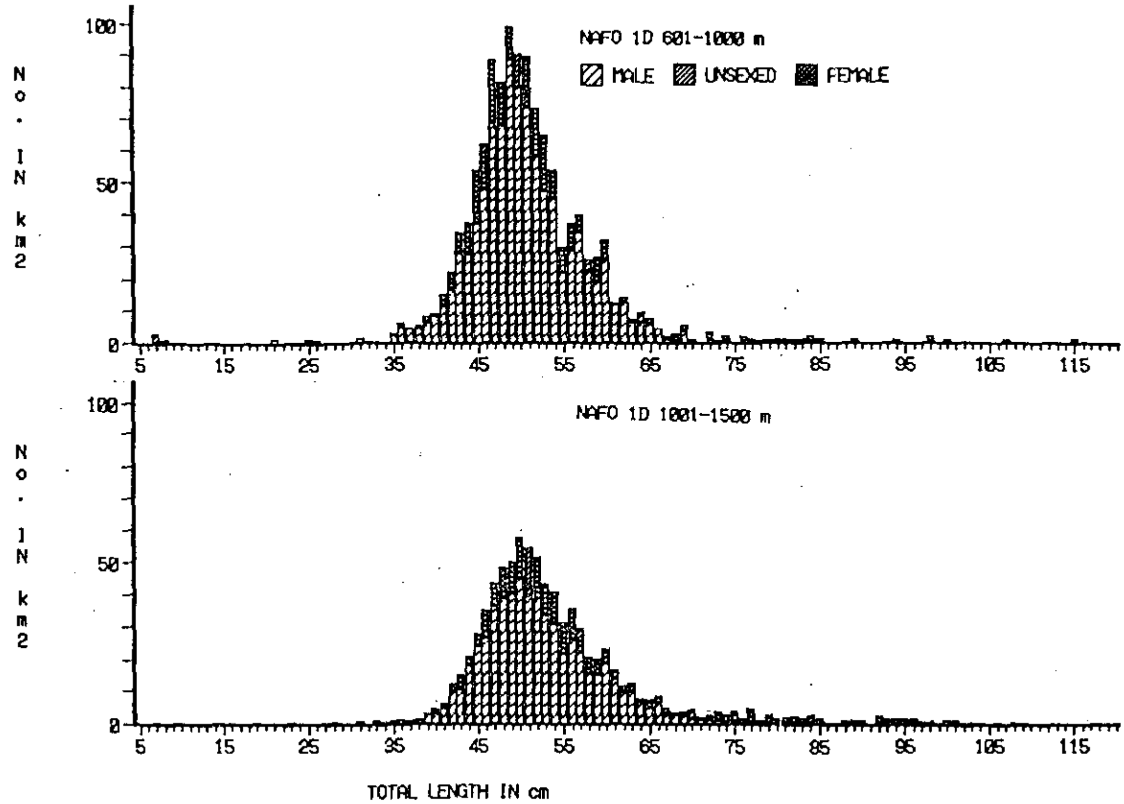


Fig. 2. Continued.

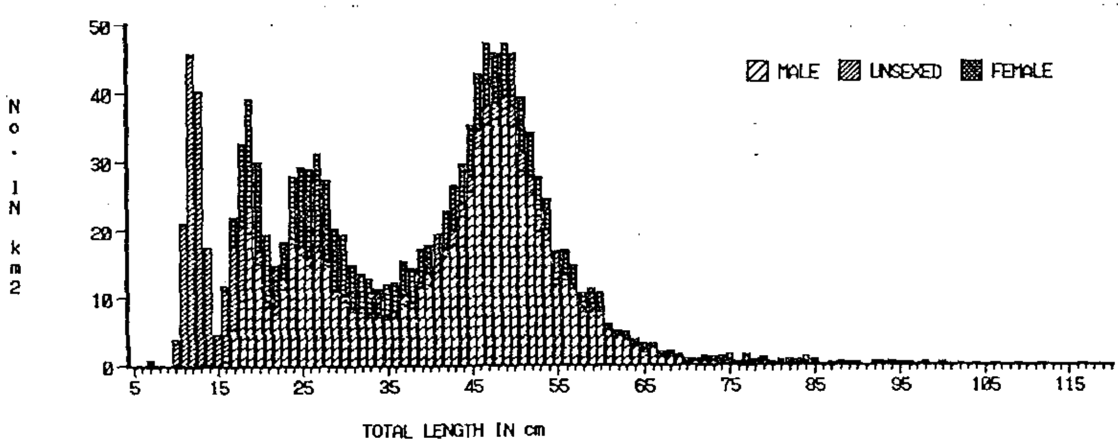


Fig. 3. Mean size composition of Greenland halibut off West Greenland in number per km^2.

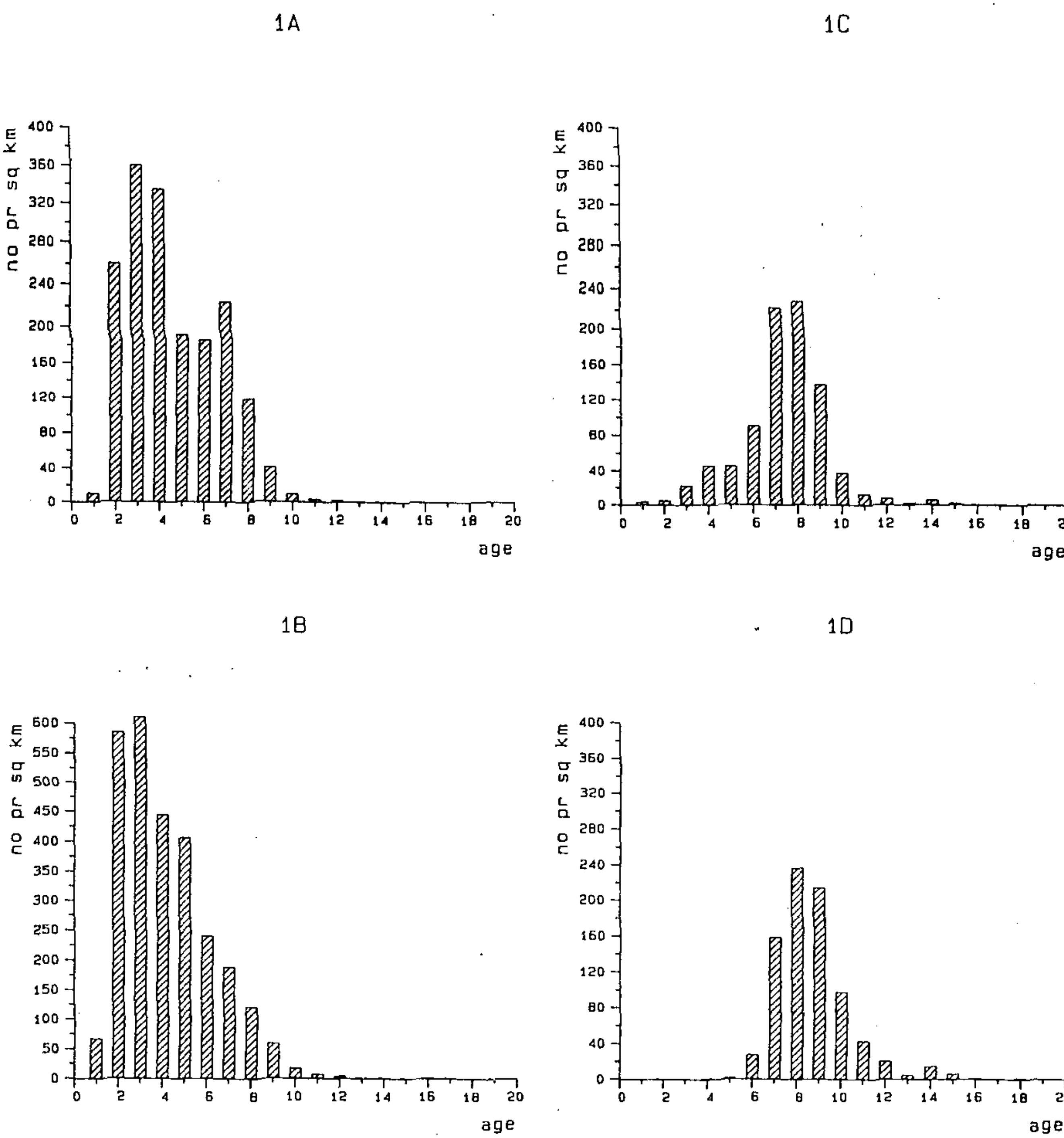


Fig. 4. Age composition of Greenland halibut by NAFO Division. N.B. Different scale on y-axis in NAFO 1B.

1A - 1D

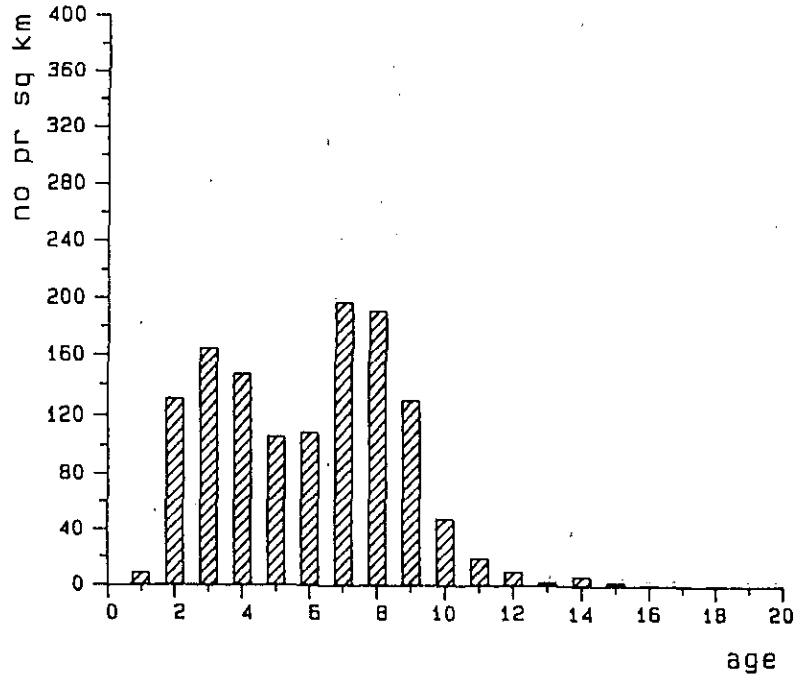


Fig. 5. Mean age composition of Greenland halibut off West Greenland.

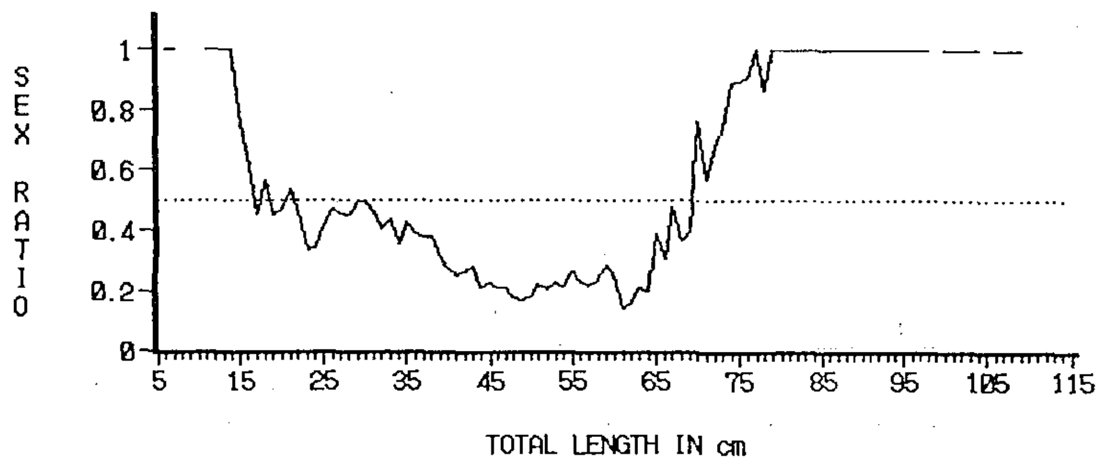


Fig. 6. Sex ratio (ratio of females to both sex combined, excluding unsexed) by 1 cm group; calculated from the mean size composition (Fig. 3).

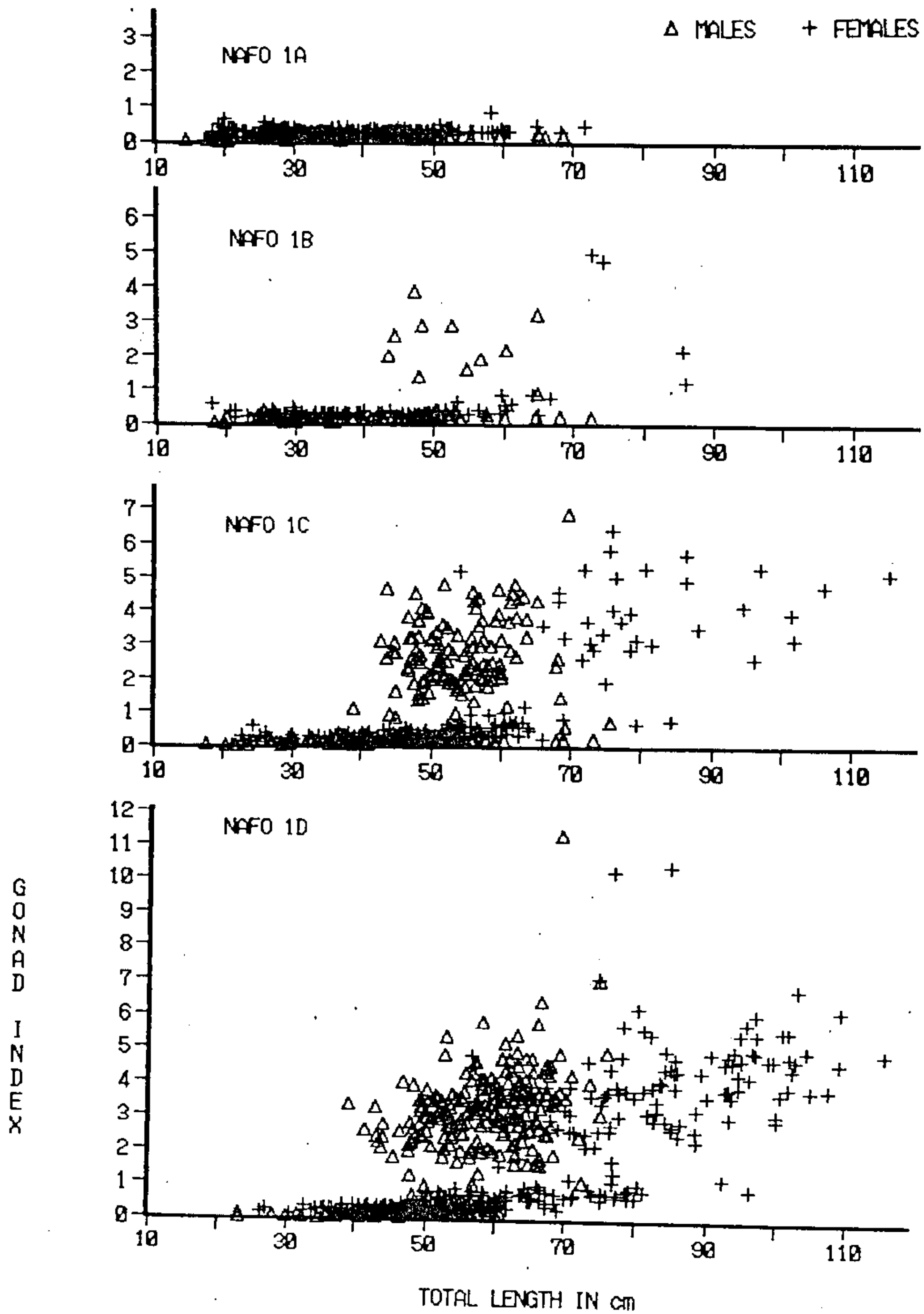


Fig. 7. Relationship between total length and gonad index of Greenland halibut in NAFO Divisions 1A-1D.

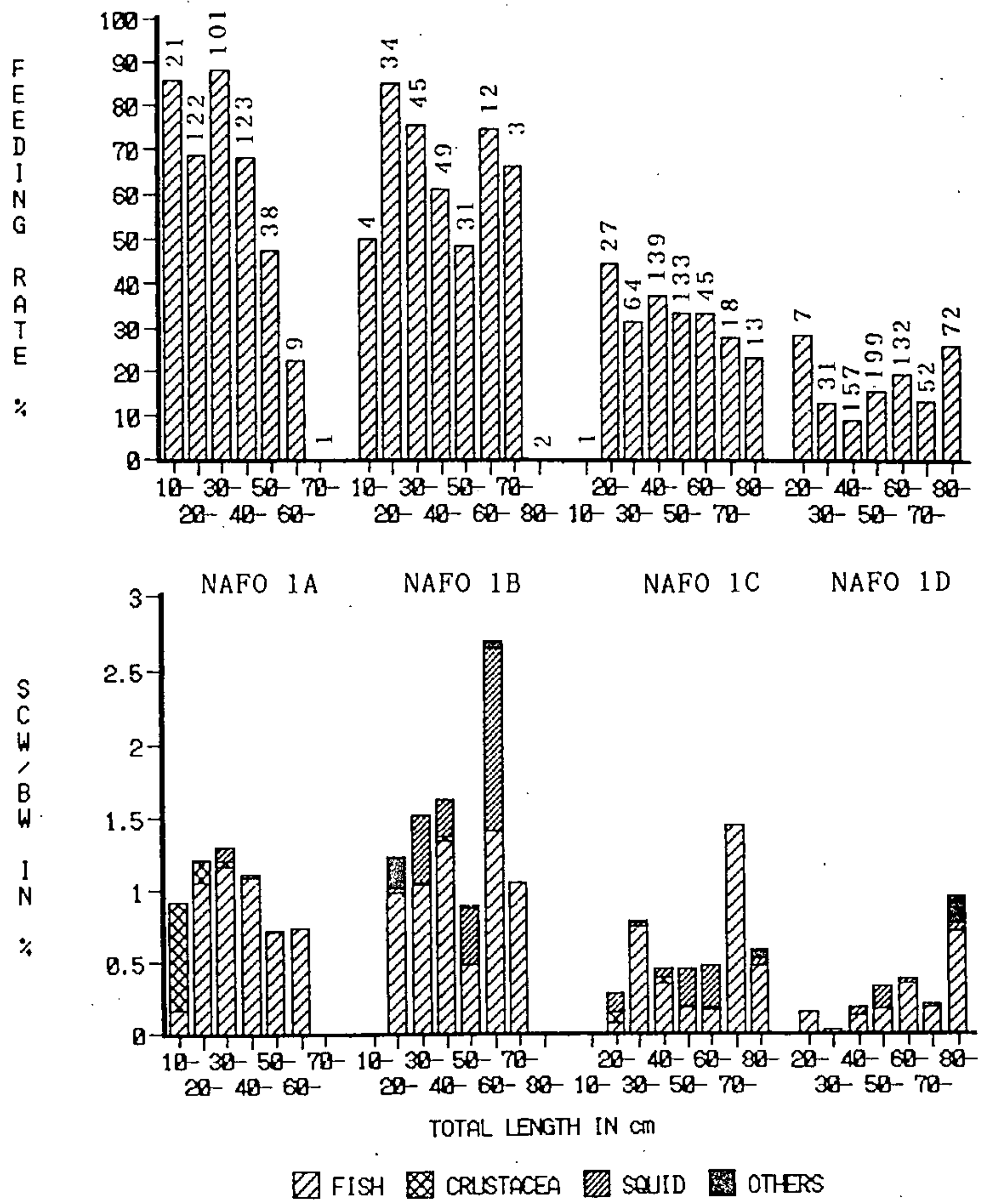


Fig. 8. Feeding rate (top) and composition of stomach contents (bottom) of Greenland halibut in NAFO Divisions 1A-1D and 10 cm length groups. Numeral above each feeding rate denotes number of stomach examined.