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Distribution of Greenland Halibut from the Greenland-Canadian Population

by

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Abstract

This paper considers juvenile and adult Greenland halibut distribution in Divisions of the Northwest Atlantic. The population structure of halibut, i.e. size-age composition, ratio of males and females in different parts of the area are analysed. An information confirming the fact that mature individuals of halibut migrate northward from the southern parts of the area is also adduced.

A prolonged period of passive drift of Greenland halibut eggs and larvae promotes a rather broad distribution of the Greenland-Canadian population of this species along the coast of the North America and that of West Greenland.

The paper considers a question on organizing a rational fishery of halibut in the Northwest Atlantic as a single population taking into account their distribution, size-age and sex composition.

Introduction

Greenland halibut Reinhardtius hippoglossoides Walbaum is one of the most valuable commercial fishes of the Northwest Atlantic.

During the last decade this species draw attention of numerous investigators not only by peculiarities of its life, body structure, conditions of dwelling, but also by the fact that depending on a level of commercial exploitation of the continental slope biologic resources it has become an important object of trawl fishery.

In autumn-winter period Greenland halibut form dense commercial concentrations on the continental slope practically everywhere from the Greenland-Canadian Threshold to the Grand Newfoundland Bank, which makes possible their effective trawl fishery.

The aim of these investigations is to characterize the regularities of Greenland halibut size-age groupings distribution and to determine boundaries of the population by way of systematization and generalization of long-term biologic material collected during marine research expeditions.

Material and methods

Recular collections of biologic data for the period 1967-1981 obtained from the research vessels "Persey III", "Artemida", "Nikolay Kononov", "Rossiya", "Volgograd", "Polyarnoye siyaniye", "Vspolokh", "Parallax", "Neptun", "Zarnitsa", "Suloy" served as the material for the present paper.

Hydrologic and hydrochemical observations and mass tagging were carried out simultaneously with the analysis of size-age composition of Greenland halibut in catches, their feeding and maturity. A fish-counting bottom trawl with a small-mesh insertion in the cod-end and also a conventional trawl were used. In every cruise (duration of each 4-5 months) an area of 1500 miles in extent was investigated and 400-500 haulings were carried out. The total amount of cruises was 76.

Mass length measurements were carried out with a precision up to 1 cm and determination of a sex. A stage of gonads maturity was determined by a 6-division scale created by Fedorov (1968).

The age was determined mainly by scales using a microprojector and a binocular microscope. In cases when scales were unsuitable for age reading we used otoliths in reflected light under binocular microscope. Age may be easily determined from fresh or frozen scales.

Distribution, migrations, size-age composition

Greenland halibut are distributed on the shelf and continental slope of the Northwest Atlantic, their area of dwelling extends from the Arctic region southward along the Canadian coast to about 42°N. Some investigators (Boyar, 1964; Barrett, 1968) report that some individuals were captured on the Georges Bank and in the Bay of Fundy.

The densest concentrations good for effective trawl fishery are formed by Greenland halibut on the continental slope from the Greenland-Canadian Threshold up to Div.3K (Chumakov, 1981). On the slopes of the Grand Newfoundland Bank halibut were found individually, they were of no commercial importance there.

In the south of the area (shelf and continental slope) immature individuals are dominant, further to the north a relative number of mature males and females increases. Inasmuch as immature halibut dwelling in the south of the area are not able to be a self-reproductive population we supposed that in Subareas 0,2,3 (including the Greenland-Canadian Threshold) there dwells a single population (Chumakov, 1975). The southwest part of the Greenland shelf is, apparently, the area where the Greenland-Canadian and Icelandic populations are mixed together; there are data (Smidt, 1969) on halibut migration from the West Greenland (Subarea 1) to the north of the insular slope of Iceland. Papers by Jensen (1925, 1935), Smidt (1969, 1974), Templeman (1973) give a general notion of reproduction of halibut and distribution of early stages and adult individuals. Data of our ichthyoplankton surveys show that fecundated eggs develop mainly at considerable depths over the continental slope. In June - July larvae ascend into the surface layer.

Spawning grounds of Greenland halibut are located in the south of the Greenland-Canadian Threshold, in the West-Greenland Current which moves northwardly and the left branch of which interflows with the Baffin-Island (Canadian) and Labrador Currents. According to Kudlo and Svetlov's (1975) data an amount of water (from one-fourth up to one-half) moving northwardly may flow into the Baffin Bay over the Greenland-Canadian Threshold.

Just in this way larval and juvenile Greenland halibut are brought from the West Greenland spawning grounds onto the Canadian shelf.

During the period from spawning (January-March) to transformation of larvae into an active-moving form (June-August) the early stages are carried away in enormous distances even at minimum speed of currents. Average speeds of the West-Greenland, Canadian and Labrador currents are 10-14 miles per day (Killerich, 1943; Bogdanov,

1959; Buzdalin and Elizarov, 1960; Kudlo, 1972). Calculations show that during the period of drift Greenland halibut eggs and larvae may be carried more than 2000 miles away.

Hence, a certain portion of juveniles at the end of the first year of life may reach the remotest parts of the area in the Northwest Atlantic; they may be spread up to the Georges Bank in the southwest and reach the Arctic regions up to where the West-Greenland Current penetrates.

Of course, a considerable influence upon juvenile halibut distribution is caused, parallel with permanent currents, by various vortices and addies of waters of different directions due to which a deceleration in drift of halibut larvae in certain Divisions is observed.

Buzdalin and Elizarov (1960) described a strong cyclonic vortix of water masses on the shelf in Div.3K due to which there occurs a delay and accumulation of passively drifting larvae and juveniles. Just there, between 49°20'N and 52°20'N commercial catches consist mainly of small individuals: males 34-60 cm long and females 34-65 cm long (Fig.1). While moving northward along the Canadian coast males and females become larger. In Subarea 0 located between 60°N and 67°30'N 45-70 cm long males and 50-90 cm long females compose the basis of the catches. These differences allow us to suppose that only a part of the Greenland-Canadian population is presented in every of those Divisions: young fish inhabit the south of the area (Div.3KL), older fish inhabit Divisions 2JH and the oldest ones inhabit Subareas 0,1 and Div.2G.

It is notorious that halibut size composition varies depending on depths of dwelling. The deeper a trawl is hauled the larger individuals are captured. Besides, in the northern areas at the same depths males and females of halibut are larger than those in the southern areas (Chumakov, 1975). A similar conclusion was made by Bowering (1977).

A comparison of mature and immature males and females size composition demonstrates that mainly immature individuals inhabit the southern parts of the area (Fig.2). Size composition of immature males is presented by individuals of 14-73 cm long and that of fema-

les by 14-95 cm long individuals.

Mature individuals are concentrated mainly in the northern part of the area, on the Baffin Island continental slope (Subarea 0) and the Greenland-Canadian Threshold (Subarea 1).

The dominance of mature fish in the north of the area may be conditioned only by their gradual migration from the southern areas.

The maximum length of mature fish is obviously larger in the northern areas. So, in Divisions 3KL the maximum length of mature males was 67 cm, in the Labrador Divisions - 77 cm, in Subareas 0+1 - 81 cm; for mature females the maximum length in those areas was 95, 103 and 109 cm, respectively.

A comparison of age composition of halibut from different parts of the area demonstrates that in Div.3K fish at age from 1 to 8 years are dominant, fish older than 8 years are not numerous. Older individuals are dominant in the northern and central parts of the area (Fig.3).

In summer and autumn, during the feeding period, a relative number of females increases depending on depths both on the shelf and continental slope (Fig.4). Though in winter, before spawning, in Subarea 0 males are dominant at all depths. In this period spawning concentrations of halibut are being formed on the Baffin Island continental slope. In the spawning grounds area males stay longer than females; such a phenomenon is marked, in particular, for the Barents Sea halibut (Sorokin, 1967; Fedorov, 1968).

Similar peculiarities of sex composition may be evident from Fig.5. In winter mature males and females migrate to Subarea 0 from the southern parts of the area for spawning, besides, in this season males are numerically dominant in the age groups 6-10 years.

By way of mass tagging of halibut we obtained the corroborations of mature individuals migration to the northern parts of the area. Depending on their growth and maturation halibut migrate from the southernmost parts of the area to the spawning grounds located in the North. Such migrations every specimen is able to perform once during its life-cycle.

Halibut migration along the continental slope to the spawning grounds occurs comparatively slower. For example, a halibut tagged

in March 1975 with No.286813 tag on the South Labrador continental slope was captured in 18 months 180 miles away to the northwest from the place of its release.

Having reached the spawning grounds area mature fish would not return back to those areas where they had been dwelling before maturation.

Conclusions

Greenland halibut dwelling in Subareas 0,1,2,3 presents a single Greenland-Canadian population, reproductively isolated from other populations of this species. Subarea 1 is apparently the area where the Greenland-Canadian and Icelandic populations mix together.

A spawn of halibut from the Greenland-Canadian population occurs from January to March at depths 1000-1500 m and temperature of bottom water 3.2-3.4°C. The main part of the population spawn in the south of the Greenland-Canadian Threshold between 62°N and 64°N.

The spawning grounds location in the system of permanent currents and also a prolonged pelagic period of eggs and larvae provide a broad distribution of the population of halibut in Subareas 0,1,2,3. Juvenile halibut find in shallow waters all necessary conditions for their lives and inhabit only the shelf whereas larger fish dwell on the continental slope and in deepwater canyons and fjords.

The Greenland-Canadian population is presented in different parts of the area by different size-age groupings: in the south of the area, on the Newfoundland shoal there dwell young fish, in the Labrador Subarea - older fish and on the continental slope in the Davis Strait - the oldest ones.

In the northern parts of the area halibut concentrations were distributed more densely at greater depths; an abundance of mature fish in older age groups was higher.

The Greenland-Canadian population of halibut should be commercially exploited mainly in the northern areas; removals of juveniles in the south of the area are not allowable.

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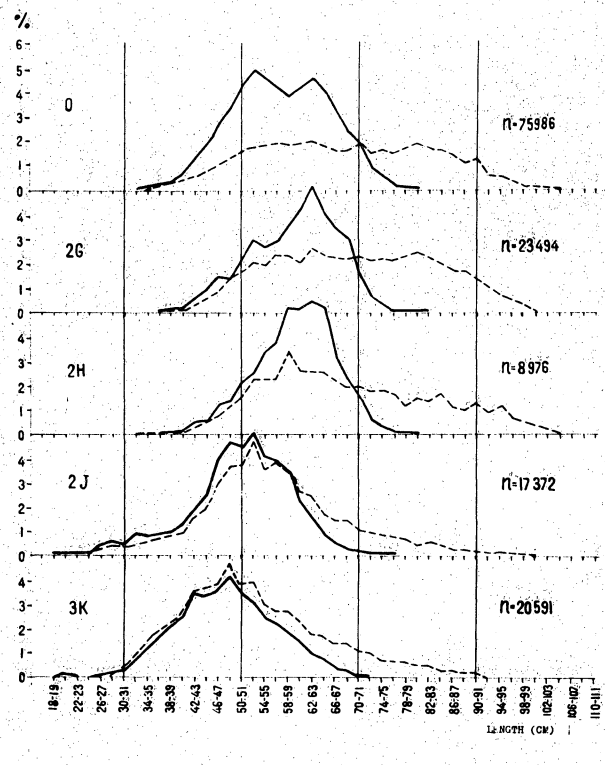

Fig. 1. Size composition of males (full line) and females (dotted line) from commercial catches (codends with a conventional mesh size) in Subarea 0 and Divisions 2G, 2H, 2J, 3K (summarized data for 1969-1981).

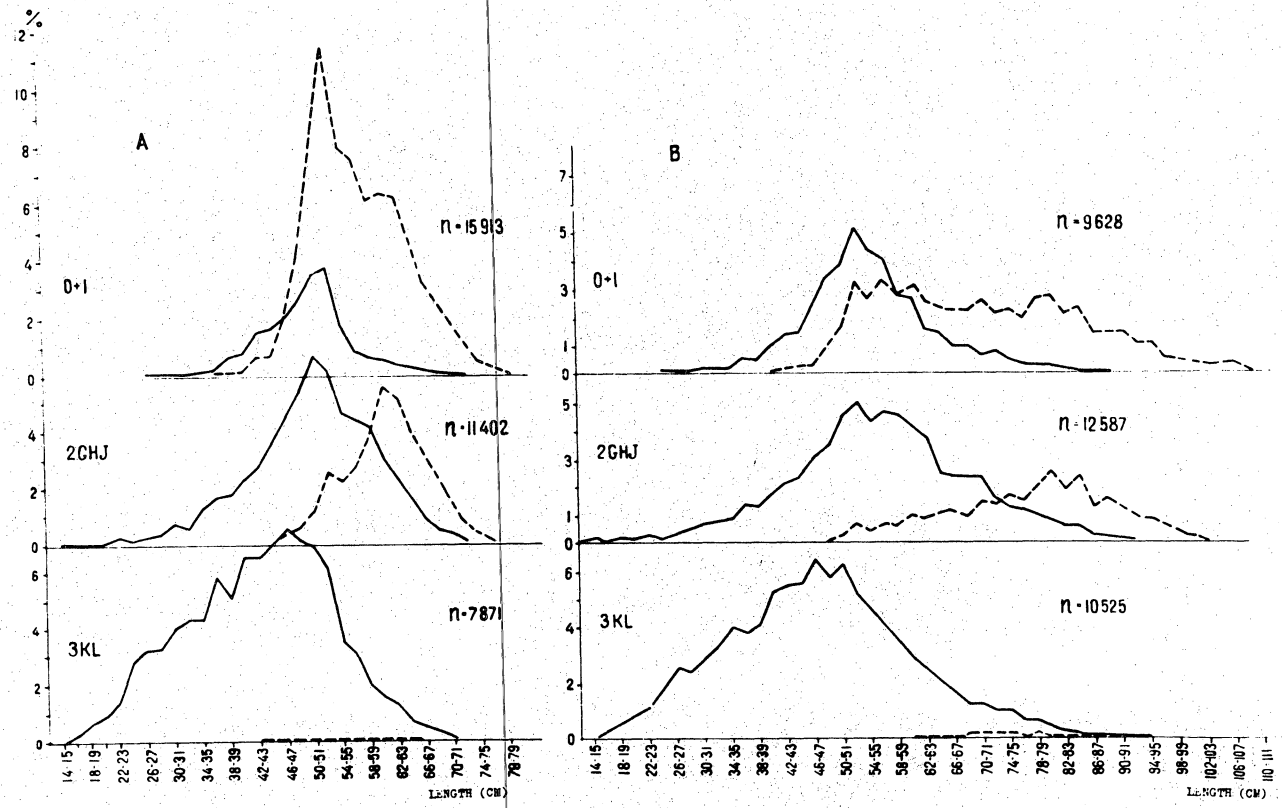

Fig. 2. Size composition of mature (dotted line) and immature (full line) males (A) and females (B); summarized data for 1969-1981.

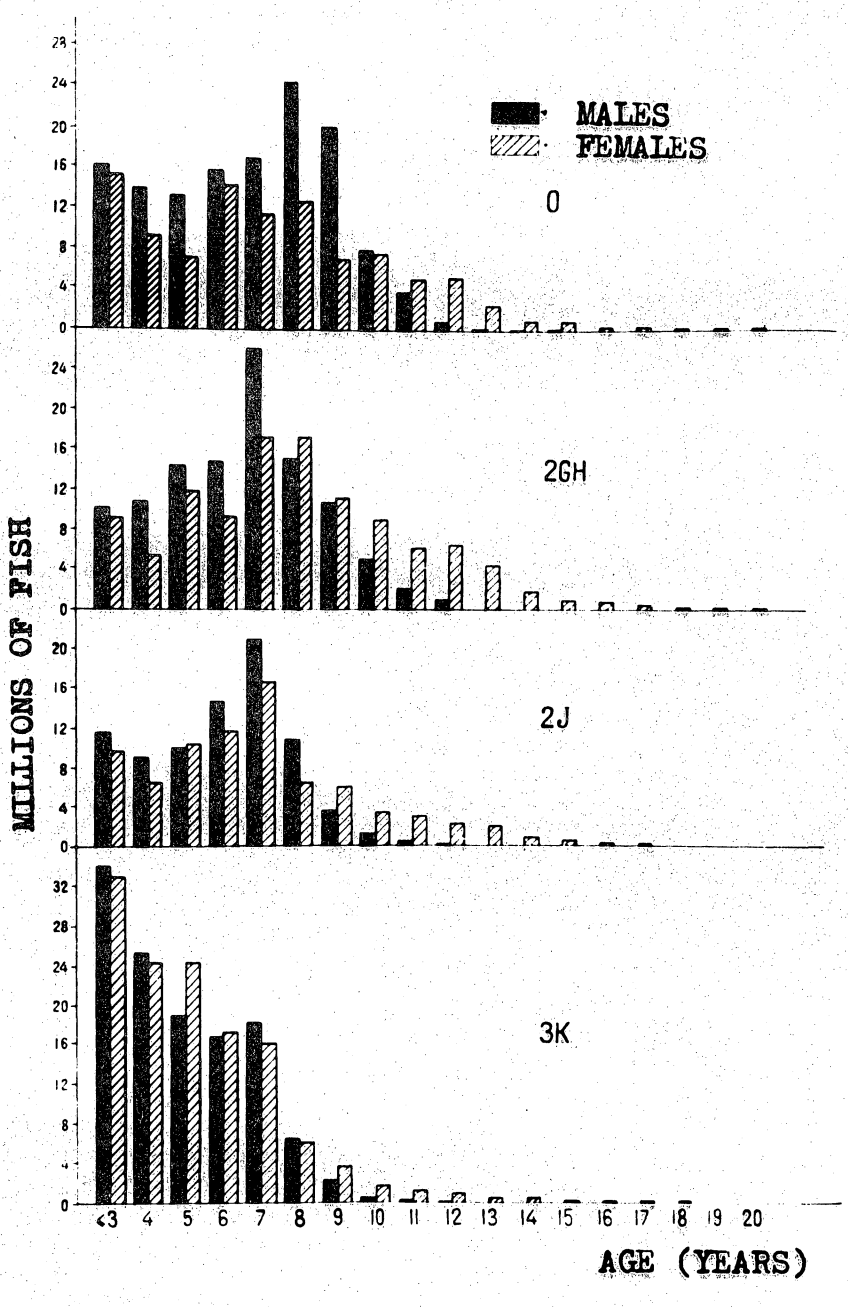

Fig. 3. Abundance of males and females in different age-groups in Subarea 0 and Divisions 2GH, 2J and 3K according to the data of a trawl survey, November 1980 - January 1981.

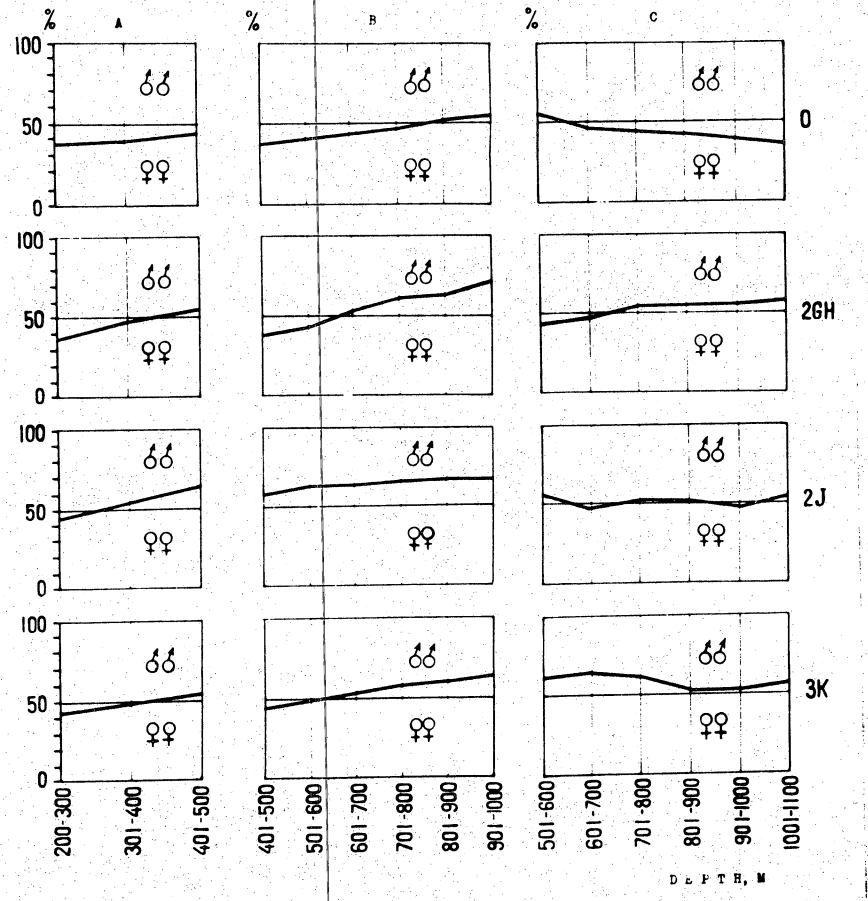

Fig. 4. Ratio of Greenland halibut males and females at different depths of the shelf (A) and on the continental slope in June-October (B), December-January (C); summarized data for 1969-1981.

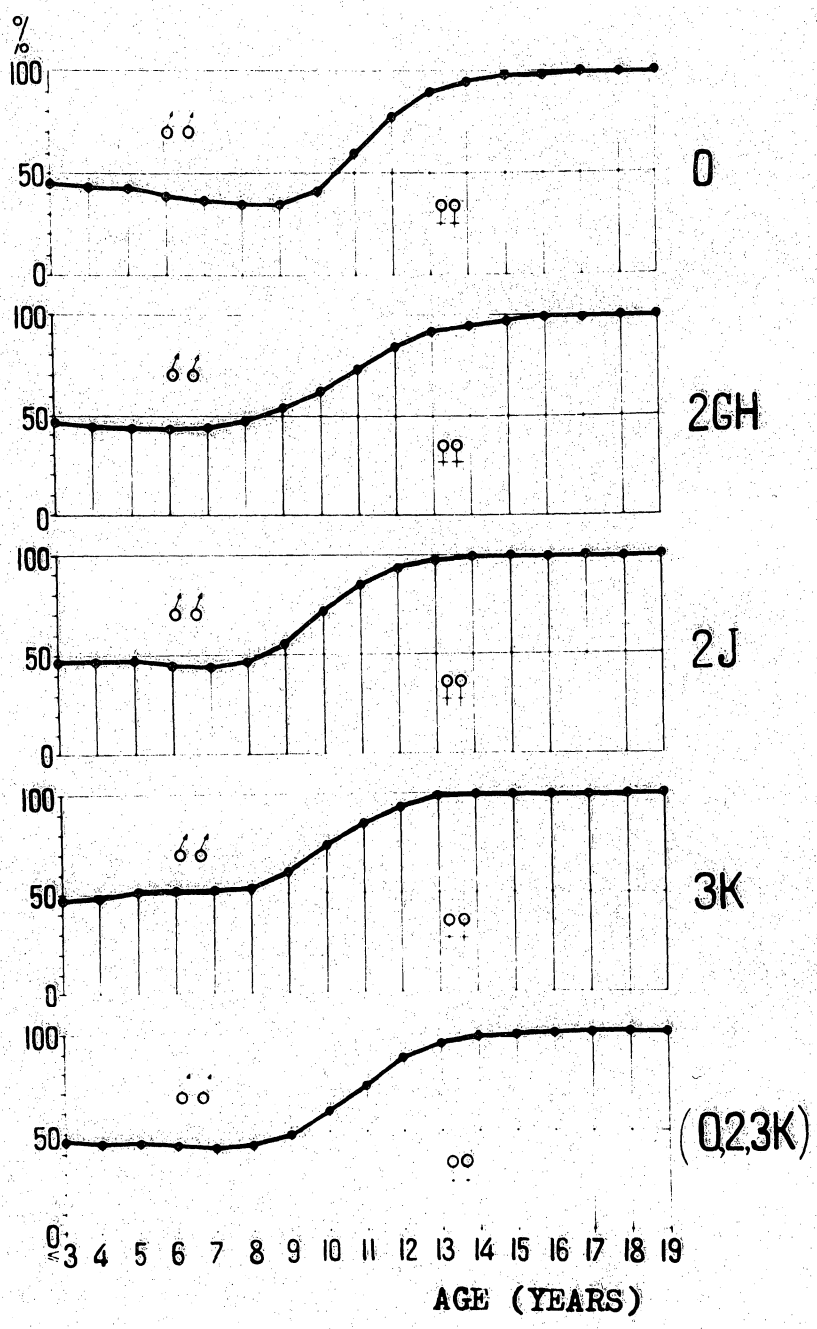

Fig. 5. Ratio of halibut males and females abundance in different age groups according to the data of a trawl survey in the NAFO Divisions, November 1980 - January 1981 (by smoothed out lines).