Northwest Atlantic Fisheries Organization

Serial No. N1376

NAFO SCR Doc. 87/76

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1987

On the Distribution and Stock Delimitation of Greenland Halibut (*Reinhardtius hippoglossoides* Walb.) in Sea Areas off East Canada and West Greenland

by

P. Ernst

Institut für Hochseefischerei und Fischverarbeitung, Rostock-Marienehe,
An der Jägerbäk 2, Rostock 2510, German Democratic Republic

SPECIAL SESSION ON DEEPWATER FISHES

1. Introduction

The Greenland halibut of the NW Atlantic occurs in the area from the arctic part in the north up to the Nova Scotia shelf in the south (LEIM and SCOTT 1969, TEMPLEMAN 1973) and constitutes an important component of the fishery in the NW Atlantic.

The strong halibut directed fishery in different areas of this region of distribution near West Greenland (SMIDT 1969), east of Newfoundland (BOWERING 1983 b) and in the Golf of St. Lawrence (BOWERING 1982 b) as well as within the Labrador area (main fishing area of GDR and USSR) raises the question to which stock the fish belong.

Regarding economic aspects of fishing performance the Scientific Council of ICNAF/NAFO associated the stocks of halibut to the "stocks" of the ICNAF/NAFO Subareas 0 + 1 and the ICNAF/NAFO Subarea and the Divisions 2 + 3 K, 3 L, respectively and treated them accordingly when catch analysis and proposals for quotas are established. At present this procedure is carried out on this way.

Results concerning distribution and delimitation of the stocks of Greenland halibut are discussed by means of own investigations and analysis of the international scientific literature.

2. Material, methods and results on distribution and identification of stock

2.1. Distribution

2.1.1. Tagging

Tagging experiments have been carried out in the years 1969-1970 (Tab. 1). Within this period a total of 1041 specimens of Greenland halibut have been tagged within the areas Baffinland, Labrador and Newfoundland.

After starting deep sea exploration fisheries two problems gave cause for tagging experiments:

1. The collection of data on distribution and migration of Greenland halibut

2. Development and improvement of methods for tagging halibut.

In compliance with tagging of cod carried out by the Institute of Deep Seas Fisheries and Fish Processing Rostock (IfH) (BIESTER 1966) Greenland halibut was caught by bottom trawl at a trawling time of about 30 minutes. Fishing depths were between 500 and 1200 m. Heave durations were 30 to 60 minutes depending on fishing depths to enable the Greenland halibut to adapt to depths. From the fish lying on deck the liveliest ones were put at once into a basin filled with flowing sea water (the basin consisted of a net berth covered with a tarpaulin; basic area 3 x 3 m, level of water about 1 m). After keeping them in the basin for a period from 8 to 12 hours those animals were caught by ring-net for tagging which were swimming in the basin or had recovered from their lateral position on the ground, respectively after havingbeen chased and now showed a nearly vertical swimming position.

After having ascertained the length of fish (L_t below) and special characteristics the tag was fixed before the dorsal fin.

The tagging was carried out by means of a hydrostatic tag (after LEA) produced in the GDR according to the technique of cod tagging (BIESTER 1966).

After tagging the fish was at once put into the open water and his submerging was observed. After being put into the water the fish submerged steeply at once of after a short delay at the surface taking positions from lateral to vertical. Deviations in behaviour after disembarkation have been noted in the tagging report.

Recoveries within the scope of these tagging experiments have not been recorded.

A further tagging experiment on Greenland halibut has been carried out by the GDR in the sea area SW Iceland in June 1971. This experiment can be valued as a comparison. The outlined methods were applied. Up to 1975 (introduction of the Icelandic 200 sm limit) 24 recoveries out of 2203 tagged specimens were presented (rate of recovery 1,09 %). Up to 1975 the international fishing intensity on Icelandic - East Greenlandic halibut was at a high level.

Inspite of equal tagging methods both tagging experiments showed different results.

The negative result of the tagging series in the NW Atlantic was established by the insignificant international fishing intensity within the divisions OB, 2 G and 2H. 98 % of the specimens of this experiment have been tagged within these divisions.

The tagging number of 1041 specimens in the NW Atlantic as compared with a number of 2203 specimens in the Iceland experiment has to be eleminated as a factor u.E. influencing the result, because the rate of recoveries tagged by equal methods is determined above all by fishing intensity.

Since the time of the 70es tagging experiments by the USSR have been carried out on Greenland halibut stocks in the NW Atlantic (CHUMAKOV and SEREBRYAKOV 1982), but they are not yet summarized or presented in detail.

In the years 1969, 1971, 1979 and 1981 the Canadian Fisheries Research Institution St. John's/Newfoundland carried out extensive taggings of halibut (n = 24399) achieving a rate of recoveries of 1,3 % (n = 322) up to the end of 1983.

The main interest was focussed on selected "inshore" and "offshore" tagging experiments (BOWERING 1984 b). The tagging areas were mainly exploited by national and partially by international fisheries. Recovery rates of 13.0 % (White Bay experiment) and 35.9 % (Trinity Bay experiment) respectively, are mainly delivered by the Canadian line and pool fishery and gillnetting (Newfoundland, South Labrador).

According to the insignificant international fishing effort rates of recoveries from Labrador and Baffinland were smaller. Up to 1983 recovery rates from the Canadian Labrador Experiment were only 0.15 % (n = 56) referring to 9163 taggings. Concerning the Funk Island experiment 0.45 % referring to 13570 taggings were achieved.

It is to be stated, that specimens tagged in the Newfoundland area and in the Labrador area were not recovered in the Golf of St. Lawrence. On the other hand recoveries of the Fortune Bay tagging experiment (Eastern exit of the Golf of St.Lawrence) are exclusively restricted to the Golf of St. Lawrence area. Therefore it is to be derived, that occurrences south of Newfoundland are to be associated to a special stock which does not correspond with occurrences north of the Grand Bank.

On the basis of results of recoveries of Canadian tagging experiments it can be stated, that within the area of Funk

Island and within the area of Trinity Bay as well a coastal migration takes place. In the course of this migration deep water furrows and canyons northeast of Newfoundland are entered. In accordance with TEMPLEMAN (1979) who describes migration movements of cod into the same direction and JENSEN (1935) as well as SMIDT (1969) who reports "offshore - inshore" alternating migrations of Greenland halibut off West Greenland, these migrations are marked by a feeding period. According to LEAR (1969) and TEMPLEMAN (1979) this feeding migration is identical with the migration of capelin (Mallotus villosus MÜLLER) as the main feeding object. Predominant recoveries

identical with the migration of capelin (Mallotus villosus MÜLLER) as the main feeding object. Predominant recoveries of tagged specimens were juveniles smaller than 60 cm. Only a few specimens migrating northwards were at the stage of beginning maturity (BOWERING 1984 b).

The results of tagging experiments off the coast of Labrador are showing a similar situation as well. The tendency of migration northwards and the migration between "inshore" and "offshore" respectively, is documented by recoveries.

Besides the migration route the velocity of migration is shown and again two phases are obvious:

1. Migrations of significantly short distances within the region of the tagging place (up to a maximum of 250 sm east in the area of deep water in the White Bay tagging experiment)

2. Migrations of larger distances northwards from the tagging place.

Besides "offshore - inshore" migrations within the region of the tagging place following distances during northward migrations can be established according to Canadian data (BOWERING, 1982 a):

- Tagging experiment White, Bay Division 3 K
  - 280 sm, recovery after 2 years on the continental slope, Division 2 J
  - 370 sm, recovery after 5 years on the edge of the continental slope, Division 2 H
  - 780 sm, recovery after 7 years within the sea area Baffinland, Division 0 B
  - 850 sm, recovery after 2 years on the continental slope of West Greenland, Division 1 C

- Tagging experiment Trinity Bay Division 3 L
  - 100 sm, recovery after 1 year at the entry of the Bonavista Bay, Division 3 L (northern part)
- Tagging experiment Funk Island Division 3 K
  - 60 sm, recovery after 1 year within the area South Labrador, Division 2 J
  - 250 sm, after 2 years within the area North Hamilton Bank, Division 2 J
- Tagging experiment Labrador Northern part, Division 2 J and Labrador Southern part, Division 2 H
  - 240 sm, after 2 years within the area east of Cape Chidley, Division 2 G
  - 60 sm, after 1 year within the area 2 H.

Migrations of Greenland halibut over long distances are known from other sea areas as well.

One specimen of Greenland halibut which had been tagged at the eastern coast of Iceland in January 1970 was recovered in the Barents Sea in August 1972 (NIZOVTSEV 1974). The distance between the place of tagging and that of recovery was about 1000 sm.

A further proof was presented by SIGURDSON (1979) who informed on the recovery of one specimen of Greenland halibut in the Barents Sea in November 1973. This specimen had been tagged four months previously in the sea area off North Iceland near Kolbeinsey.

The overcoming of longer distances during migration has been shown by SMIDT (1969) as well. He reported on a recovery of one specimen of Greenland halibut near Northwest Iceland in June 1959 which had been tagged near Julianehab/Southwest Greenland in August 1954 (distance ca. 900 sm).

KOSIOR et al. (1970) too have been reported too on migrations of Greenland halibut covering distances about 900 sm within the Northeast Atlantic.

2.1.2. Spawning area and distribution of larvae and juveniles

According to assumptions of JENSEN (1935) and SMIDT (1969) the spawning area of Greenland halibut is situated north of 67^{o}N (NAFO Divisions 0 A, 1 B, 1 C) in the deep water area of the atlantic warm water component of the West Greenland Current.

CHUMAKOV and SEREBRYAKOV (1982) proceed hypothetically from the fact that the spawning area extends within the sphere of the

Greenlandic Canadian Threshold between 62° and 64°N and that the spawning process takes place in depths of 1000 - 1500 m from January to March.

For the present it is not possible to deliver an absolute proof on international level because this area is covered by ice during the space of time mentioned above and no fishing can be carried out.

Investigations of the Institut für Hochseefischerei Rostock on occurrences of fish eggs, fish larvae and juveniles in the area West Greenland within the period from 1961 to 1963 (BIESTER and MAHNKE 1963) as well as from 1964 to 1965 (MAHNKE 1967) confirm the occurrences of larvae (MAY) and juveniles (July/August) of Greenland halibut on the outer edges of the northern banks of West Greenland. North of 65°N the number of larvae and juveniles decreased significantly. North of 68°N no larvae and juveniles have been found.

According to reports of JENSEN and HANSEN (1931) stomachs of investigated cod of the fishing area Sukkertoppen (65°20'N; 54°W) contained fry of Greenland halibut at the stage of transition to a life on the bottom.

According to statements under consideration and in contrast to assumptions of JENSEN (1935) and SMIDT (1969) the presumed spawning area is situated south of 67°N within the region between 62°N and 64°N - 65°N.

This area is situated within the range of an extensive current system and consequently larvae of the pelagic stage and juveniles are extensively distributed within the areas of West Greenland, Baffinland, Labrador and Newfoundland (CHUMAKOV and SEREBRYAKOV 1982). They are mainly drifting with the West Greenland Current northwards (JENSEN 1935, SMIDT 1969), in the Baffin Bay they are taken up by the Polar Current and are drifting southwards whereby they passively by means of the Labrador Current (Polar Current and partial component of the West Greenland Current which carries atlantic waters) arrive at the broad shelf areas of South Labrador (Division 2 J) and Newfoundland (Divisions 3 L, 3 K), where they grow up (TEMPLEMAN 1973, CHUMAKOV 1975, ATKINSON et al. 1982, BOWERING 1984 b).

Juveniles identified in the south area of West Greenland are partially not taken up by the passive drift. They remain in this area and grow up in the southern fjords and on the banks of West Greenland respectively (SMIDT 1969).

The results of investigations presented by the IfH concerning occurrences of larvae and juveniles of Greenland halibut within the area of West Greenland (BIESTER and MAHNKE 1963, MAHNKE 1967) give evidence on the basis of ascertained different larval stages, that the period of spawning is an extensive one. The hypothetical specification of the spawning period as January - March according to CHUMAKOV and SEREBRYAKOV (1982) may be supported. According to present investigations no larvae had been identified in July/August, i.e. the larval phase ended in July.

With reference to the spawning period, being concluded in the late March, a total period of embryonic and larval development of about 80 - days can be suggested.

The larval phase of Pleuronectes platessa takes about 70 days at temperatures from +2 to +4 $^{\circ}$C (CUSHING 1984).

At a medium drift velocity of the Labrador Current of about 0.4 sm/h (SCHARNOW 1961) and under optimum conditions the distance from the spawning area to the southern distribution area near East Newfoundland (ca. 900 - 1000 sm) is covered within a period of 90 - 105 days.

While drifting passively larvae perform their larval development. Because of the drift velocity of the Labrador Current and the period of time concerning the development of larvae, occurrences of larvae can't be expected at Newfoundland. Because of the extended time of spawning different larval stages and juveniles respectively, are found in the same fishing area of the northern region of distribution at the same time. Concerning the West Greenlandic area BIESTER and MAHNKE (1963) furnished the proof. Occurrences of larvae within the North and Central Labrador area are to be suspected, because juveniles are distributed south of these areas.

Juveniles were found near North Labrador (ERNST 1980) as well as near Newfoundland (CHUMAKOV and SEREBRYAKOV 1982, BOWERING 1984 b) and for that reason they are distributed within the whole area south of the spawning place. Occurrences of larvae and juveniles are decreasing in southern direction.

2.1.3. Migration of juveniles and adults of Greenland halibut

Besides tagging experiments papers by JENSEN (1935) and SMIDT (1969) give information on migration movements, which have been observed within the area of West Greenland. According to this information the mature Greenland halibut migrates from the fjords of West Greenland to the south of the Greenlandic Canadian Threshold. Here he spawns and retuns to the coast of West Greenland where successful summer-postspawning fisheries take place in the fjords.

According to our investigations males mainly obtain maturity after 6 years of age and females after 7 years of age (Table 2).

Within the 4. quarter of the year the Greenland halibut migrates to the areas of Central and North Labrador and forms overwintering concentrations in the furrows and deep water areas of the shelf. This immigration finishes in January.

While large mature (female) specimens are emigrating after the 2. half of December, overwintering concentrations in December and January mainly consist of smaller Greenland halibut (CHUMAKOV 1982).

Own results (Fig. 1 and 2) and mass measurements by CHUMAKOV and SEREBRYAKOV (1982) (Fig.3 and 4) and BOWERING (1984 a) (Fig. 5) as well show an increase in length of males and females in a south-northern direction. According to our investigations (Fig. 5) and Tables 2, 3) and according to CHUMAKOV and SEREBRYAKOV (1982) (Fig. 4) maturity of both sexes increases in south-northern direction as well.

According to our data (Fig. 7) as well as to those of CHUMAKOV and SEREBRYAKOV (1982) (Fig. 8) the mean age increases in the same direction.

The increase of the distribution depth in south-north direction along with the increase of the mean composition of lengths (Fig. 2, 4. 9 and 10), of age (Fig. 11) and maturity (Fig. 4,6 and Tables 2, 3) is significant as well as the migration of Greenland halibut between coastal shallow areas of the shelf (CHUMAKOV 1982) in relation to the stage of maturing (feeding period and prespawning period respectively) (ERNST 1987).

2.1.4. Summarizing presentation of the migration and life cycle

On the basis of tagging results, of statements concerning horizontal and vertical distribution of occurrence of juvenile and adult Greenland halibut as well as concerning larval and juvenile fish migration and life cycle of the Greenland halibut can be reconstructed in the sea area between the northern part of the Grand Newfoundland Bank (Northeast Newfoundland) up to Baffin Bay.

At first larvae and juveniles respectively, are drifting passively along with the West Greenland Current northwards. They are mainly taken up into the westward directed West Greenland Current Component by the southward running Polar Current and are shifted by the herefrom resulting Labrador Current to the growing area within the shelf region of Labrador and North Newfoundland.

While drifting passively larval development is finished. Juveniles are distributed within the whole area of Labrador up to NE Newfoundland. Their abundance gets less dense in southern direction.

Juveniles of the Greenland halibut migrate actively northward leaving their growing areas.

Those larvae and juveniles respectively, which are not seized by this drifting remain in the southern areas of West Greenland and grow up in the fjords and on the West Greenlandic banks. A migration of these specimens when being adults into the East Greenlandic - Icelandic spawning area of the Icelandic stock is imaginable. But it is not possible to establish a proof of this migration. ERNST (1986) refers to a connection between the stocks of Southwest Greenland and the Icelandic stock.

The northward migration lasting for a period of several years is marked by a continuous process of growing and maturing.

The depth of distribution increases in the course of the northward migration. The Greenland halibut arrives at the Baffinland-Greenland Threshold when matured and spawns in the area of the Greenland Canada Threshold (62^{0}N - 65^{0}N) beneath 1000 m within the range of the warm water component of the Davis Strait.

During the northward migration lasting several years the Greenland halibut performs actively onshore-offshore migrations within the year's cycle. These migrations are marked by the feeding migration in east-westward direction from the deep water area of the continental slope into the shallow area of the Canadian shelf during summer months. During this period the Greenland halibut forms feeding concentrations within the shelf area.

Within the year's cycle from September/October onward the feeding concentration disperses and the fish immigrate from the more shallow areas of the shelf seaward into the warmer deep water areas. Here the juvenile halibut forms overwintering concentrations.

Adult halibut concentrates in the northern distribution area and forms prespawning and spawning concentrations. They emigrate to the spawning area within the range of the deep water of the Greenlandic Canadian Threshold (62^{0}N to 65^{0}N) and spawn here in the 1. quarter of the year. After spawning feeding areas of the North Labrador and the West Greenland shelf respectively, are frequented again.

On the basis of present findings migrations of the Greenland halibut during life and year's cycle are demonstrated in the figures 12 and 13.

Feeding concentration are commercially exploited by the Canadian gill net fishery in the shelf area of Newfoundland (ICNAF/NAFO Divisions 3 L, 3 K) and by international bottom trawl fishery at the northern slope of the Great Newfoundland Bank. In connection herewith attention has again to be drawn to successful postspawning fisheries in the fjords and coastal areas of West Greenland respectively, during summer months as here also occurrences of prefeeding and feeding concentrations are exploited by fisheries. The immigration of Greenland halibut from the shallower areas of the shelf off the Canadian East coast to the deep water furrows and depressions of the continental slope and the herefrom resulting development of overwintering concentrations and prespawning concentrations respectively, are the basis of the GDR fishery on halibut within the area of North and Central Labrador (ICNAF/NAFO Divisions 2 G, 2 H) from October to December.

2.2. Delimitation of stocks

Final results of stock delimitation and identification of Greenland halibut in the area of the NW Atlantic were presented in 1970 for the first time (meristic investigations according to TEMPLEMAN) and were carried on and completed respectively, by biochemical (FAIRBAIRN 1981) and parasitological analysis (KHAN et al. 1982) as well as by tagging experiments (BOWERING 1984 b).

2.2.1. Meristic investigations

TEMPLEMAN (1970) carried out meristic comparisons by quantitative investigations of vertebra and fin rays (dorsal, pectoral, anal) on the basis of selected sample materials of the West Greenland/ Baffinland area up to SW Grand Newfoundland Bank.

The author draws the conclusion that quantitative investigations of the vertebra did not succeed in the identification of separate halibut stocks in the large area between West Greenland/Baffinland and the Grand Newfoundland Bank because the mean number of vertebra did not differ significantly. There were no differences between males and females.

Comparing the results of vertebral investigations of the West Greenland/Grand Newfoundland Bank area with those of the Golf of St. Lawrence area statistically secured differences are significant, which may provide the idea of the existence of two separate stocks.

2.2.2. Biochemical investigations and their results

FAIRBAIRN (1981) describes and discusses population delimitations of occurrences of Greenland halibut in the areas of the Northwest Atlantic, in the Golf of St. Lawrence and the Bering Sea by means of biochemical methods. For this purpose samples were analysed be means of electrophoresis concerning alleles and genotypical frequency of 16 protein loci. 13 of these determined arrangements of proteins could be ascertained in all samples as monomorphic identically. It was noticed, that one locus (malate dehydrogenase) was only proved in samples of the Bering Sea and two further loci (phosphoglucomutase and phosphohexose isomerase) were proved as ploymorphic in all samples.

The analysis of frequency of alleles in the arrangement of proteins of malate dehydrogenase, phosphoglucomutase and phosphohexose (glucose phosphate) - isomerase refer to the fact, that Greenland halibut of the Northwest Atlantic is to incorporate into a genetically homogeneous stock and that occurrences in the Golf of St. Lawrence exist as one separate but not totally isolated stock. These results will be qualitatively more transparent by the statement, that the findings of samples of the Bering Sea differ significantly from those of the Northwest Atlantic and the Golf of St. Lawrence. A genetic distance between occurrences of Greenland halibut in the Northwest Atlantic and in the North Pacific can't be ignored.

2.2.3. Parasitological investigations and their results

Investigations on parasitism of Greenland halibut in the North Atlantic (FUNK and KÖSTLER 1978, REIMER 1981) showed differences concerning extensity and intensity of infestation rates of parasites in the North East Atlantic (Bear Island) and in the Northwest Atlantic (Davis Strait). In both areas the specification of observed parasites is insignificant. The results show, that the intensity of infestation with nematode larvae is significantly smaller in the fishing area Davis Strait than in the fishing area Bear Island. At this it is spectacular, that on fish being considerably infested with Anisakis other kinds of parasites are almost completely missing. There were also differences in the extensity of infestation by cestode larvae of the grouping Scolex pleuronectis which was more significant in the fishing area Bear Island than in the fishing area Davis Strait.

These observations may be valued as indicium of stock delimitation between the stocks of the NW Atlantic and the NE-Atlantic but wouldn't allow a statement on stock identification in the NW-Atlantic as sample material was only derived from the area of the general position around 65°N; $56^{\circ}30$W (Davis Strait).

KHAN et al. (1982) analysed qualitative and quantitative rates of infestation of blood protozoans for proving natural fish taggings and their significance for population delimitation of Greenland halibut in the NW Atlantic. Sample material of West Greenland, Davis Strait, Labrador (Divisions 2 G, 2 H, 2 J), North and East Newfoundland (Division 3 Pe, including Fortune Bay) and the Golf of St. Lawrence (Divisions 3 Pn, 4 R, 4 S, 4 T) was surveyed concerning infestation rates of Trypanosoma murmanensis and Piroplasmodium Haemohormidium terraenovae (KHAN et al. 1980). The results show, that Trypanosoma infection was significantly higher in the area north of East Newfoundland up to the Davis Strait area inclusively than in the Fortune Bay and in the Golf of St. Lawrence. The Piroplasmodium infection was high within all areas but shows differences in the infestation incidence. At this the low infestation rate in the St.Lawrence area is significant.

According to present investigation results Trypanosoma and Piroplasmodium infestation seems to be homogeneous in the areas Davis Strait, North and Central Labrador (Divisions 2 G, 2 H) as well as in the areas of East Newfoundland (Division 3 L), but it differs when compared with Division 3 J (South Labrador) and Division 3 K (North Newfoundland). KHAN et al. (1982) concluded, that occurrences in the area of South Labrador/North Newfoundland (Divisions 2 J, 3 K) therefore represent an isolated group, which possibly outlines a connection between the distribution areas.

The infestation rates of surveyed blood protozoans permit the conclusion that occurrences of Greenland halibut in the areas of the Golf of St. Lawrence and Fortune Bay can be delimited from the northern occurrences (Division 3 L and north of it).

Investigations concerning problems of ecto-parasitism (Neobranchiella rostrata (KROYER 1837), Sphyrion lumpi (KROYER 1845), Aega psora (LINNAEUS 1758) are presented (ROKICKI 1982) only from the sea area Labrador (57°45'-55°30'N; 60°22'-57°58'W) but they can't be discussed because of missing investigations for comparison from other areas of the NW Atlantic concerning stock identification by means of natural fish taggings.

3. Summarizing and discussion of the results concerning distribution migration and stock delimitation

The results of taggings north and northeast of Newfoundland show northward migration activities. Recoveries of these tagging experiments south of the Trinity Bay (47°35'N) have not been notified.

By means of tagging experiments in the Fortune Bay (east exit of the Golf of St. Lawrence, South Newfoundland, Division 3 Ps) the delimitation of these occurrences from those north of 47°30'N is significant. More than 15 specimens out of 1008 specimens, which have been tagged in the Fortune Bay in 1979 were reported as recoveries during the period 1980-1983

All these recoveries recruit from the area of the tagging place. Recoveries outside of the Fortune Bay and therefore outside of the Golf of St. Lawrence have not been reported.

The presented results of tagging experiments (BOWERING 1984 b), meristic (TEMPLEMAN 1970), biochemical (FAIRBAIRN 1981) (DEY 1982) and parasitological (KHAN et al. 1982) investigations permit the interpretation, that occurrences in the area of ICNAF/NAFO Divisions 3 L, 3 K (Newfoundland), 2 J, 2 H, 2 G (Labrador), 1 D, 1 C, 1 B (West Greenland) and 0 B, 0 A (Baffinland) are to be associated to one homogeneous Northwest Atlantic stock.

This stock delimitation corresponds with the comment of CHUMAKOV and SEREBRYAKOV) (1982) according to which halibut occourrences in the ICNAF/NAFO Subareas 0, 1, 2 and Divisions 3 K, L on the basis of lon therm investigations of the USSR (CHEKOVA . 1973, 1974, (1975, 1976 CHUMAKOV 1982) belong to a homogeneous "Candadian - West Greenlandic stock", which recruits independently of other populations.

In this connection it has to be reffered to the fact, that occurrences off SW Greenland possibly are occasionally mixed occurrences, which recruit from specimens of Canadian - West Greenlandic stock and Icelandic stock entering joint feeding places off West Greenland. BIESTER and MAHNKE (1963) and MAHNKE (1967) referred to the drifting of larvae with the Irminger West Greenland Current system from Iceland to West Greenland.

Significant results of investigations of meristic, parasitological and biochemical analysis as well as taggings prove occurrences in the area South Newfoundland/Golf of St. Lawrence to be a separate stock of Greenland halibut.

FAIRBAIRN (1981) discusses by means of biochemical investigations the possibility of a connection of occurrences in the Golf of St. Lawrence with those in the Canadian West Greenlandic distribution area.

It has also to be referred to results of population dynamic investigations by BOWERING (1983 a), who describes significant differences in length growth per age group between occurrences in the Golf of St. Lawrence and those of Labrador (North Newfoundland).

References

1. ATKINSON, D. B.; BOWERING, W. R.; PARSONS, D. G.; HORSTEDT, Sv. Aa.; MINET, J. P.: A Review of the Biology and Fisheries for Roundnose Grenadier, Greenland Halibut and Northern Shrimp in Davis Strait
NAFO Sci. Coun. studies.- Dartmouth (1982) 3. - p. 7 - 28

2. BIESTER, E.; MAHNKE, W.: Untersuchungen über das Vorkommen von Fischeiern und Fischlarven im Gebiet Westgrönland 1961 bis 1963 und zwischen den Faröern und Kap Farwell 1961 und 1962
Fischereiforschung. - Rostock 1 (1963) 1. - S. 37 - 46

3. BIESTER, E.: Kabeljaumarkierungen 1961 bis 1963 bei Westgrönland.
Fischereiforschung. - Rostock 4 (1966) 1. - S. 7 - 58

4. BOWERING, W. R.: (a) Stock identification studies of Greenland halibut (Reinhardtius hippoglossoides) in the Northwest Atlantic from tagging experiments
NAFO SCR Doc. - Dartmouth (1982) IX/78. - Ser. No. N 584

5. BOWERING, W. R.: (b) Populations Dynamics of Greenland Halibut in the Gulf of St. Lawrence
J. Northw. Atl. Fish. Sci. - Dartmouth 3 (1982) 2. - p. 141 - 148

6. BOWERING, W. R.: (a) Age, Growth and Sexual Maturity of Greenland halibut,Reinhardtius hippoglossoides in the Canadien Northwest Atlantic
Fish. Bull. - Long Beach 81 (1983) 3. - p. 599 - 611

7. BOWERING, W. R.: (b) By-catch levels of Greenland halibut in the roundnose grenadier directed fishery in NAFO Subareas 2 + 3
NAFO SCR Doc. - Dartmouth (1983) VI/28. - Ser. No. N 680

8. BOWERING, W. R.: (a) Distribution and relative abundance of the Labrador - eastern Newfoundland stock complex of Greenland halibut (Reinhardtius hippoglossoides)
NAFO SCR Doc. - Dartmouth (1984) VI/61. - Ser. No. N 850

9. BOWERING, W. R.: (b) — Migrations of Greenland halibut, Reinhardtius hippoglossoides, in the Northwest-Atlantic from Tagging in the Labrador-Newfoundland Region

J. Northw. Atl. Fish. Sci - Dartmouth 5 (1984) 1. - p. 85 - 92

10. CHEKHOVA, V. A.: — The trawling survey of groundfish in the Newfoundland area

ICNAF SCR. Doc. - Dartmouth (1973) 40. - Ser. No. 2979

11. CHEKHOVA, V. A.: — Groundfish trawl survey in the Newfoundland area in 1973

ICNAF SCR. Doc. - Dartmouth (1974) 54. - Ser. No. 3263

12. CHEKHOVA, V. A.: — Trawl survey of demersal fishes in the Newfoundland area in 1974

ICNAF Res. Doc. - Dartmouth (1975) 85. - Ser. No. 3561

13. CHEKHOVA, V. A.: — Total trawl survey of bottom fishes in the Newfoundland area in 1975

ICNAF Res. Doc. - Dartmouth (1976) 53. - Ser. No. 3839

14. CHUMAKOV, A. K.: — K voprosu o Lokal'nosti stad černogo paltusa v Severo Zapadnoj Atlantike

Trudy PINRO. - Murmansk (1975) Vyp. 35. - S. 203 - 209

15. CHUMAKOV, A. K.: — O tralovoj s"emke zapasov černogo paltusa v kanadskoj zone severnoj Atlantiki

Trudy PINRO sbornik naučnych trudov. - Murmansk (1982). - S. 21 - 31

16. CHUMAKOV, A. K.; SEREBRYAKOV, V. P.: — Distribution of Greenland halibut from the Greenland-Canadian population

NAFO SCR Doc. - Dartmouth (1982)IX/96. - Ser. No. N 605

17. DEY, A. C.: — Comparison of the properties of phosphoglucomutase from muscle of turbot (Reinhardtius hippoglossoides, Greenland halibut) and witch flounder (Glyptocephalus cynoglossus) from the Northwest Atlantic and Gulf of St. Lawrence

Comp. Biochem. Physiol. - Ottawa 72B (1982) 2. p. 249 - 254

18. ERNST, P.: — Bericht über das Grundtrawl-Survey von ROS 414 "Walter Barth" vom 29.10. - 28.12.1979 in das Seegebiet der nationalen Fischereischutzzone Kanadas

Rostock (1980). - Instit. Hochseef., unveröffentlicht

19. ERNST, P.: Bestandsbiologische Untersuchungen am Schwarzen Heilbutt (Reinhardtius hippoglossoides WALB.) im Nordwest-Atlantik
Inaugural-Diss. - Univ. Rostock, Sektion Biologie (1986). - 148 S., 38 Abb., 30 Tab.

20. ERNST, P.: Verbreitung der kanadisch-grönländischen Vorkommen des Schwarzen Heilbutts (Reinhardtius hippoglossoides WALB.) in Abhängigkeit vom Temperaturniveau
Fischerei-Forschung, Rostock 25 (1987), im Druck

21. FAIRBAIRN, D. J.: A biochemical genetic analysis of polulation differentiation in Greenland halibut (Reinhardtius hippoglossoides (Walbaum)) from the Northwest-Atlantic, Gulf of St. Lawrence and the Bering sea
Can. J. Fish. Aquat. Sci. - Ottawa 38 (1981) 7. - pp. 782 - 794

22. FUNK, R.; KÖSTLER, R.: Zum Parasitierungsgrad von Reinhardtius hippoglossoides (Walb.) aus dem Nordatlantik
1978. Güstrow, Päd. Hochschule, Dipl.Arb.

23. JENSEN, A. S.; HANSEN, P. M.: Investigations on the Greenland Cod (Gadus callarias L.)
Rapp. et Piocés-Verb. des Reunions. - Kopenhagen 72 (1931)

24. JENSEN, A. S.: The Greenland Halibut (Reinhardtius hippoglossoides (Walb.) its Development and Migrations
Kgl. Danske vid. selsk. skr., Natur v. og Math. - Kopenhagen 6 (1935) 4. - 37 S.

25. KHAN, R. A.; DAWE, M.; BOWERING, R.; MISRA, R. U.: Blood protozoa as an aid for separating stocks of Greenland halibut, Reinhardtius hippoglossoides, in the Northwest Atlantic
Can. J. Fish. Aquat. Sci. - Dartmouth 39 (1982) 9. - pp 1317 - 1322

26. KOSIOR, A.; DRAGANIK, B.: Halibut mebieski pn-wsch. Atlantyku
Technika i Gospodarka Morska. - Gdynia 20 (1970) 10

27. LEAR, W. H.: Length-weigth relationsship of commercial-size Greenland halibut, Reinhardtius hippoglossoides (WALB.)
ICNAF Research Bull. - Dartmouth 6 (1969). - p. 119

28. LEIM, A. H.; SCOTT, W. A.: Fishes of the Atlantic Coast of Canada

Fish. Research Board Canada Bull. 155. - Ottawa, 1966, 485 S.

29. MAHNKE, W.: Untersuchungen über das Vorkommen von Fischeiern und Fischlarven der wichtigsten Nutzfischarten vor Westgrönland und zwischen den Faröern und Kap Farwell in den Jahren 1964 und 1965.

Fischerei-Forschung. - Rostock 5 (1967) 1. S. 75 - 82

30. NIZOVTSEV, G. P.: Černyj paltus mečennyi v vodach vostočnee islandii i vylovlen v Barencevom more

Vopr. ichtiol. - Moskva 14 (1974) 2.

31. REIMER, L.: Parasiten von Reinhardtius hippoglossoides (WALBAUM), dem Schwarzen Heilbutt aus dem Nordatlantik

Physiologie, Biologie und Parasitologie von Nutzfischen; IV. Konferenz WPU Rostock. - Rostock (1981). S. 121 - 123

32. ROKICKI, J.: Ektopasożyty Halibuta Niebieskiego Reinhardtius hippoglossoides (WALBAUM, 1972) z towisk Labradoru.

Polskie Towarzystwo Parazytologiczne. - Warszawa 28 (1982) 1-2. - S. 199 - 203

33. SCHARNOW, U.: Ozeanographie für Nautiker

Berlin: Transpress 1961

34. SMIDT, E.: The Greenland Halibut, Reinhardtius hippoglossoides (Walb.), Biology and Exploitation in Greenland waters

Med. Danmarks Fiskeri - og Havundersøgelser. - København 6 (1969) 4. - S. 79 - 148

35. SOROKIN, V. P.; GRIGORYEV, G. V.: Spermatogenez i polovoj cikl cernogo paltusa populjacii Barencego morja

Trudy PINRO. - Murmansk 23 (1968)

36. TEMPLEMAN, W.: Distribution and abundance of the Greenland halibut, Reinhardtius hippoglossoides (Walbaum), in the Northwest-Atlantic

ICNAF Res. Bull. - Dartmouth 10 (1973). - p. 83

37. TEMPLEMAN, W.: Migration and intermingling of stock of Atlantic cod, Gadus morhua, of the Newfoundland and adjacent areas from tagging in 1962 - 66

ICNAF RES. Bull. - Dartmouth 14 (1979). - p. 5 - 50

Tab. 1: Tagging experiments on Greenland halibut in the NW Atlantic carried out by the GDR

time of tagging		area	ICNAF/NAFO concention area	n
August	1968	Baffinland	0B	213
		Davis-Strait	0B	110
		Holsteinsborg	0A	4
June	1969	Baffinland	0B	138
		Davis-Strait	0B	93
		Labrador	2G	201
		Labrador	2H	33
		Newfoundland	3K	11
June	1970	Labrador	2H	239
Total	1968-70			1042

Table 2: Mean stage of maturity (after SOROKIN et al. 1968) of Greenland halibut according to year classes and areas, data of the GDR, IV. quarter 1975 - 1984, ICNAF/NAFO 0, 2 and 3K

area / age	♂♂ 3K	♂♂ 2J	♂♂ 2H	♂♂ 2G	♂♂ 0	♀♀ 3K	♀♀ 2J	♀♀ 2H	♀♀ 2G	♀♀ 0
0	-	-	-	-	-	1,00(1)	-	-		-
1	1,08(16)	1,00(2)	1,11(9)	1,00(6)	1,00(4)	1,00(24)	1,00(6)	1,0(1)	1,00(6)	-
2	1,17(36)	1,11(18)	1,27(15)	1,19(37)	1,03(17)	1,06(31)	1,00(23)	1,0(2)	1,00(13)	1,0(8)
3	1,10(91)	1,42(42)	1,25(16)	1,30(50)	1,37(37)	1,23(38)	1,09(43)	1,35(23)	1,14(12)	1,13(3)
4	1,25(284)	1,49(251)	1,70(50)	1,72(88)	1,90(57)	1,61(33)	1,44(25)	1,59(81)	1,52(23)	1,50(52)
5	1,52(339)	1,89(233)	1,95(293)	2,02(175)	2,04(95)	1,66(78)	1,62(96)	1,97(92)	1,82(89)	1,73(66)
6	1,83(46)	1,87(130)	2,14(322)	2,40(473)	2,64(163)	1,52(160)	1,94(143)	2,10(160)	2,02(179)	1,94(132)
7	1,87(43)	1,90(105)	2,49(207)	2,64(562)	2,93(197)	1,65(270)	2,0(195)	2,40(234)	2,31(265)	2,25(121)
8	2,06(39)	2,52(103)	2,58(145)	2,81(239)	3,07(180)	1,55(190)	2,26(242)	2,78(201)	2,63(253)	2,22(98)
9	2,02(18)	2,81(45)	2,71(153)	2,99(158)	3,29(112)	1,95(83)	2,40(107)	2,71(171)	2,67(180)	2,42(134)
10	2,14(5)	2,99(24)	2,86(29)	3,09(98)	3,95(82)	2,0(90)	2,43(76)	2,68(79)	2,65(93)	2,71(75)
11	2,10(9)	2,81(15)	3,0(26)	3,42(64)	4,19(51)	2,08(36)	2,50(51)	2,92(64)	2,85(34)	2,89(85)
12	2,36(6)	2,95(11)	3,0(4)	3,60(45)	4,50(7)	2,23(17)	2,60(14)	3,00(84)	2,91(41)	3,00(76)
13	2,30(5)	3,01(2)	-	4,0(11)	4,5(2)	2,33(7)	2,80(10)	3,12(40)	3,21(14)	3,28(60)
14	2,50(6)	3,0(2)	3,0(1)	4,0(9)	4,0(4)	2,43(12)	3,31(13)	3,22(54)	3,86(17)	3,92(42)
15	-	3,0(1)	4,0(2)	4,4(6)	4,5(4)	2,67(9)	3,25(4)	3,53(62)	4,20(5)	4,54(33)
16	-	3,0(2)	4,0(1)	4,4(6)	-	2,70(3)	3,50(2)	3,31(58)	4,75(4)	4,70(51)
17						2,70(3)	3,25(8)	3,47(38)	4,50(2)	4,04(12)
18						2,70(3)	3,0(2)	3,74(42)	3,00(3)	
19						2,5(2)	-	3,92(23)	4,66(3)	
20						3,0(4)	-	3,78(9)	-	
21						3,0(2)	-	4,00(3)	-	
22						3,0(2)	-	4,00(1)	-	

( ) = n

Table 3: Analysis of maturity+ of Greenland halibut in relation to the depth and to the investigation period (NAFO Division 2H, Nov., Dec. 1983)

Level of depth (m)	stage of maturity			
	1.-10.11.	11.-20.11.	21.-30.11.	1.-10.12.
A males				
500 - 600	-	2,1(I-IV)	-	-
600 - 700	2,9(II/III/V)	3,1(III/IV)	-	-
700 - 800	-	-	2,8(II-IV)	2,8(II/III)
900 -1000	-	-	3,2(III/IV)	-
B females				
500 - 600	-	2,2(II/III)	-	-
600 - 700	2,0(II)	2,5(II/III/IV)	-	-
700 - 800	-	-	3,3(II-IV)	3,5(II-IV)
900 -1000	-	-	3,7(III/IV)	-

+) mean maturity (according to SOROKIN et al. 1968) of all investigated specimens with the dominance of the maturity stage, i. e. (III/IV)

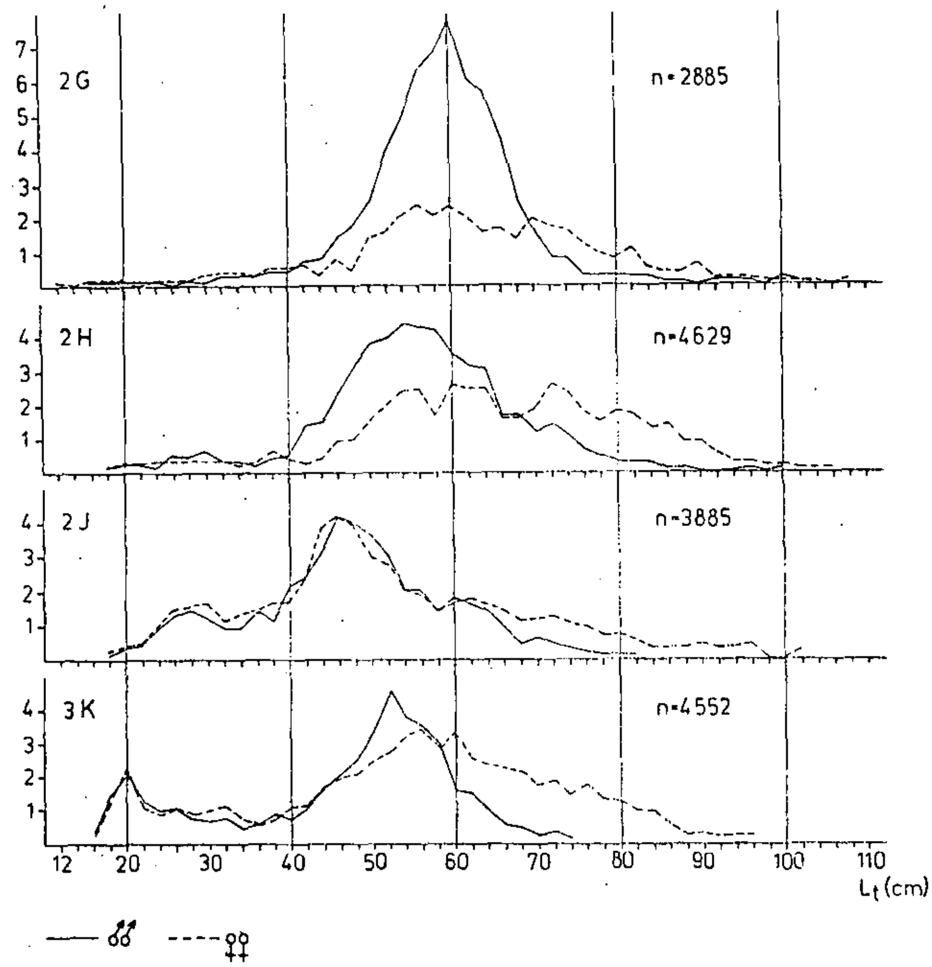

Fig. 1 Size composition by males and females based on G.D.R. catches (mesh opening >130 mm) in the Divisions 2G, 2H, 2J, and 3K; summarized data for 1975-1983

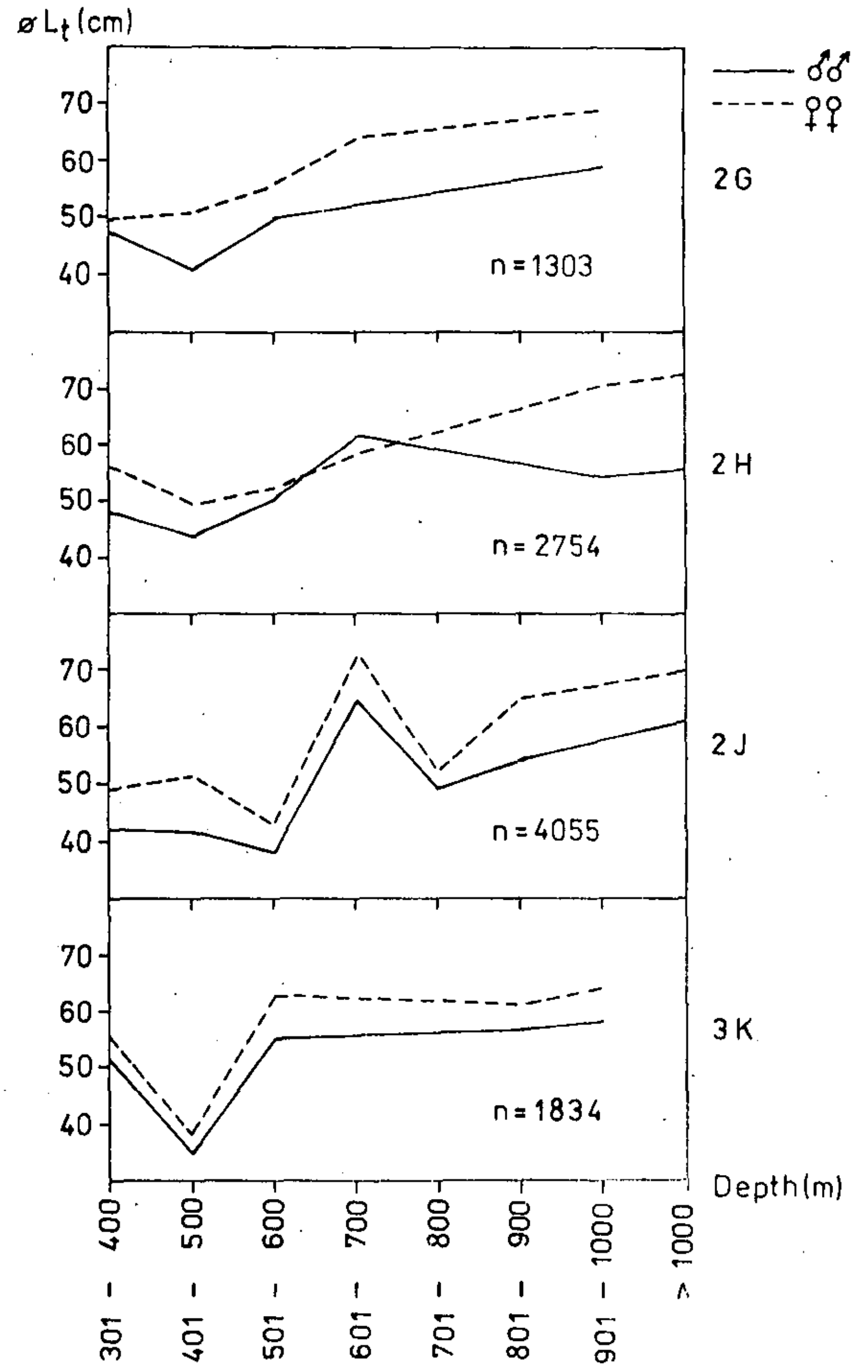

Fig. 2 Development of average lengths by males and females and areas in dependence of catch depth in the period 1975-1983 (4th quarter) based on G.D.R. investigations

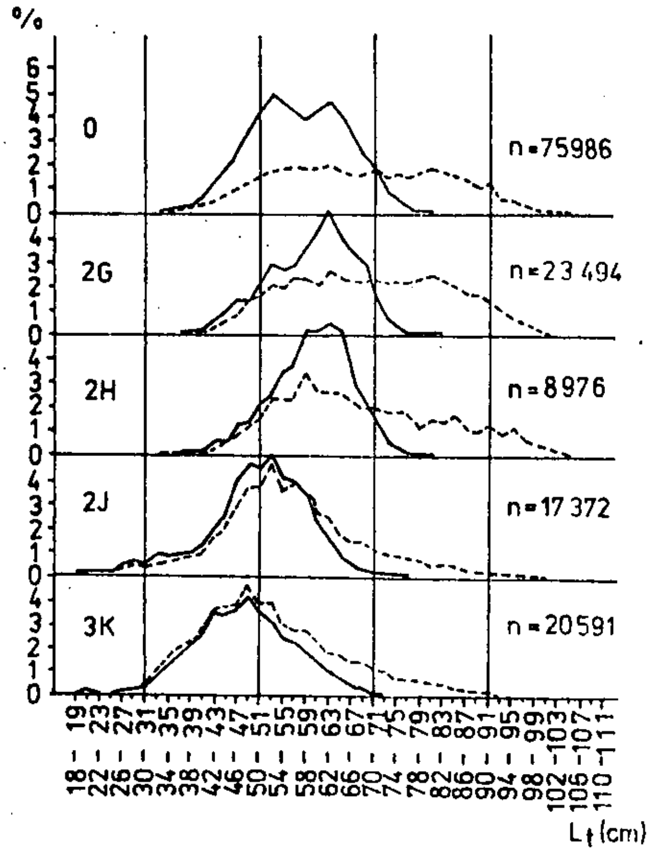

Fig. 3 Size composition of males (full line) and females (dotted line) from commercial catches (codends with a conventional mesh size) in Subarea 0 and Divisions 2G, 2H, 2J, 3K (summarized data for 1969-1981) (CHUMAKOV and SEREBRYAKOV 1982)

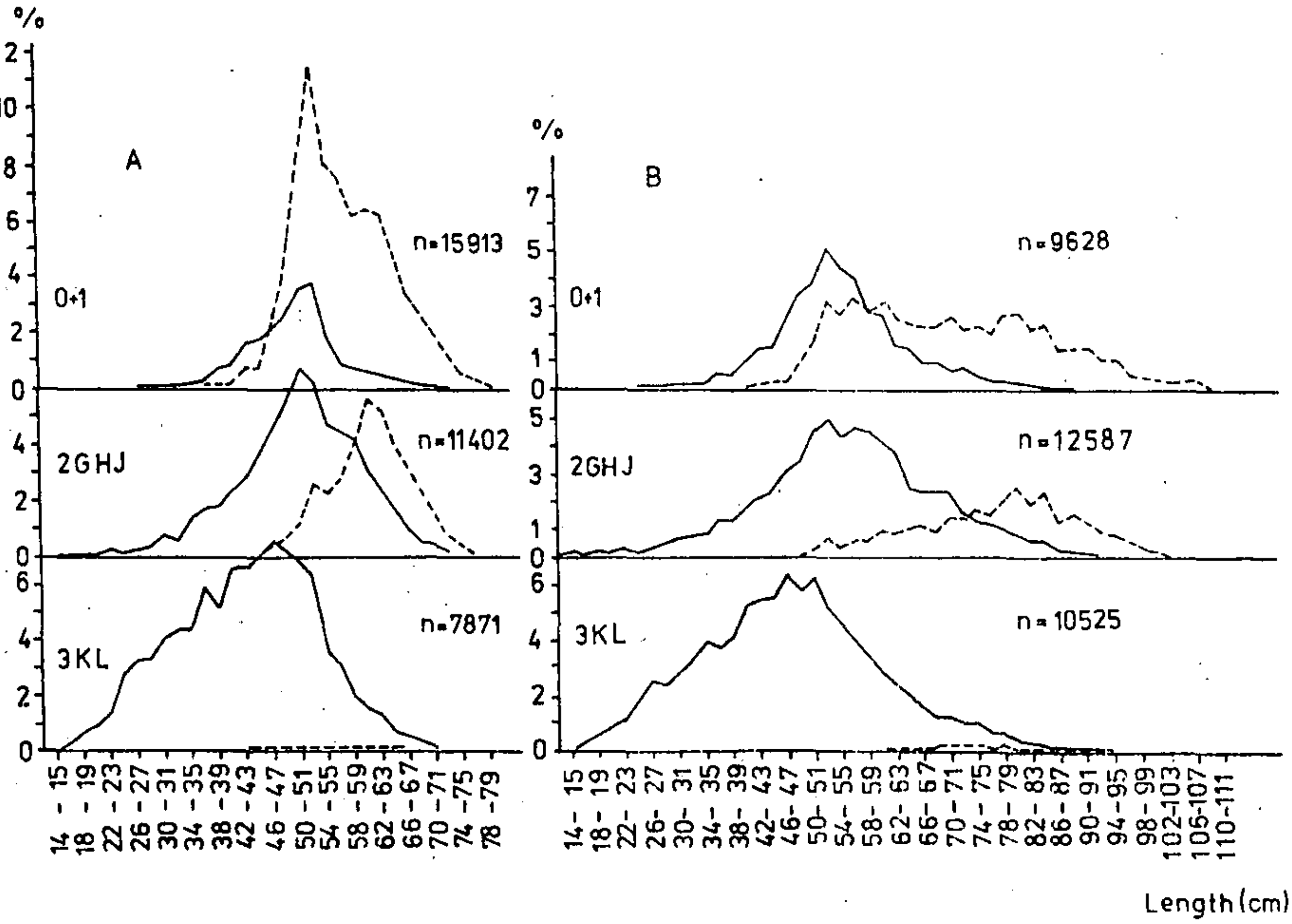

Fig.4

Size composition of mature (dotted line) and immature (full line) males (A) and females (B); summarized data for 1969-1981 (CHUMAKOV and SEREBRYAKOV 1982)

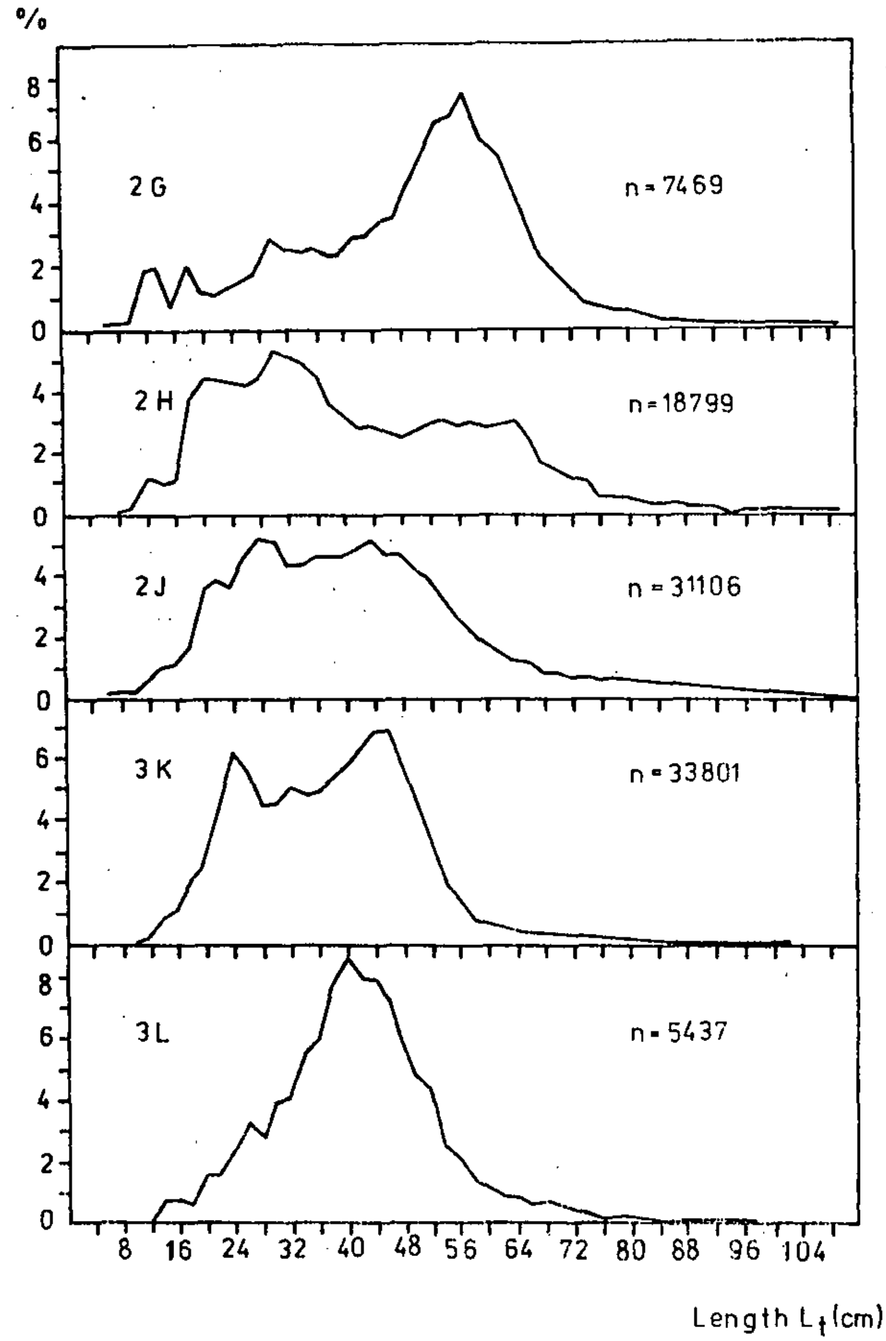

Fig. 5 Length frequency distributions of Greenland halibut by NAFO division from 1975 - 1983 combined where data were available (BOWERING 1984 a)

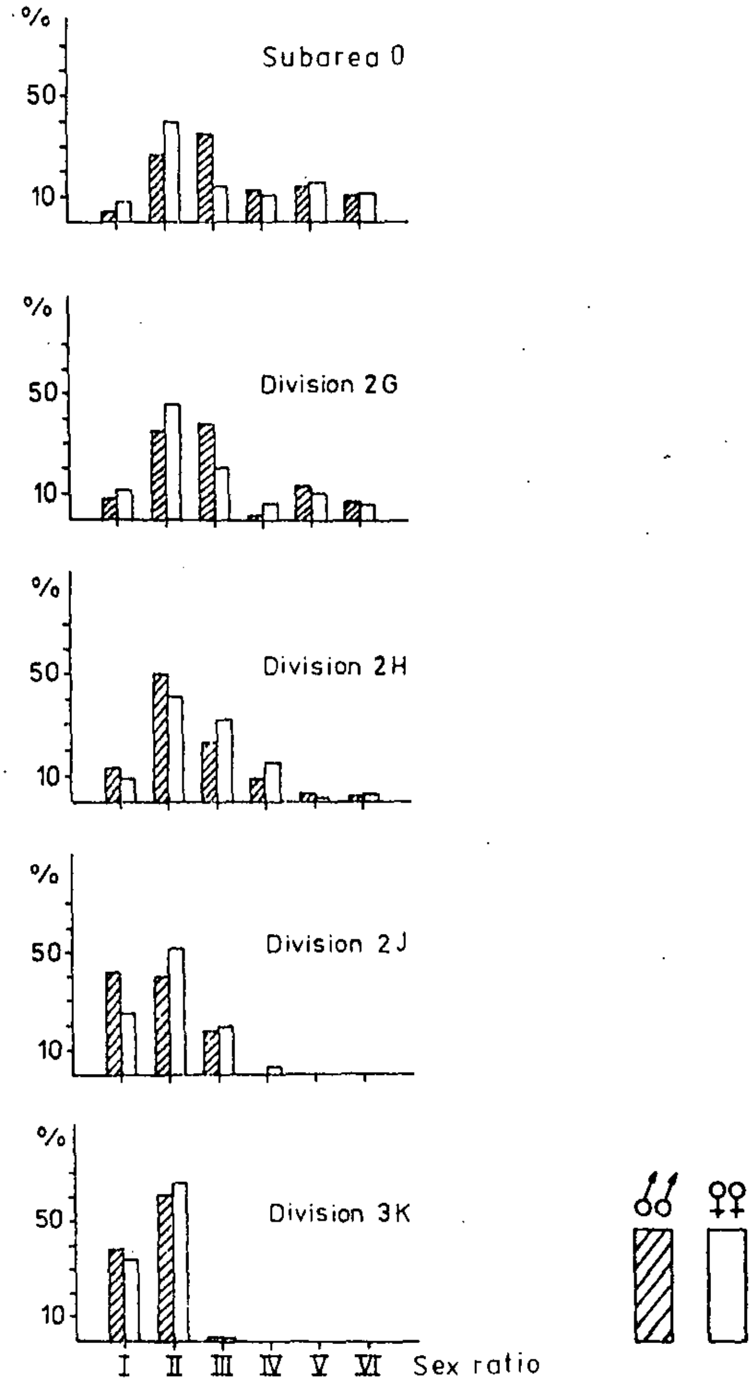

Fig. 6 Sex ratio (after SOROKIN 1968) of the males and females of Greenland halibut in the Subarea 0 and in the Divisions 2G, 2H, 2J, and 3K in the 4th quarter (1975-1984)

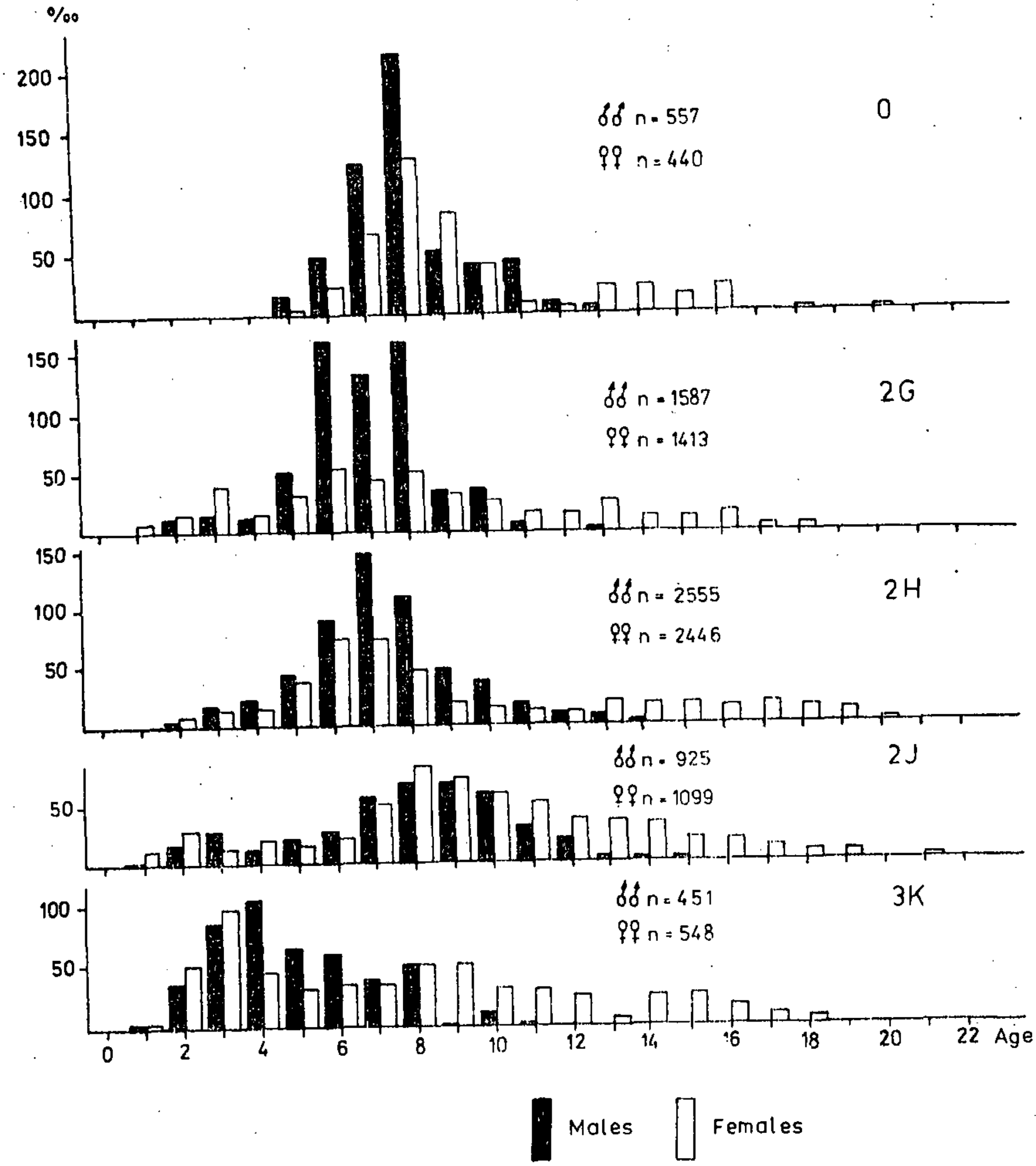

Fig. 7 Age composition of the males and females of Greenland halibut in the Subarea 0, and in the Divisions 2G, 2H, 2J, and 3K based on G.D.R. data in the period 1975-1983 (3th and 4th quarter)

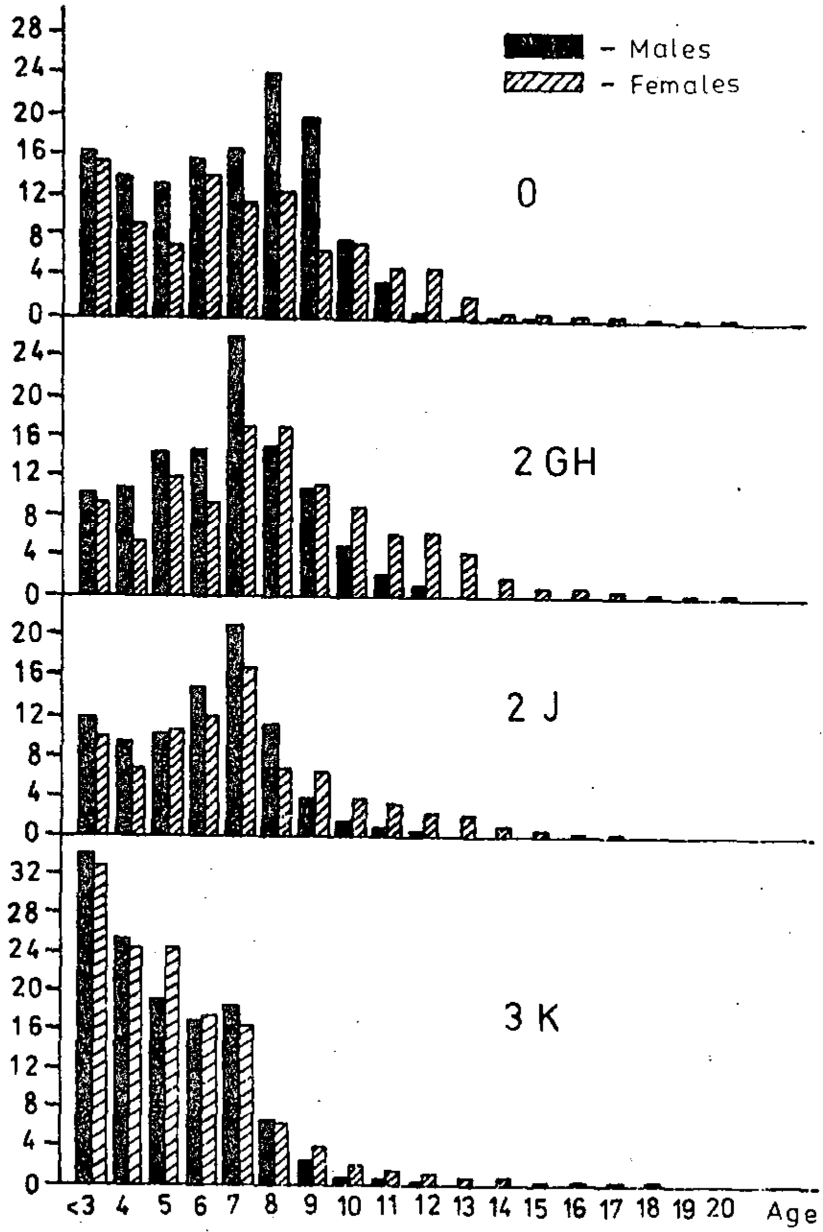

Fig. 8 Abundance of males and females in different age-groups in Subarea 0 and Divisions 2G, 2H, 2J, and 3K according to the data of a trawl survey, November 1980 – January 1981 (CHUMAKOV and SEREBRYAKOV 1982)

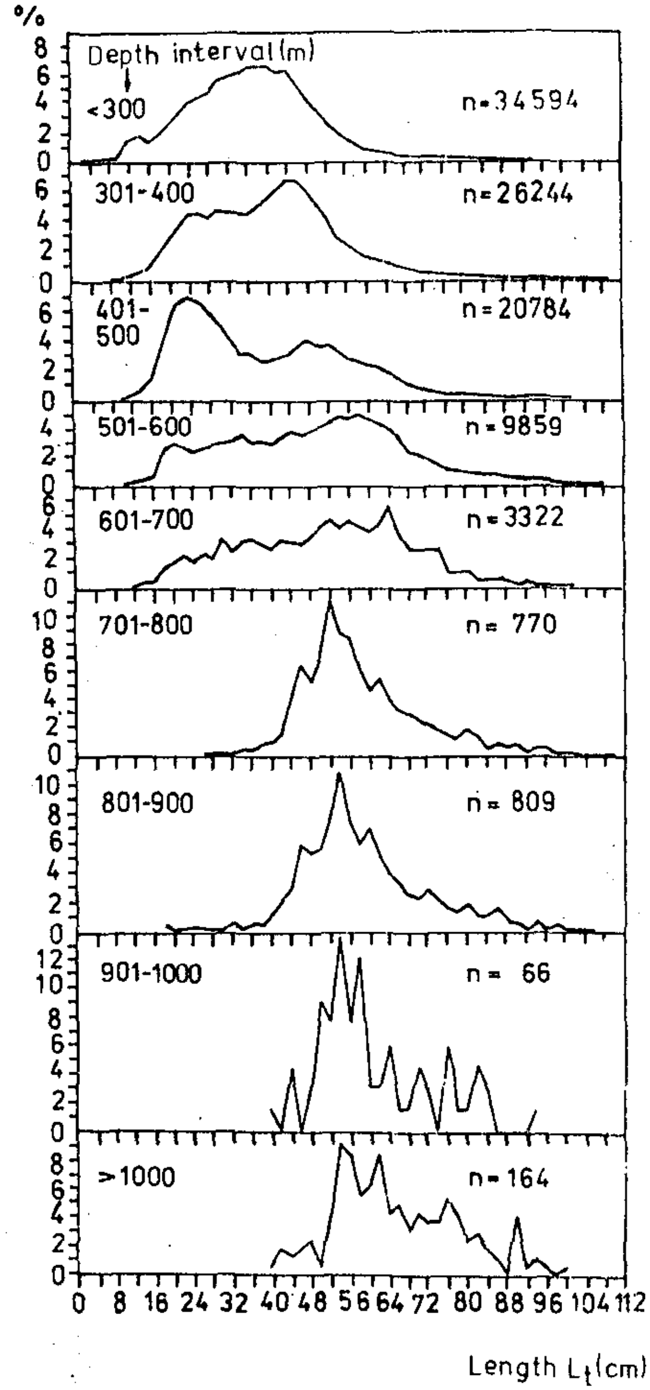

Fig. 9 Length frequency distributions of Greenland halibut by depth interval (m) for NAFO Subarea 2 and Division 3 K,L for 1975-1983 combined where data are available (BOWERING 1984 a)

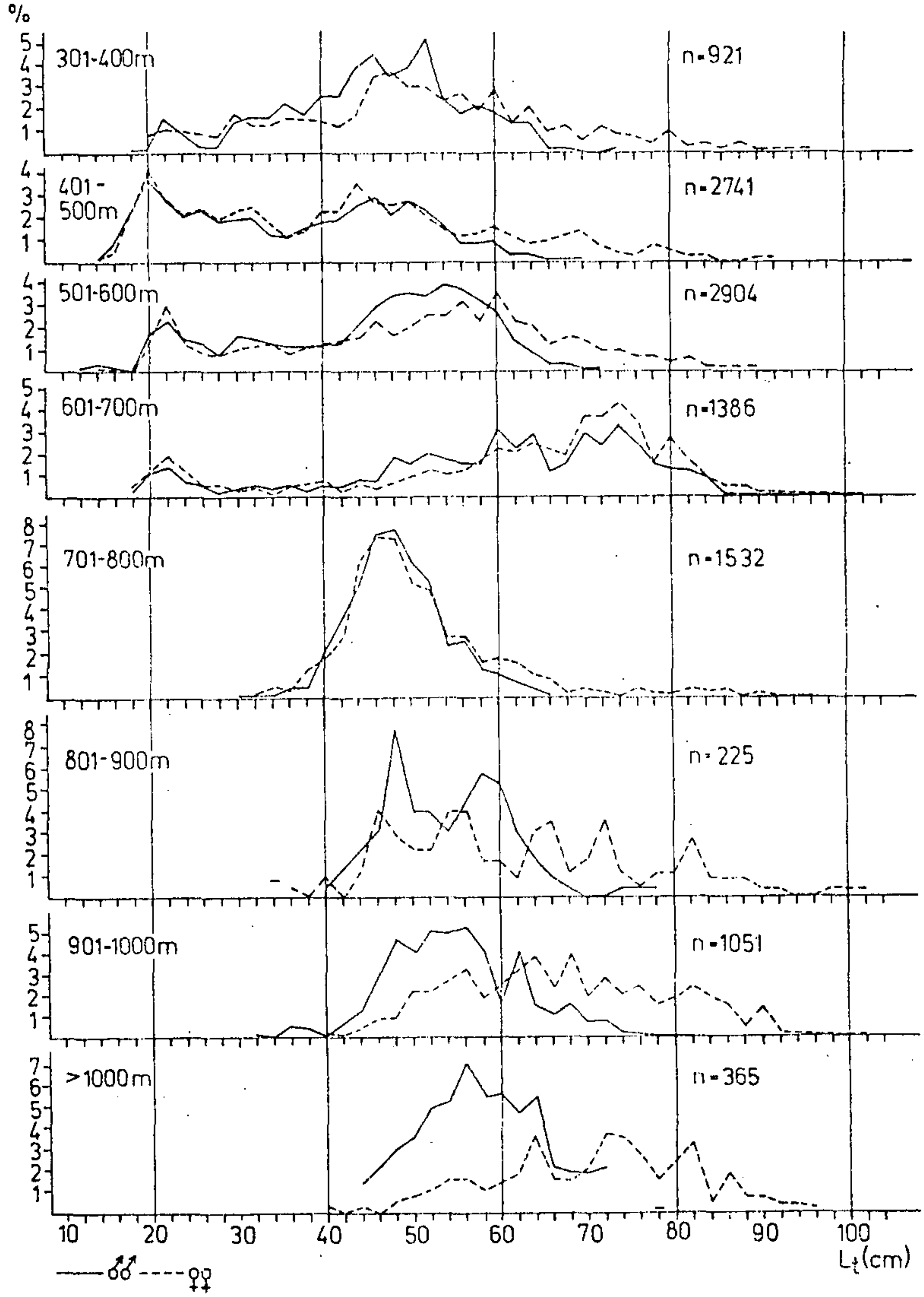

Fig. 10 Length frequencies of males and females of the Greenland halibut by depth interval (m) of the continental slope of the Subarea 2 and of the Division 3K based on all available G.D.R. data in the period 1975-1983

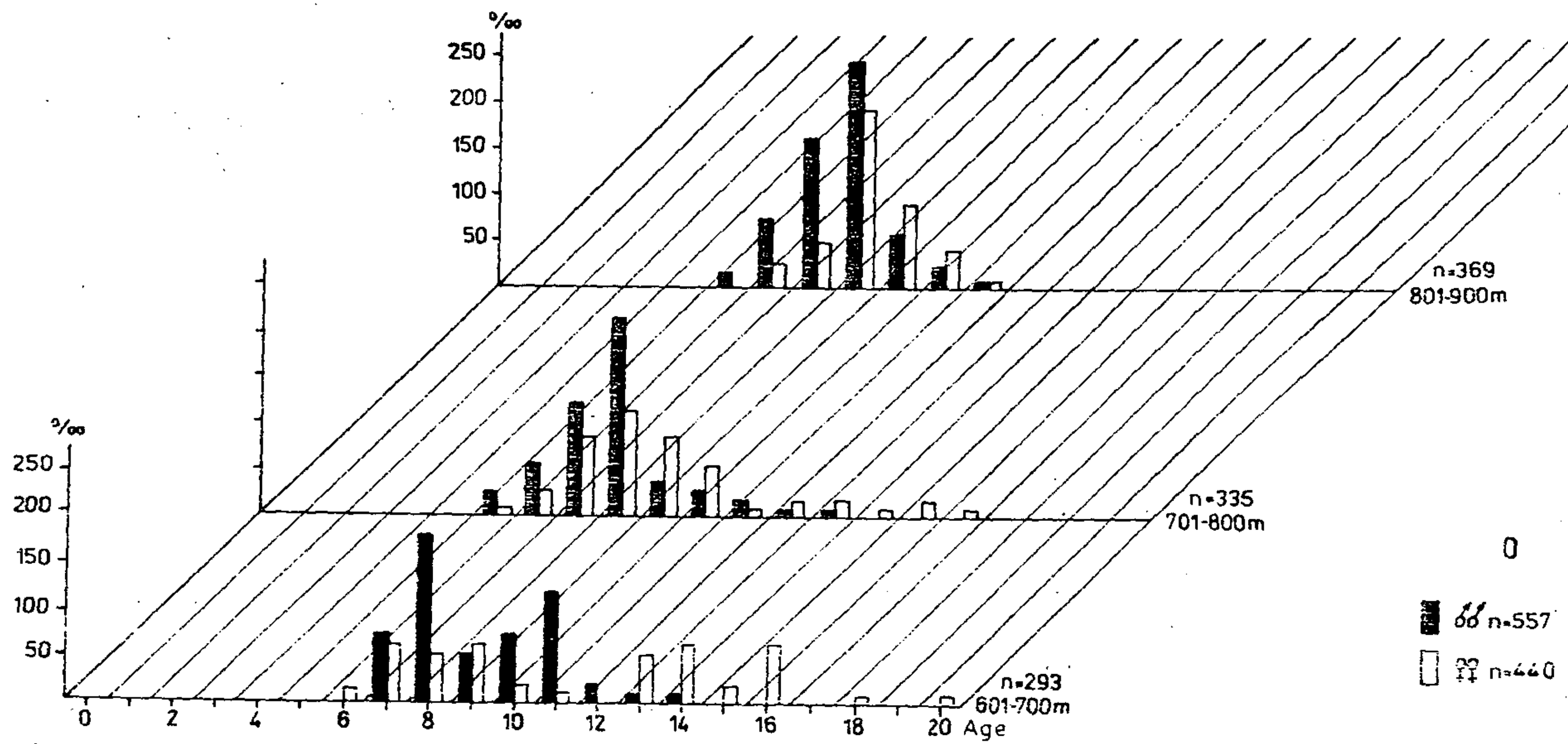

Fig.11 Age distribution of males and females of Greenland halibut by depth intervals (m) in the Subarea 0 and the Divisions 2G, 2H, 2J, and 3K based on G.D.R. data in the period 1975-1983 (4th quarter)

A Subarea 0

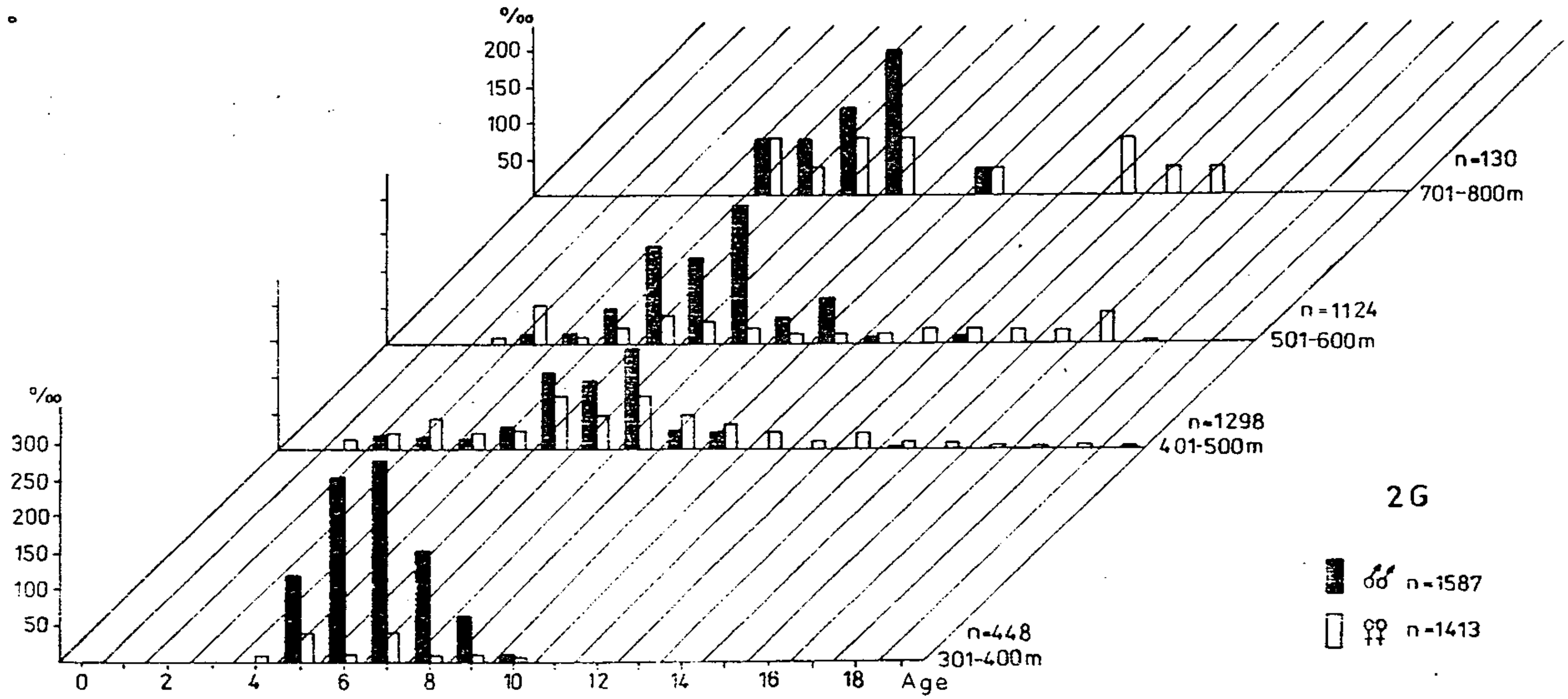

Fig. 11B Division 2G

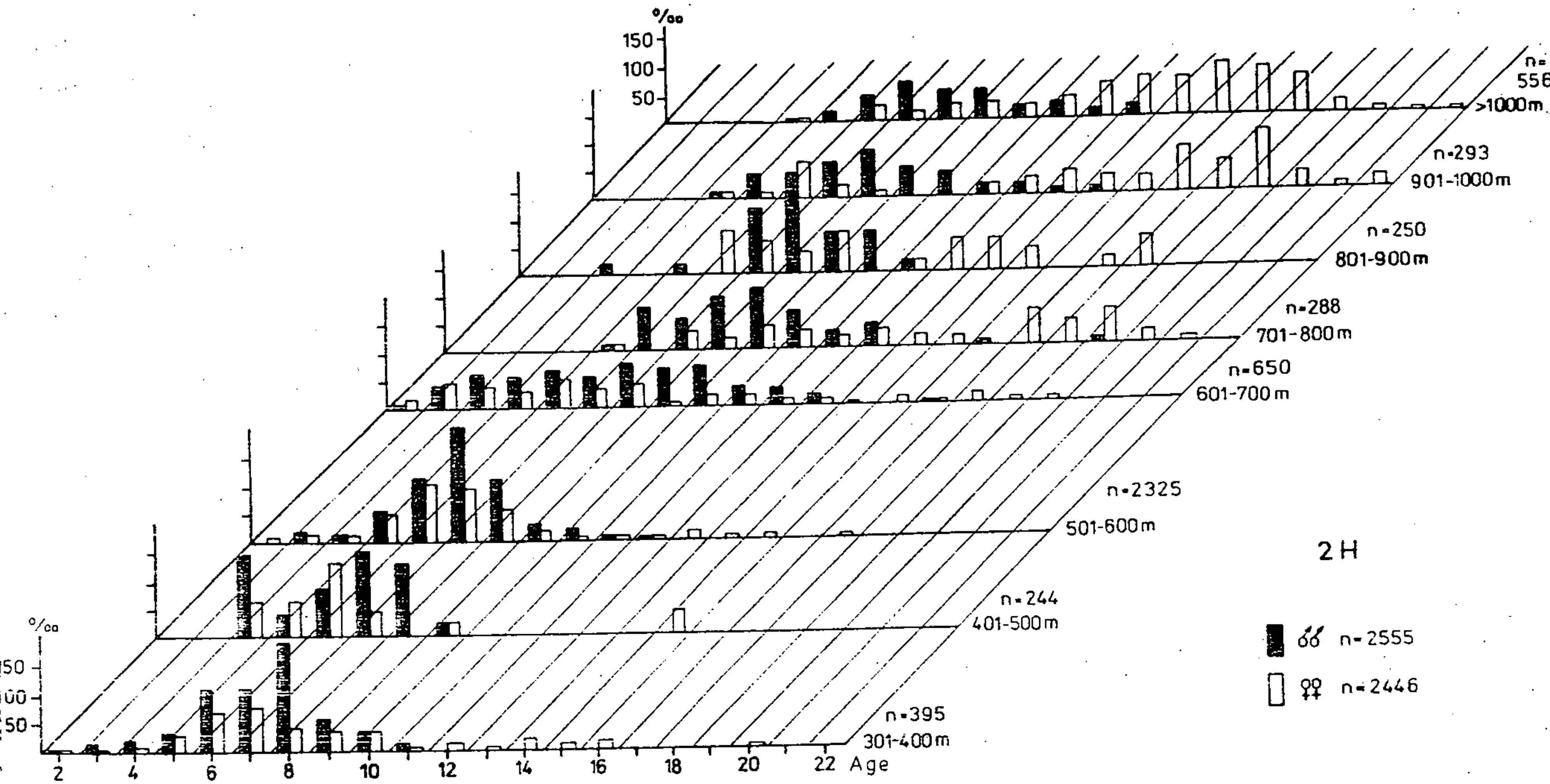

Fig. 11C Division 2H

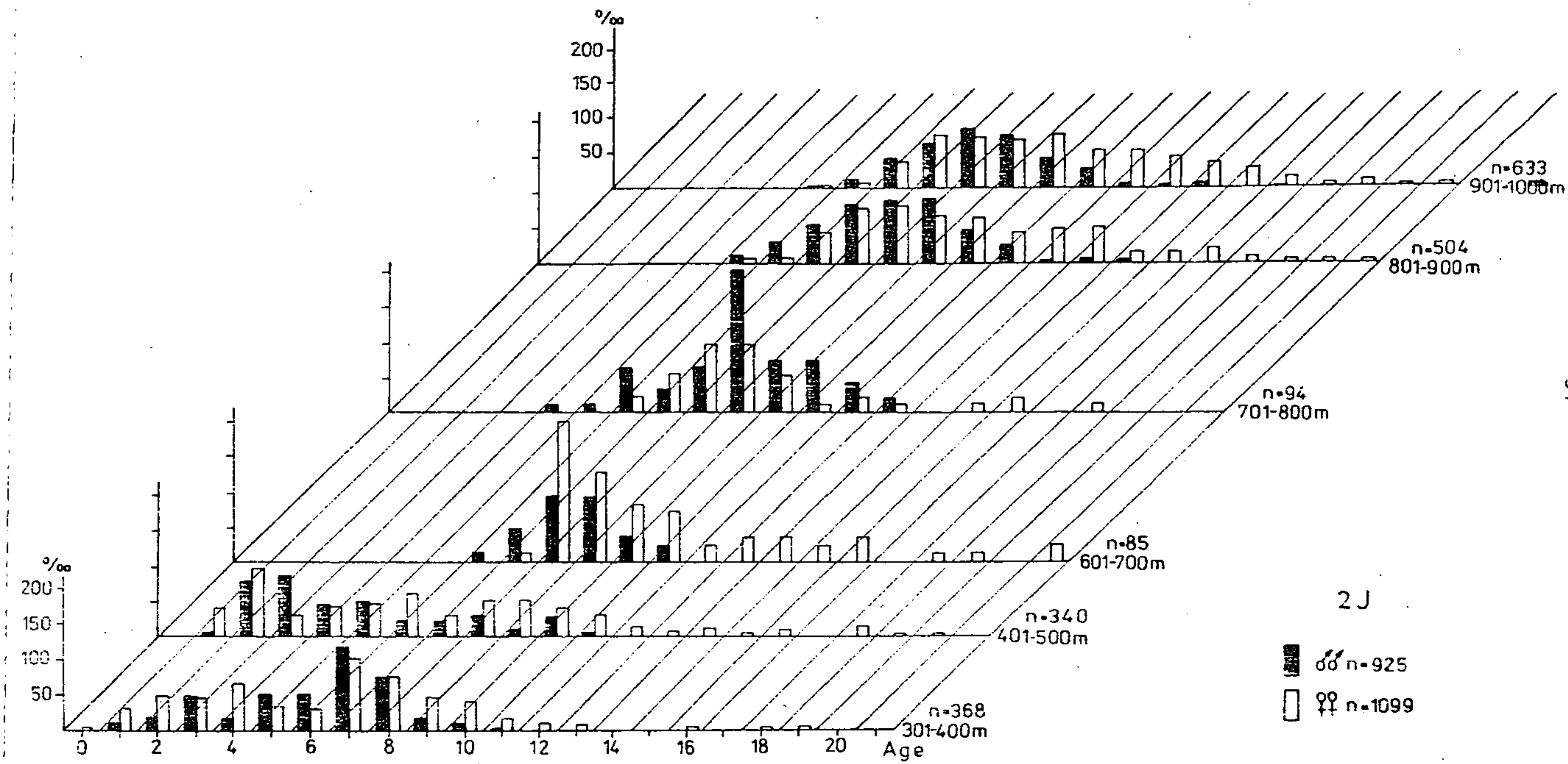

Fig. 11 D Division 2J

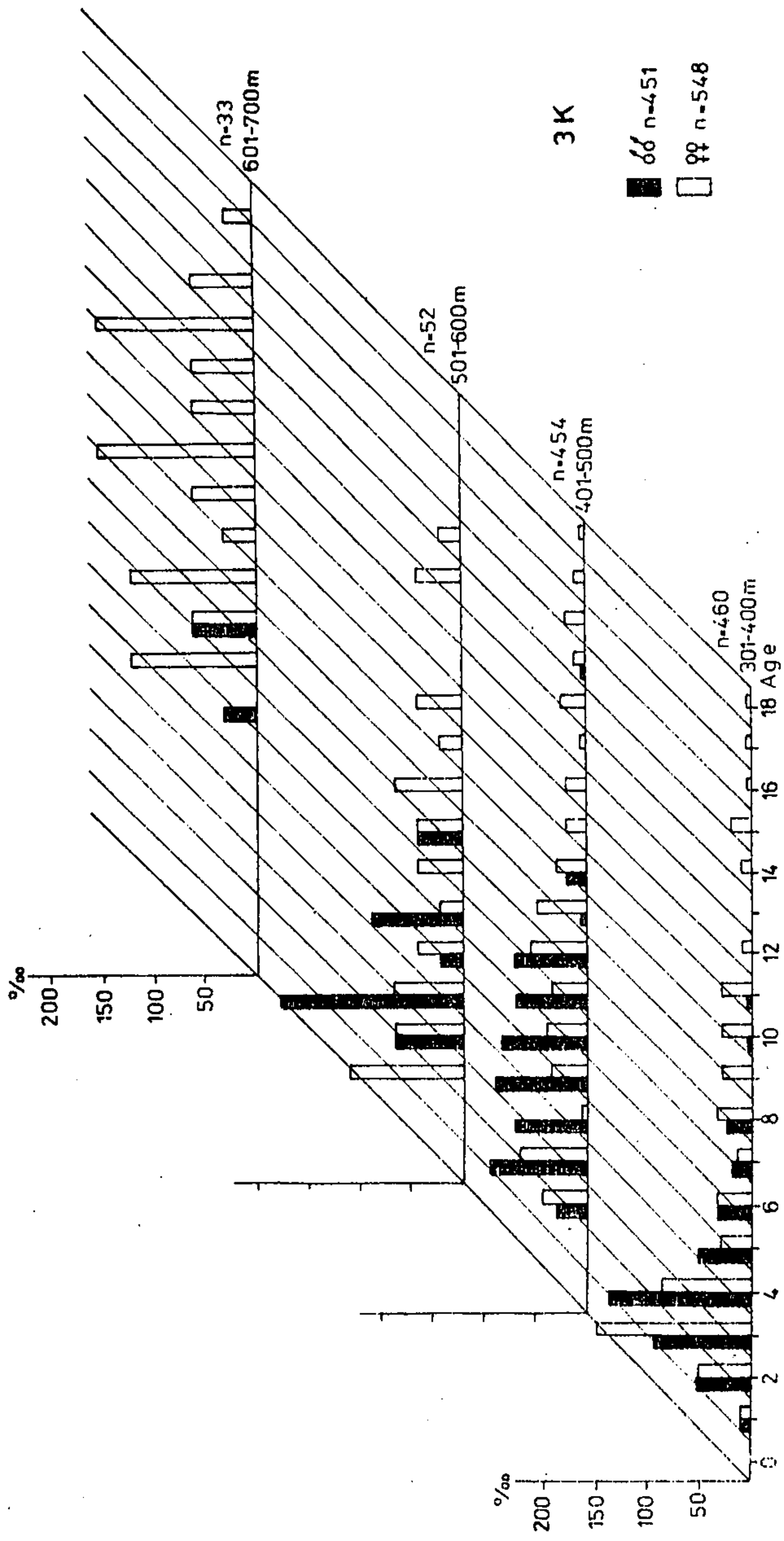

Fig. 11 E Division 3K

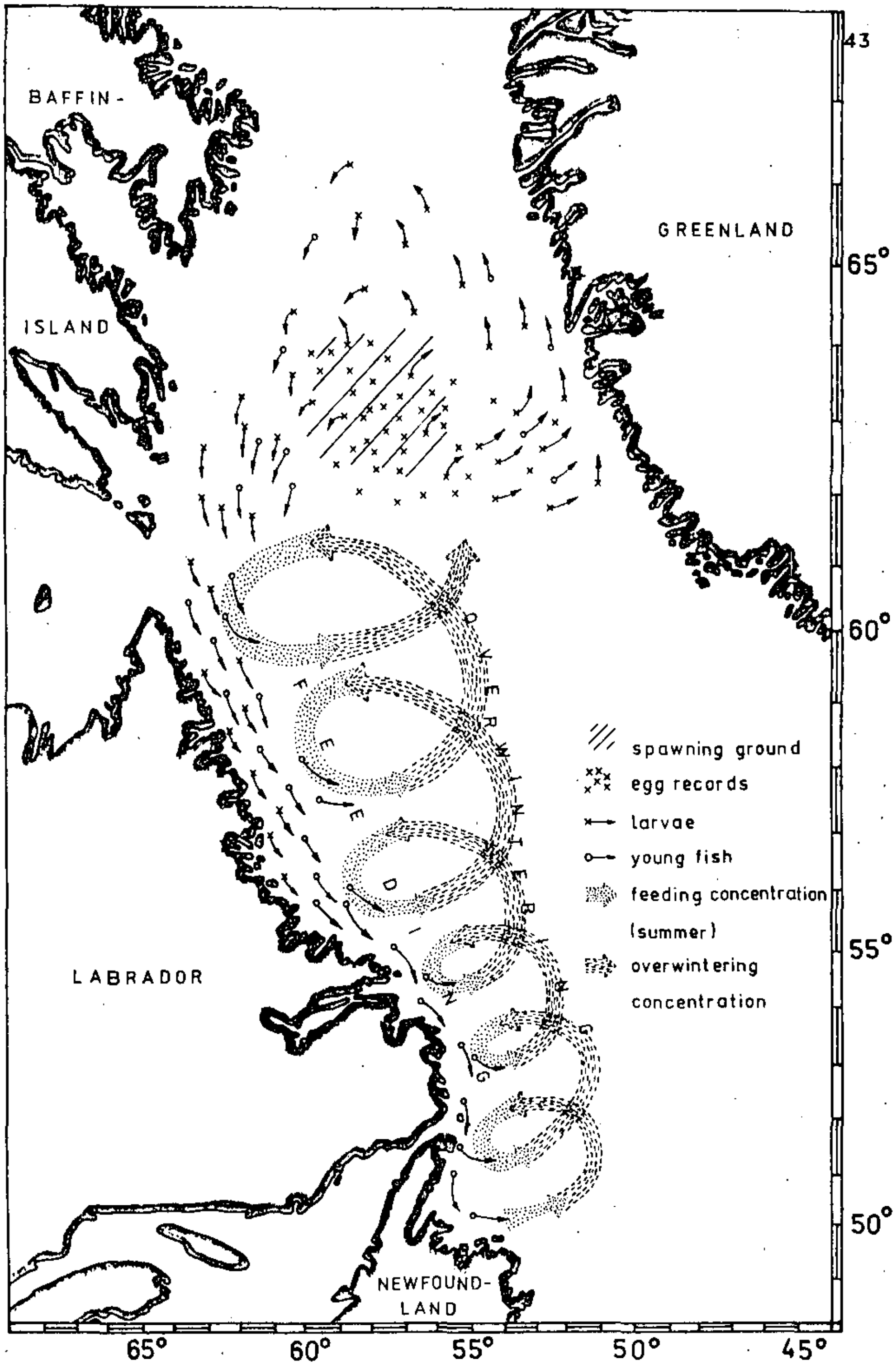

Fig.12 Spawning ground, larval drift and the migration of young fish of Greenland halibut stock off Canada and Westgreenland

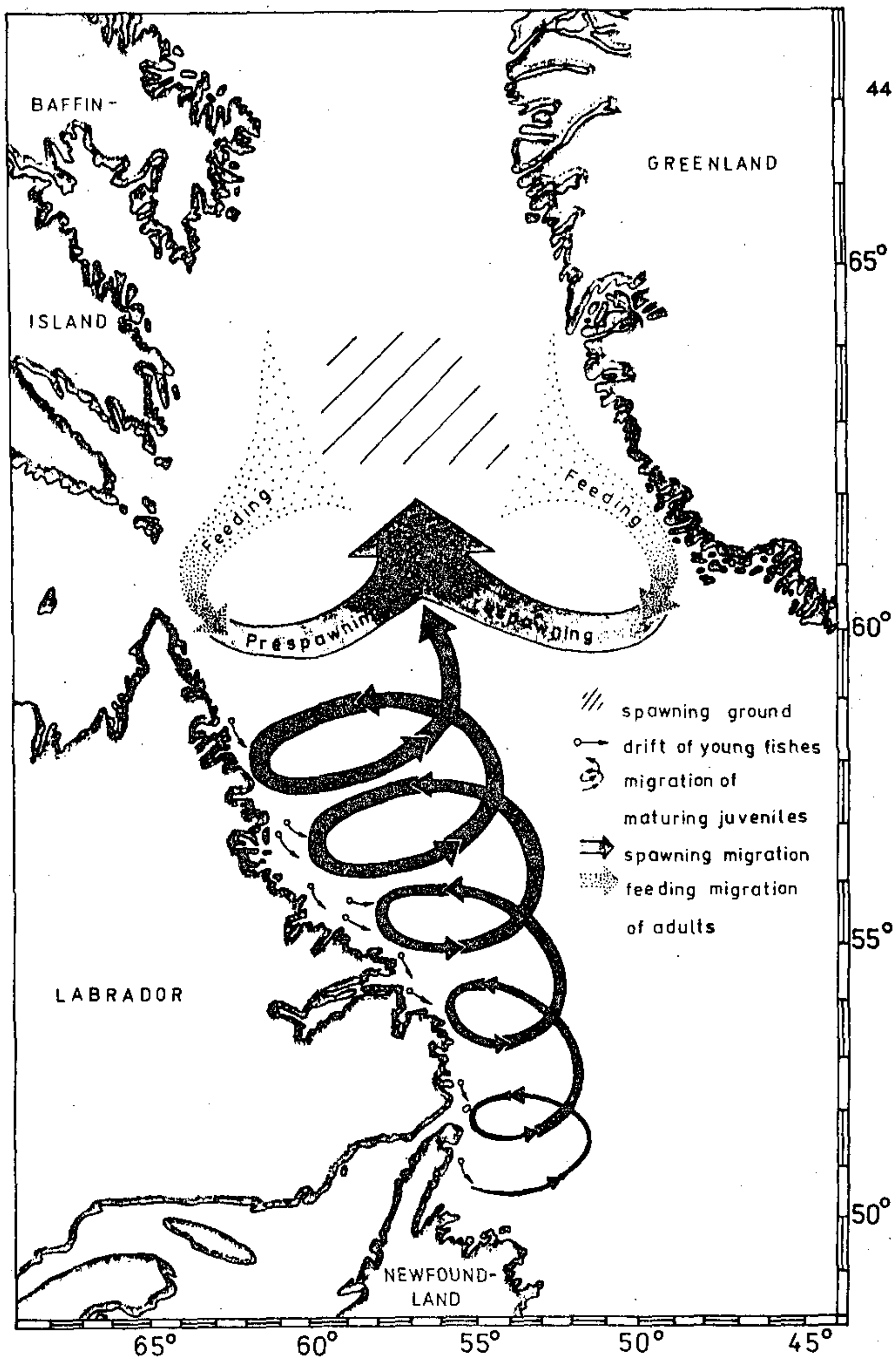

Fig.13 Migrations of the spawning and juvenile halibut off Canada and Westgreenland