Northwest Atlantic Fisheries Organization

Serial No. N1341

NAFO SCR Doc. 87/87

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1987

# Grenadier Fish in Icelandic Waters

by

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**Abstract**

The areal and depth distribution and the relative abundance of grenadier fish (*Coryphaenoides rupestris* Gunnerus and *Macrourus berglax* Lacépède) is described based on material collected mainly in the period 1976-1987 by research vessels. The areal distribution of the Roundnose is more restricted to warmer waters of mainly 4-6°C than that of the roughhead which was found all around Iceland and off East Greenland, mainly in temperatures of 3-5°C. Young stages of the roundnose are most abundant in depths greater than 900 m and a nursery ground is described off the SW coast of Iceland. Young stages of the roughhead are not observed in Icelandic waters but they are recorded off East Greenland.

The spawning period for both species extends over the whole year but seems to be more intensive in the winter months January-April. For the roundnose, there are indications of a second intensive spawning period in the summer possibly of a separate spawning stock.

Maturity is reached at an age of 14 years for male roundnose and the resp. anal-fin length is appr. 15 cm. The corresponding data for females are 16 years and 17.8 cm. Female roundnose grow faster than the males but the weight at length is similar for both sexes while there are considerable differences between male and female roughhead in this respect.

Some notes on the feeding of the two species are given.



## Introduction

Several species of Macrouridae are common in deep waters off Iceland. Only two of them are of potential commercial value, i.e. the roundnose grenadier (*Coryphaenoides rupestris* Gunnerus) and the roughhead grenadier (*Macrourus berglax* Lacépède). Both species have been subject to the commercial fishery particularly in the sixties and early seventies. The roundnose was caught by the Soviet fleet mainly in the sixties (Pechenik & Troyanovskii, 1970) off the S and SE coasts but the roughhead by the international fleet in connection with the fishery for Greenland halibut off the W and NW coasts. The magnitude of these fisheries is not known. Until now, the Icelandic fishing industy has not yet shown great interest in these species. Thus, there has not been any aimed grenadier fishery in Iceland. Icelandic trawlers do, however, occasionally get big catches of roundnose when engaged in the fishery for other species.

Since the mid seventies during some surveys, effort has been made to catch grenadier fish, in particular the roundnose. The results were, however, not satisfactory for the commercial fleet. Small incidental landings are of minor importance.

Recent publications on grenadier fish in Icelandic waters are not very many. Here are mainly to mention the Soviet scientists like Podrazhanskaya (1968, 1971), Savvatimsky (1969, 1971, 1983, 1984, 1985), Grigorev (1972), Pechenik & Troyanovskii (1970), Gushchin & Podrazhanskaya (1984). Further, information on grenadier fish in Icelandic waters has been given by Magnússon (1977, 1978 and in Ann. biol., Copenhagen, 1975-1983).

The purpose of this paper is to give an overall view on some biological aspects of the two species of grenadier based on material which has been collected more or less incidentally, mostly during the last decade.

## Material and methods

In late years, some cruises have been made to examine the possibility of exploiting deep sea species of fish in Icelandic waters. Additionally, during several other cruises, some effort

was put into fishing in deep water. The material here presented derives from these cruises and from single hauls of other cruises. Besides, some few samples were provided by the captains of Icelandic trawlers when they incidentally got catches of grenadier fish with bottom trawl.

Records on quantity and catch per unit effort were not kept in all instances. Therefore, the distribution charts here presented reflect only the locations where the resp. species were recorded regardless to density. However, localities with relatively high densities are indicated.

Length measurements of grenadiers, i.e. the total length are a well known problem in particular for the roundnose. A great part of the oldest material on roundnose could only partly be used because the length measurements were applied to the total length. The method of measuring snout to anal-fin (anal-fin length) was, however, commenced in 1978. A conversion factor was calculated in spite of the very limited number of intact specimens.

The measurements here used are expressed in 1/2 cm from the snout to the first ray of the anal-fin except for the youngest stages where the total length was measured. For the roughhead, the length measurements are expressed as total length because the tail of that particular species is by far not as often broken as that of the roundnose, the percentage lying in most cases below 5% per sample.

The length-weight relationship is obtained from samples frozen on board and weighted later in the laboratory at shore.

The maturity is divided into 4 stages: I = immature, II = maturing, III = spawning and IV = newly spent. Mature fish is thus classified into three groups.

For the age determination, scales were read and the dyeing method developed by Kosswig (1980) applied.

The material for the roundnose derived exclusively from bottom trawl catches while the material on the roughhead was obtained both by bottom trawl and by long-line the latter named in connection with the Greenland halibut fishery in the early seventies.

For the information on the areal division and on local names used in this paper, a chart was prepared (Fig. 1).

## Roundnose grenadier

### *Distribution and abundance*

The roundnose grenadier is common off the south and west coasts of Iceland (fig. 2). It is also common on the western slope of the Iceland-Faroe Ridge. Although there are no records on roundnose from the slope of the continental shelf off the SE coast of Iceland in our material, it is assumed that the roundnose is in fact very common in this area. There are even indications that the greatest concentrations might be found in this area. Thus, most of the reports on big catches (up to 30 tons in one haul, personal communication with captains of Icelandic trawlers) in relatively shallow waters are from the SE corner of Iceland, in winter and early spring. Besides, the Soviet fleet reportedly obtained good catches in this area in the sixties. The reason for the lack of observations from the SE area in our material is that the bottom in this particular region is unsuitable for trawling in depths which are considered optional for the abundance of roundnose.

From the N-, NE- and E-coasts there are no records on roundnose. Only few specimens have been recorded at two locations off East Greenland (not shown in Fig. 2).

An example of the abundance according to depth is indicated in Table 1 which shows the average catch per hour by area and depth regardless of time based on material from several cruises. In all areas, the average catch is best in depths greater than 800 m. The samples from depths less than 800 m are rather few except for the SW area. The biggest average catches were obtained in depths greater than 1000 m but it should be noted that in these depths, a great part of the catch consisted of juvenile fish.

For studying the distribution of young roundnose, the information had to be taken from the general samples because no special young fish survey had been carried out. Young fish is here defined as fish of 20 cm total length and smaller. Young stages of roundnose are found spread over a wide area along the continental slope. None have been recorded off East Greenland. They are extremely rare at the Iceland-Faroe Ridge. Off the NW and W coasts of Iceland (north of 65° N), they are frequently found but in small numbers. They are most abundant off the SW coast in particular in the area from the Reykjanes Ridge north to 64° N (Fig. 3). Small roundnose are also abundant at some locations between the Westman Islands and the Reykjanes Ridge. Young fish is seldom found in depths less than 800 m. On the whole, small roundnose is only found at relatively few localities in depths less than 900 m although then sometimes in considerable numbers. All these localities are to be found on both sides of the Reykjanes Ridge, i.e. within an area showing the greatest depth distribution and highest densities of young stages. The area, can thus be characterized as nursery ground for the roundnose. Small roundnose are frequent in depths over 900 m but in particular in catches taken in depths greater than 1000 m. In these depths, the small roundnose show the widest distribution.

The frequency of catches with young roundnose in different depths is as follows:

| Depth (m) | No of hauls | No of hauls with young | % |
|---|---|---|---|
| <600 | 29 | 1 | 3.5 |
| 600-800 | 66 | 8 | 13.3 |
| 800-1000 | 80 | 37 | 46.3 |
| >1000 | 40 | 28 | 70.0 |

The roundnose are observed in temperatures ranging from 2.5° C to 6.9° C in Icelandic waters regardless of area and depth. However, in the area of greatest abundance, i.e. in the SW and W area, they are most common in temperatures between 4° C and 6° C in depths greater than 800 m. Young stages are most abundant in temperatures about and below 5° C. On the western slope of the Iceland-Faroe Ridge, temperatures in which the roundnose were observed varied greatly, i.e. from 2.5° to 6.9° C and there, they were not linked to certain depths like in the SW area.

**Maturity and spawning**

Considerable effort was devoted to the study of maturity in anticipation of establishing the spawning time and region. Material from several years has been arranged by time and areas. Observations on maturity are available from all months except for December. Very few are from January, May, June and August. On the whole, maturity stage I (immature) was dominating in most months (Table 2) both for males (68.9%) and for females (69.2%). Further, females were much more numerous (62%) than males (38%).

The main difficulty in defining the spawning season lies in the fact that spawning grenadier appear extremely seldom in the bottom trawl catches which leads to the assumption that the grenadier spawn off the bottom i.e. bathypelagic and are therefore inaccessible to bottom trawl. The few direct observations on spawning specimens are spread over several months (Table 2 and 3). Spawning males were observed in all months except in January, June and August and spawning females were observed in February to July and in September. These observations were made regardless to area and they indicate that some spawning may take place in Icelandic waters to some extent more or less throughout the year.

In Fig. 4, the relative abundance of maturity stages II to IV of the whole material is shown by month.

Since the observations on spawning fish (stage III) only give very little information on the spawning habits, the distribution of mature fish of stages II and IV was studied on a monthly base. For both males and females, the two stages could be observed throughout the year. But the proportion differed considerably according to season. Fig. 5 demonstrates the relative abundance of fish with stages II and IV separately by sex and month. Considering the maturing fish (stage II), the highest percentages for males are observed in the months October to March with appr. 70 to 97% of mature males in stage II. The lowest values are observed in May and June (about 15%). Females show also the highest percentage of maturing fish (stage II) in September to November and the lowest ones in July, August and January. Newly spent males (stage IV) are most common in May and June but their frequency is lowest in the months October to March. The females on the other hand show a rather high frequency of newly spent fish (stage IV) throughout the year with the lowest percentages in September to November.

The material at hand is rather limited in some of the months as said before. This might certainly effect the total outcome. Nevertheless, it is obvious that at least some spawning takes place throughout the year in Icelandic waters as has been suggested before (Grigorev (1972), Magnússon (1977)). There seems to be, however, a more intensive spawning period during the winter months which might be the main spawning season. This is more obvious for males than for females. Moreover, looking at the proportional distribution over the months, there might be a second period of intensive spawning in the summer and consequently, a possibility of the existence of two spawning stocks, i.e. winter and summer spawners should not be excluded.

For studying possible areal differences in spawning, the material was arranged by stages and areas (Fig. 6 and Table 4). Again, the coverage per month is very limited in some instances. The indication of the spawning period - or periods of more intensive spawning - are more pronounced within the resp. areas than for the Icelandic area as a whole. This is in particular the case for the two areas W and SW. The observations in the area SE are too scarce to draw conclusions but they give some indications. The main spawning might take place in somewhat different times in the different areas at Iceland.

The spawning depth cannot be decided on by the material at hand, but all spawning specimens but one of this material were taken in depths of 600 to 1200 m. Only very few of the newly spent were taken in greater depths.

The proportion of mature fish at length reveal that 50% maturity is reached by males at an appr. anal-fin length of 15.0 cm while the females reach this point at an anal-fin. length of about 17.8 cm.

**Length measurements**

It has proved extremely difficult to find roundnose in the catches with the tail intact so that total length measurements could be carried out. The record of intact specimens throughout the years is therefore small (60 males and 121 females). For these specimens, the total length was found to be highly correlated with the anal-fin length, for both males and females of roundnose. The ratio of anal-fin length to total length was calculated to be 0.212 which is in good accordance with the ratio given by Atkinson (1981) for the roundnose in the NW Atlantic. The slope of the regression line for the sexes separately differs, however, somewhat perhaps because of the scarcity of specimens both in the lower and higher ranges

resulting in a slope difference of 1.3 cm in total length corresponding to 16 cm anal-fin length.

**Age and growth**

The roundnose in Icelandic waters shows a different growth rate for males and females. In Table 5, the calculated length at age is given for males and females separately and in Fig. 7, the calculated age/length curves for both sexes is shown. The growth rate of the females is considerably higher than that of the males.

There is a great range in length within each age group like it is commonly observed by deep-sea fishes as e.g. for redfish. With reference to the maturity at length, the males mature (50%) at an age of about 14 years but the females of about 16 years.

The age/length key was applied on samples taken during cruises in 1984, 85 and 87 to give an idea of the age composition of roundnose in Icelandic waters (Table 6). It should be noted that the application was restricted to lengths which the ageing covered. The majority of the roundnose was of age 12 to 16.

**Weight**

A total of 1058 roundnose were weighted (ungutted). The material derives from the years 1984, 1985 and 1987. The overall calculated weight for the three years combined for the sexes is shown in Fig. 8, the length being expressed as anal-fin length in 1/2 cm.

Some information on gutted fish was received by one sample (387 sps.). The conversion factor for gutted roundnose was calculated and proved to be 1.064. This relationship was highly correlated r, being 0.9998.

The length/weight relationship is very similar for males and females. Looking into the relation weight at age, there are distinct differences, the females being heavier at the same age (Table 7). The males, e.g. at their age of maturity, i.e. 14 years weigh 646 gr while the females of 14 years weigh 825 gr. Females of 16 years (age of maturity) weigh 1135 gr., but males at that age 844 gr.

**Feeding**

During the period of the investigations, frequently some notes were made as to the stomach contents of the roundnose mostly though without any detailed analysis. Euphausids are by far the most common species mentioned both in frequency and quantity. Other deep-sea crustaceans as e.g. unidentified deep-sea shrimps were not uncommon. Less common were small squid, medusae, Myctophanes spp. and several other species of the deep-sea community. In Table 8, the results are given from a random sample of 132 fishes taken in 700 to 730 m depth, in September 1975, with a length range of 38 to 96 cm total length. All fish were of maturity stages I and II. According to this sample, the feeding habits of males and females are very similar which is also confirmed by less systematic observations. Further, it confirms the predomination of Euphausids in the diet. Usually the stomachs of individual fish contained only one group of food. Rather seldom, the diet was more variable.

## Roughhead grenadier

**Distribution and abundance**

The distribution of the roughhead in Icelandic waters and at East Greenland has already been described (Magnússon 1978). Additional information in later years show that this species has a considerably wider distribution than described before (Fig. 9). Besides being common off the N and NW coasts of Iceland, it has also been recorded off the S and E coasts and on the Iceland/Faroe Ridge. Further, at East Greenland its distribution extends farther south than described earlier (to 62° 30'N). In general terms, the roughhead is found all around Iceland and has thus a much wider distribution than the roundnose though it is most abundant in the Dohrn Bank-Víkuráll area W of Iceland. In the other areas, it is in general only recorded in minor quantities usually as single specimens.

**Depth**

The roughhead is found in a great variety of depths. It has been recorded from 295 m to 1260 m depth. The depth range is, however, variable for the different areas. Thus , e.g. in the slope area west of Iceland north of the Reykjanes Ridge, it has not been recorded in depths less than 400 m. In the Víkuráll area, the roughhead was not observed in depths less than 500 m but there it is quite common in depths from 600 m to 900 m, in temperatures from 4°C to 5°C. In the Dohrn Bank area where the roughhead is most common, it has been found in depths of less than 300 m down to 1000 m but mainly in depths from 500 to 800 m and especially between 700-800 m, in temperatures from 3° C to 5°C.

At East Greenland, it has been recorded in depths less than 300 m down to 700 m.

Thus, the roughhead is found in shallower waters in the Dohrn Bank area and at East Greenland than west of Iceland.

Contrary to the roundnose, young stages of roughhead have not been observed in Icelandic waters and only in very limited numbers off East Greenland. During the series of 0-group research (1970 to 1987), only once an 0-group grenadier was observed, a roughhead (47 mm in size) off East Greenland (62°00'N 40°44'W), in 50 m depth (Vilhjálmsson and Magnússon, 1982). Few specimens of small roughhead were observed over the East Greenland shelf, in depths from 250 to 560 m, in the area from 60°30'N to 65°20'N, in lengths smaller than 20 cm total length, in October 1985. These findings have not been included in the distribution chart. (Fig. 9).

**Maturity**

It has been suggested that the main spawning of roughhead takes place in February to May mainly in the Dohrn Bank-Víkuráll area (Magnússon 1978). Additional material from February 1985 and 1987, from the Dohrn Bank area and West Iceland confirm this and show that quite intensive spawning is already going on in February (Table 9). But some few specimens (26) collected at different localities in the SW area of Iceland, in September 1985, indicate that some spawning is still going on at that time. Thus, about 39% (7) of the males (18) were of stage III while all the females (8) were of stage IV.

The main spawning area was described in 1978 (Magnússon 1978) based on findings of spawning females and of bathypelagic eggs. Additional information collected in later years support these findings.

**Length**

Length measurements of the roughhead have not been as problematical as for the roundnose. Only a fracture of the measured specimens had a damaged tail. Therefore, the greatest part of the older measurements could be used and in fact, information given in this paper are mostly expressed in total length measuements. However, when the anal-fin length measurements were commenced in Iceland in 1978, they were also applied for the roughhead. The total length was highly correlated to the anal-fin length, the correlation coefficient (r) being 0.9734. The ratio of anal-fin length to total length was calculated and proved to be 0.3835.

**Weight**

The material for the calculation of the length/weight relationship was not very extensive and the length/weight curve was calculated for both sexes combined (Fig. 10). However, the limited material indicated a considerable difference in length/weight for males and females (Fig. 11). Thus, e.g., at a length of 60 cm, the females weigh appr. 250 gr more than the males of the same length.

**Age**

Only few specimens of roughhead in Icelandic waters have been aged. The range was 9 to 19 years and the resp. length range 46 to 83 cm total length. This range in age is simlar to that observed for the roundnose.

**Feeding**

The menue of the roughhead is quite different from that of the roundnose. Several species of small deep-sea fish seem to be preferred by the roughhead but Euphausids and other crustaceans as well as squid and medusae were also recorded.

Fish species identified in the stomach contents were such as *Bathylagus euryops, Mallotus villosus, Stomias boa ferox, Malacosteus niger, Myctophidae spp., Onogadus argentatus, Careproctus reinhardti* and *Lycodes* spp.

**Parasites**

A notable number of roughhead were infested by *Sphyrion lumpi*, a parasite not observed on the roundnose but quite common on redfish in particular of the Irminger Sea oceanic stock.

**Discussion**

In general, the information gathered here on the roundnose and roughhead in Icelandic

waters reveal what has already emerged in numerous studies on the two species in other regions, i.e. there are sometimes considerable difference as to certain biological aspects of the populations in the various regions.

As has been pointed out here, the distribution and abundance of roundnose and roughhead in Icelandic waters differ. The roughhead is found all around Iceland while the roundnose is limited mainly to the southern and western coasts. Parsons (1976) also reports a wider distribution of roughhead than roundnose off the Canadian area of the NW Atlantic. In agreement is also the difference in the depth distribution of the two species. Like in Iceland, the roughhead is found in shallower waters. However, in Iceland, the main depth for this species is greater: 500 to 800 m which is also about the range given for the roughhead off Norway (Eliassen, 1983). The roundnose is most common in depths greater than 700 m in Icelandic waters and is thus observed in deeper waters than the roughhead like in the NW Atlantic (Parsons 1976). However, these conditions seem to be reversed for the two species in Norwegian waters (Eliassen, 1983). Young stages of roundnose are very abundant in Icelandic waters and their densities indicate rather extensive nursery areas not reported as far as known from other regions. Since the roundnose spawns in Icelandic waters and all sizes and maturity stages of this species have been observed, we assume that the roundnose at Iceland can be considered as a separate population or stock. Accumulations of young stages of roughhead have not been observed in Icelandic waters so far as known but spawning roughhead and bathypelagic eggs of the roughhead were observed in the Dohrn Bank area (Magnússon 1978) and young stages farther south on the East Greenland shelf suggesting a possible drift of eggs and fry southwards along the East Greenland coast even around Cape Farewell.

In general, considerable effort has been put into determining the spawning season of the roundnose (e.g. Savvatimsky 1969, Podrazhanskaya 1971, Marshall 1965, Geistdoerfer 1979, Grigorev 1972, Magnússon 1977). The two opinions of year round spawning and seasonal spawning are in fact both supported by our findings. The spawning season of the roughhead off Iceland and in the Dohrn Bank area has been described earlier (Magnússon 1977, 1978) and is confirmed by this presentation. It is also observed for the roughhead of the East Grand Bank area (Savvatimsky, 1984) and off the Norwegian coast (Savvatimsky, 1985). Our observations confirm the findings of Savvatimsky (1972) that the roundnose is a long-lived, slow-growing and late-maturing fish. In Icelandic waters, maturity (50%) is reached at an age of 14 and 16 years for males and females resp. According to Kosswig (1986), the roundnose grows faster in the waters W of Britain and the Faroe Islands and according to Eliassen (1986) also in Norwegian waters.

The length-weight relationship of the male and female roundnose was very similar while it differed considerably for the roughhead. However, Savvatimsky (1984) found no difference in the length-weight relation of the roughhead caught with long-line in the Eastern Grand Bank area.

Observations on feeding confirm the findings of Podrazhanskaya (1968) and Guschin & Podrazhanskaya (1984) that crustaceans are the major food component of the roundnose in the slope area at Iceland.

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Table 1. Roundnose. Catch pr hr (kg) and no of hauls by area and depth. (Records of the years 1974-1985 regardless of season)

| Depth (m)/ Area | NW | | W | | SW+S | |
|---|---|---|---|---|---|---|
| | No.h. | Catch | No.h. | Catch | No.h. | Catch |
| 600 | - | - | 2 | 21 | 26 | 43 |
| 600-800 | 2 | 7 | 3 | 51 | 59 | 136 |
| 800-1000 | 8 | 224 | 25 | 278 | 38 | 186 |
| 1000 | - | - | 13 | 284 | 21 | 235 |
| Total | 10 | | 43 | | 144 | |
| Average catch | | 180 | | 251 | | 147 |

Table 2. Roundnose. Distribution of maturity stages by month for males and females separately.

Males

| Month/stage | I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % |
| Jan | 4 | 26.7 | 10 | 66.7 | - | - | 1 | 6.6 |
| Feb | 716 | 60.0 | 332 | 27.8 | 7 | 0.6 | 138 | 11.7 |
| Mar | 2334 | 74.0 | 760 | 24.1 | 3 | 0.1 | 56 | 1.8 |
| Apr | 520 | 70.3 | 111 | 15.0 | 19 | 2.6 | 90 | 12.2 |
| May | 78 | 49.4 | 15 | 9.5 | 1 | 0.6 | 64 | 40.5 |
| Jun | 25 | 32.9 | 10 | 13.2 | - | - | 41 | 53.9 |
| Jul | 381 | 64.1 | 136 | 22.9 | 5 | 0.8 | 72 | 12.1 |
| Aug | 171 | 92.9 | 8 | 4.3 | - | - | 5 | 2.7 |
| Sep | 318 | 63.9 | 91 | 18.3 | 21 | 4.2 | 68 | 13.6 |
| Oct | 221 | 91.7 | 18 | 7.5 | 1 | 0.4 | 1 | 0.4 |
| Nov | 539 | 63.3 | 304 | 35.7 | 1 | 0.1 | 7 | 0.8 |
| Total | 5307 | 68.9 | 1795 | 23.3 | 58 | 0.8 | 543 | 7.0 |

Females

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Jan | 8 | 26.7 | 2 | 6.7 | - | - | 20 | 66.7 |
| Feb | 1107 | 57.5 | 165 | 8.6 | 5 | 0.3 | 647 | 33.6 |
| Mar | 3204 | 78.7 | 207 | 5.1 | 2 | 0.1 | 658 | 16.1 |
| Apr | 1003 | 67.8 | 84 | 5.7 | 6 | 0.4 | 386 | 26.1 |
| May | 113 | 35.5 | 59 | 18.6 | 3 | 0.9 | 143 | 45.0 |
| Jun | 157 | 43.9 | 78 | 21.8 | 2 | 0.6 | 121 | 33.8 |
| Jul | 886 | 70.6 | 30 | 2.4 | 6 | 0.5 | 333 | 26.5 |
| Aug | 202 | 87.8 | 2 | 0.9 | - | - | 26 | 11.3 |
| Sep | 384 | 60.0 | 137 | 21.4 | 2 | 0.3 | 117 | 18.3 |
| Oct | 185 | 67.0 | 40 | 14.5 | - | - | 51 | 18.5 |
| Nov | 1419 | 73.1 | 205 | 10.6 | - | - | 317 | 16.3 |
| Total | 8668 | 69.2 | 1009 | 8.1 | 26 | 0.2 | 2819 | 22.5 |

Table 3. Roundnose. Maturity stages II, III and IV by months for males and females separately.

| Months/Stages | Males | | | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | II | | III | | IV | | II | | III | | IV | |
| | No | % | No | % | No | % | No | % | No | % | No | % |
| Jan | 10 | 90.9 | - | - | 1 | 9.1 | 2 | 9.1 | - | - | 20 | 90.9 |
| Feb | 332 | 69.6 | 7 | 1.5 | 138 | 28.9 | 165 | 20.2 | 5 | 0.6 | 647 | 79.2 |
| Mar | 760 | 92.8 | 3 | 0.4 | 56 | 6.8 | 207 | 23.9 | 2 | 0.2 | 658 | 75.9 |
| Apr | 111 | 50.5 | 19 | 8.6 | 90 | 40.9 | 84 | 17.7 | 6 | 1.3 | 386 | 81.0 |
| May | 15 | 18.8 | 1 | 1.3 | 64 | 80.0 | 59 | 28.8 | 3 | 1.5 | 143 | 69.7 |
| Jun | 10 | 19.6 | - | - | 41 | 80.4 | 78 | 38.8 | 2 | 1.0 | 121 | 60.2 |
| Jul | 136 | 63.9 | 5 | 2.4 | 72 | 33.8 | 30 | 8.2 | 6 | 1.6 | 330 | 90.2 |
| Aug | 8 | 61.5 | - | - | 5 | 38.5 | 2 | 7.1 | - | - | 26 | 92.9 |
| Sep | 91 | 50.6 | 21 | 11.7 | 68 | 37.8 | 137 | 53.5 | 2 | 0.8 | 117 | 45.7 |
| Oct | 18 | 90.0 | 1 | 5.0 | 1 | 5.0 | 40 | 44.0 | - | - | 51 | 56.0 |
| Nov | 304 | 97.4 | 1 | 0.3 | 7 | 2.2 | 205 | 39.3 | - | - | 317 | 60.7 |

Table 4. Roundnose. Maturity stages II and IV by area and month, in %

| Month/Area | W | | | | SW | | | | SE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stage | II | | IV | | II | | IV | | II | | IV | |
| | ♂♂ | ♀♀ | ♂♂ | ♀♀ | ♂♂ | ♀♀ | ♂♂ | ♀♀ | ♂♂ | ♀♀ | ♂♂ | ♀♀ |
| Jan | | | | | | | | | 90.9 | 9.1 | 9.1 | 90.9 |
| Feb | 51.4 | 5.0 | 47.4 | 95.1 | 88.0 | 25.9 | 12.0 | 74.1 | 87.8 | 44.9 | 9.2 | 53.9 |
| Mar | 88.8 | 35.4 | 10.9 | 64.5 | 86.3 | 8.4 | 11.4 | 91.6 | 60.7 | 21.5 | 7.2 | 76.0 |
| Apr | 12.0 | 2.8 | 88.0 | 97.2 | 54.3 | 14.7 | 35.5 | 83.7 | 75.9 | 41.8 | 24.1 | 58.2 |
| May | 66.7 | - | 33.3 | - | 12.7 | 28.8 | 85.9 | 69.8 | - | - | - | - |
| Jun | 40.0 | 30.0 | 60.0 | 70.0 | 17.4 | 39.3 | 82.6 | 59.7 | - | - | - | - |
| Jul | 45.8 | 20.7 | 54.2 | 78.7 | 83.5 | 46.6 | 15.4 | 51.6 | 56.4 | - | 33.3 | 99.0 |
| Aug | 57.2 | 11.1 | 42.9 | 88.9 | 66.7 | - | 33.3 | 100.0 | - | - | - | - |
| Sep | 97.9 | 100.0 | 2.1 | - | 36.5 | 35.7 | 62.6 | 63.2 | 24.0 | 10.0 | - | 90.0 |
| Oct | 100.0 | 100.0 | - | - | - | - | 100.0 | 100.0 | 92.3 | 42.5 | - | 57.5 |
| Nov | 99.5 | 36.5 | 0.5 | 63.6 | 92.6 | 43.0 | 6.3 | 56.1 | - | - | - | - |

Table 5. Roundnose. Mean length at age (1984-1985) for males and females separately

| | males | | females | |
|---|---|---|---|---|
| Age | no | 1/2 cm | no | 1/2 cm |
| 8 | - | - | 3 | 19.65 |
| 9 | 1 | 22.02 | 2 | 21.74 |
| 10 | 7 | 23.68 | 5 | 23.80 |
| 11 | 6 | 25.29 | 6 | 25.83 |
| 12 | 13 | 26.86 | 24 | 27.84 |
| 13 | 27 | 28.39 | 26 | 29.82 |
| 14 | 30 | 29.88 | 26 | 31.78 |
| 15 | 14 | 31.33 | 15 | 33.72 |
| 16 | 15 | 32.76 | 22 | 35.65 |
| 17 | 7 | 34.16 | 9 | 37.55 |
| 18 | 3 | 35.54 | 6 | 39.45 |
| n | 123 | | 144 | |

Table 6. Age composition of roundnose grenadier in Icelandic waters 1984-1987.

| | males | | females | |
|---|---|---|---|---|
| Age | no | % | no | % |
| 8 | - | - | 105 | 2.6 |
| 9 | 63 | 2.6 | 34 | 0.8 |
| 10 | 261 | 10.9 | 106 | 2.6 |
| 11 | 80 | 3.3 | 109 | 2.7 |
| 12 | 177 | 7.4 | 513 | 12.7 |
| 13 | 467 | 19.4 | 678 | 16.8 |
| 14 | 595 | 24.8 | 611 | 15.1 |
| 15 | 297 | 12.4 | 416 | 10.3 |
| 16 | 259 | 10.8 | 891 | 22.1 |
| 17 | 157 | 6.5 | 285 | 7.1 |
| 18 | 48 | 2.0 | 291 | 7.2 |
| Total | 2404 | 100.1 | 4039 | 100.0 |

Table. 7. Roundnose. Weight at age for males and females separately

| Age | males (gr) | females (gr) |
|---|---|---|
| 8 | - | 215 |
| 9 | 267 | 286 |
| 10 | 329 | 368 |
| 11 | 398 | 462 |
| 12 | 475 | 569 |
| 13 | 557 | 690 |
| 14 | 646 | 825 |
| 15 | 741 | 973 |
| 16 | 844 | 1135 |
| 17 | 953 | 1313 |
| 18 | 1068 | 1506 |

Table 8. Roundnose. Information on the stomach content of 132 fishes (45 males and 87 females)

| | males | | females | | total | |
|---|---|---|---|---|---|---|
| Stomach | no | % | no | % | no | % |
| Empty | 3 | 6.7 | 7 | 8.0 | 10 | 7.6 |
| Everted | 15 | 33.3 | 20 | 23.0 | 35 | 26.5 |
| With content | 27 | 60.0 | 60 | 69.0 | 87 | 65.9 |
| Total | 45 | | 87 | | 132 | |
| Stomach content | | | | | | |
| Euphausids | 24 | 85.7 | 56 | 93.3 | 80 | 90.9 |
| Shrimps | - | - | 1 | 1.7 | 1 | 1.1 |
| Fish | 1 | 3.6 | 1 | 1.7 | 2 | 2.3 |
| Not recognizable | 3 | 10.7 | 2 | 3.3 | 5 | 5.7 |

Table 9. Roughhead. Materity stages in area W in Feb. 1985 and Dohrn Bank Feb. 1987

| | | I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|---|---|
| Time | Area | no | % | no | % | no | % | no | % |
| **Males** | | | | | | | | | |
| Feb. 1985 | W | 10 | 13.3 | 48 | 64.0 | 10 | 13.3 | 7 | 9.3 |
| Feb. 1987 | DB | 11 | 13.6 | 64 | 79.0 | 4 | 4.9 | 2 | 2.5 |
| **Females** | | | | | | | | | |
| Feb. 1985 | W | 51 | 33.3 | 39 | 25.5 | 2 | 1.3 | 61 | 39.9 |
| Feb. 1987 | DB | 54 | 28.7 | 35 | 18.6 | 7 | 3.7 | 92 | 48.9 |

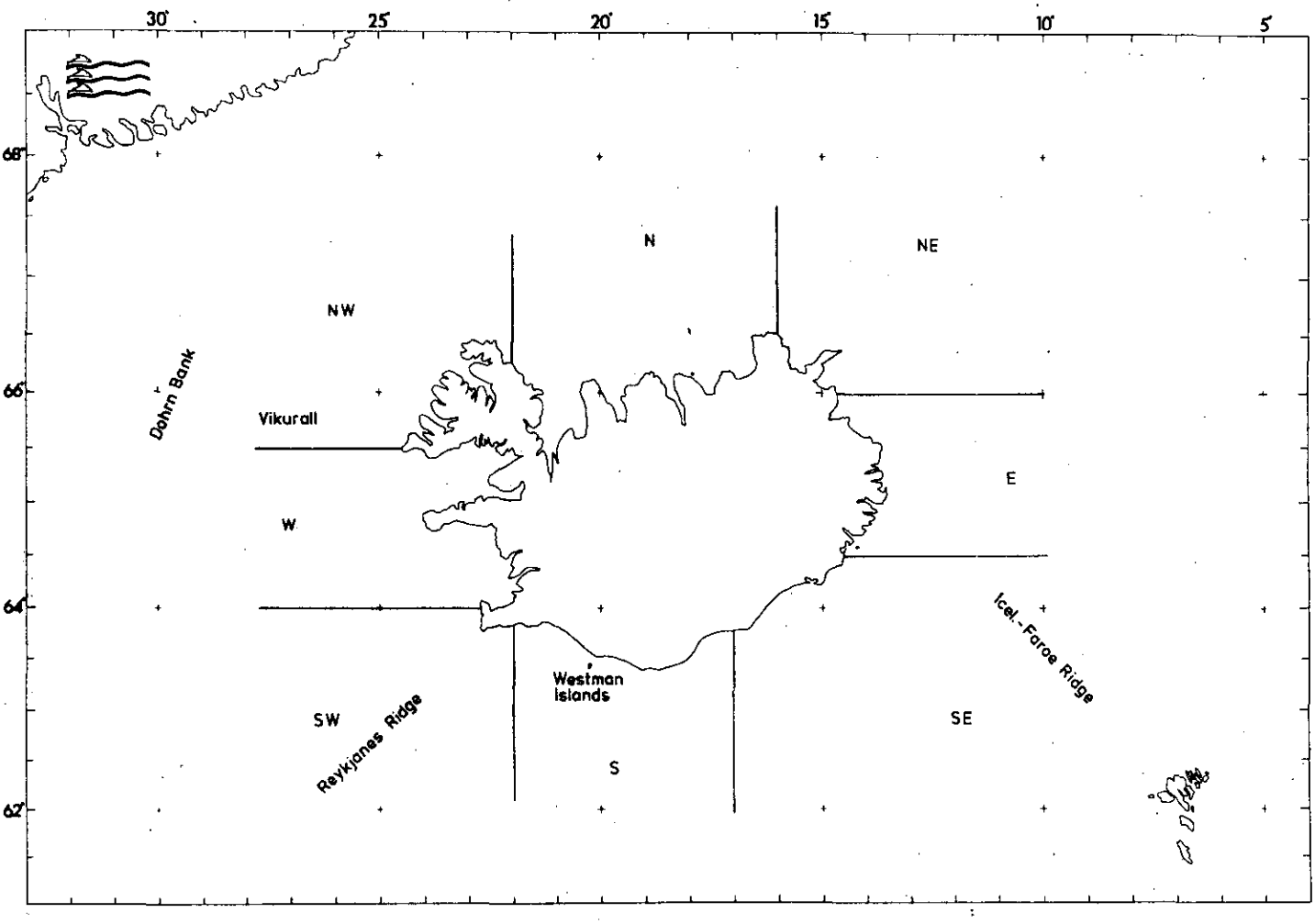


Fig. 1. Iceland. Area division and local names used in the paper.

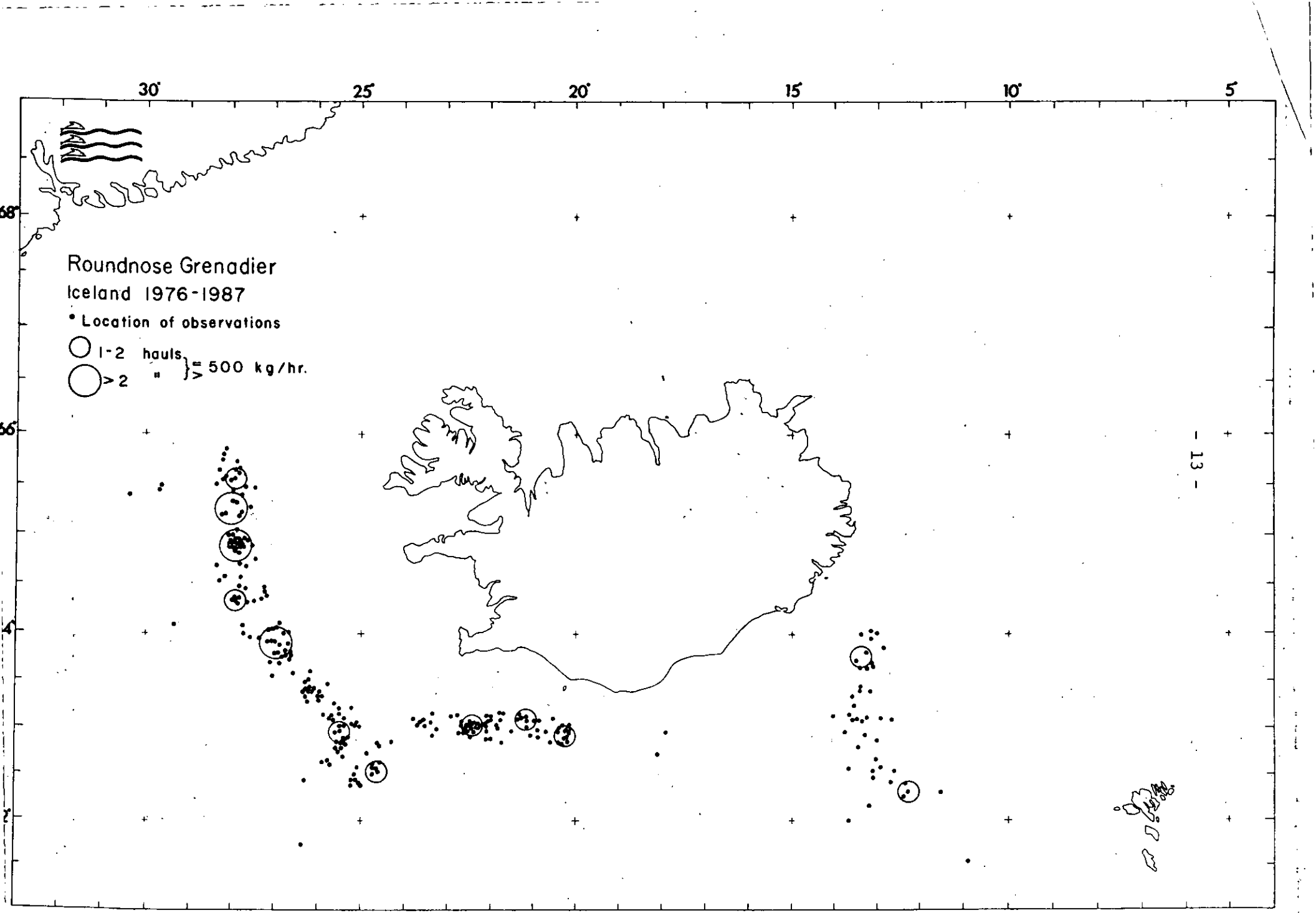




Fig. 2. Roundnose grenadier. Distribution in Icelandic waters based on catches from research cruises.

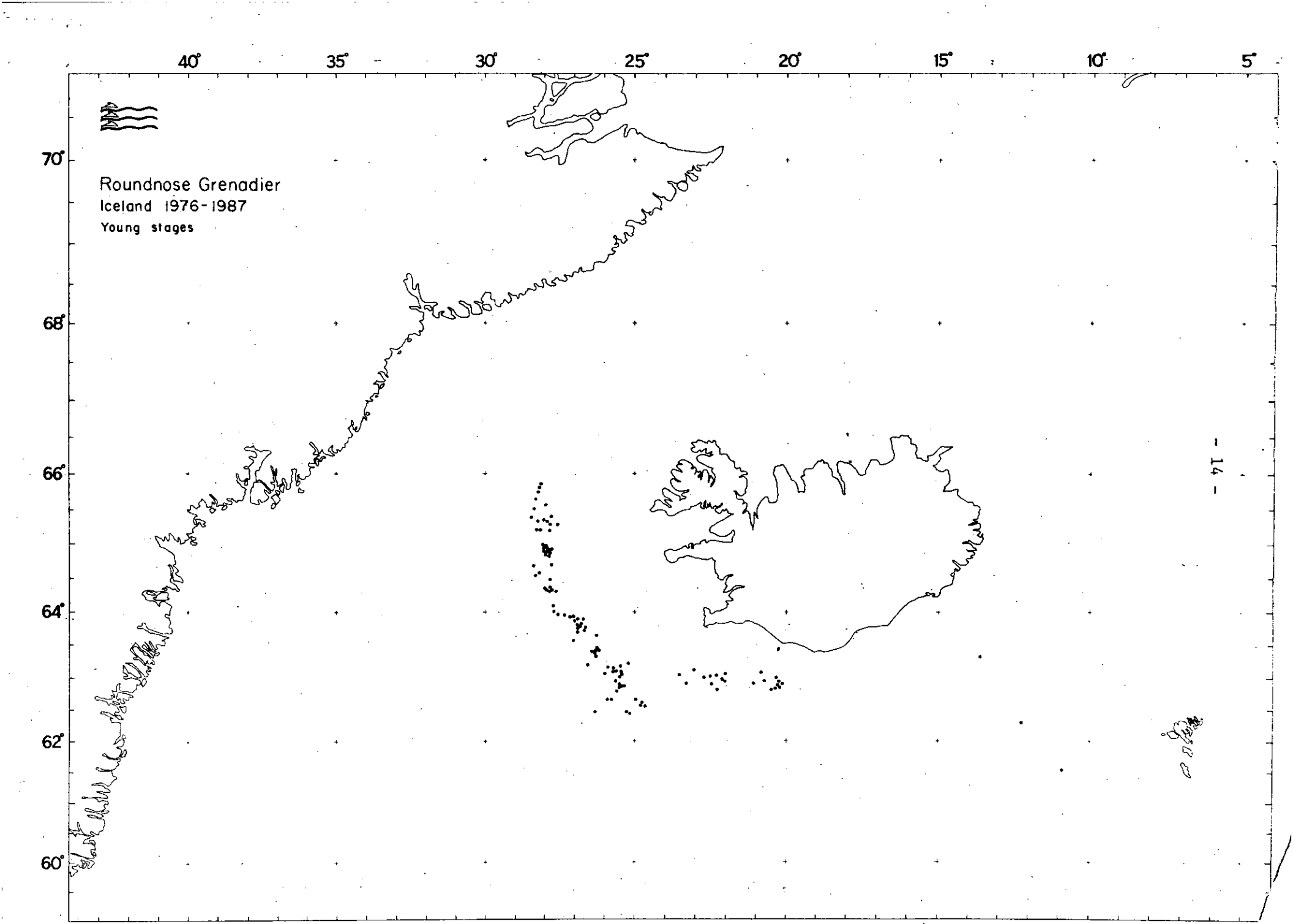


Fig. 3. Roundnose grenadier. Distribution of young stages (≦ 20 cm total length).

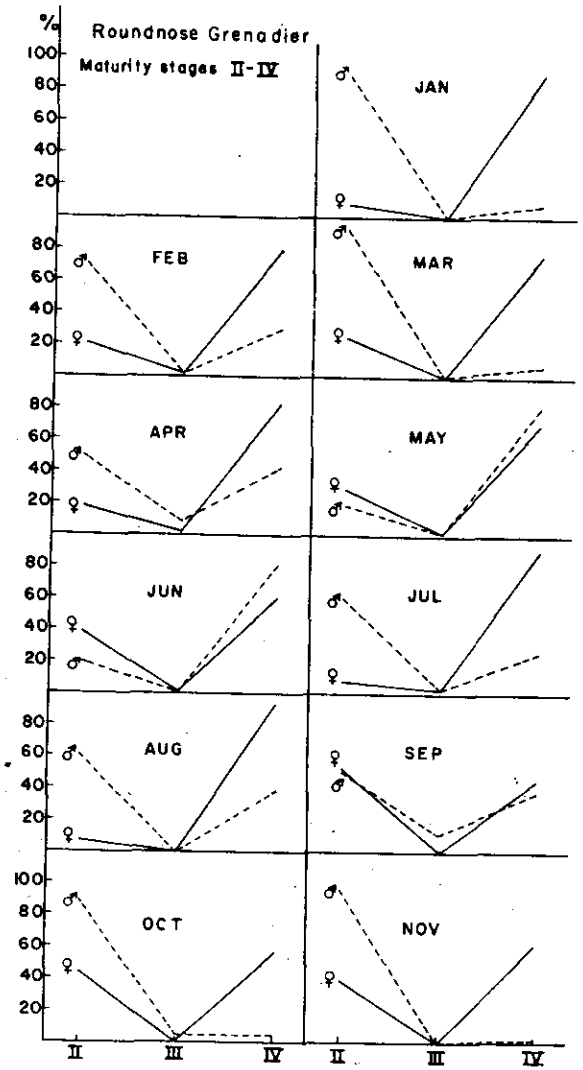


Fig. 4. Roundnose grenadier. Percentage of maturity stages II, III and IV by sex and month.

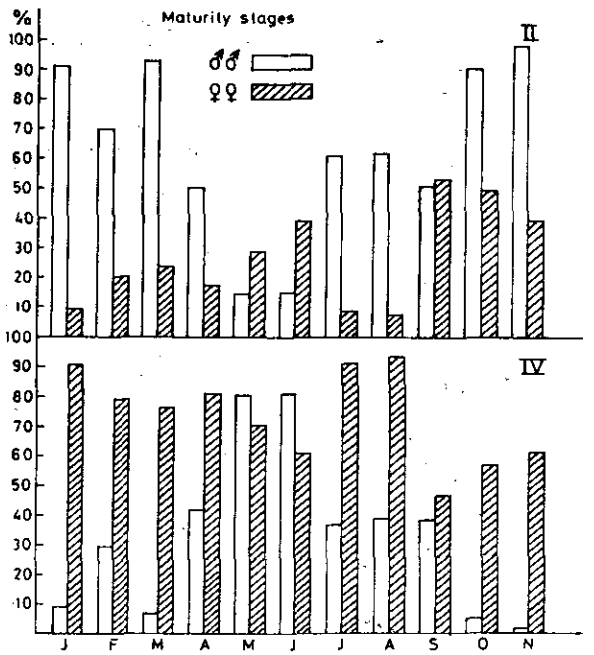


Fig. 5. Roundnose grenadier. Maturity stages II and IV for males and females by month.

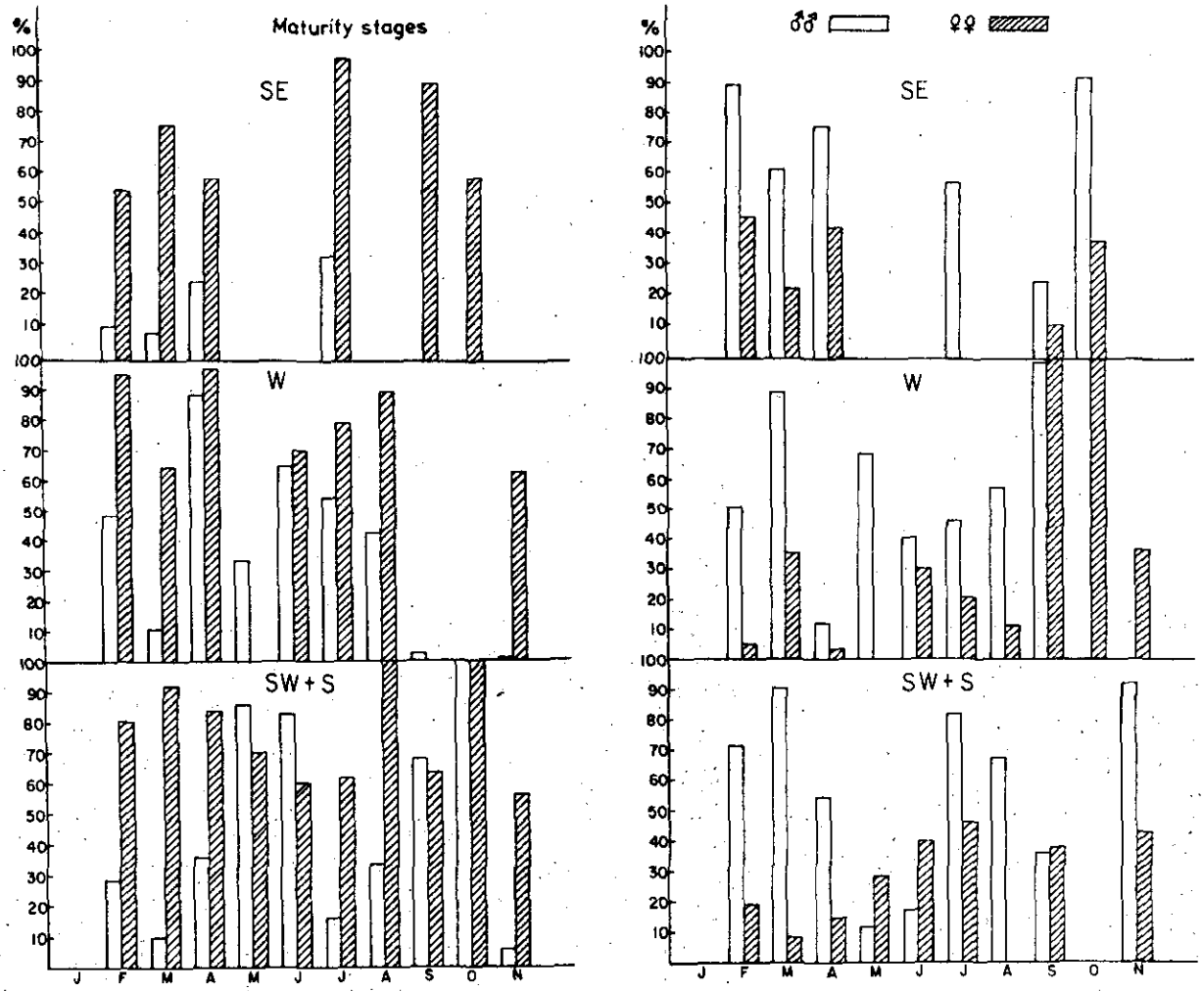


Fig. 6. Roundnose grenadier. Maturity stages II and IV for males and females by area and month.

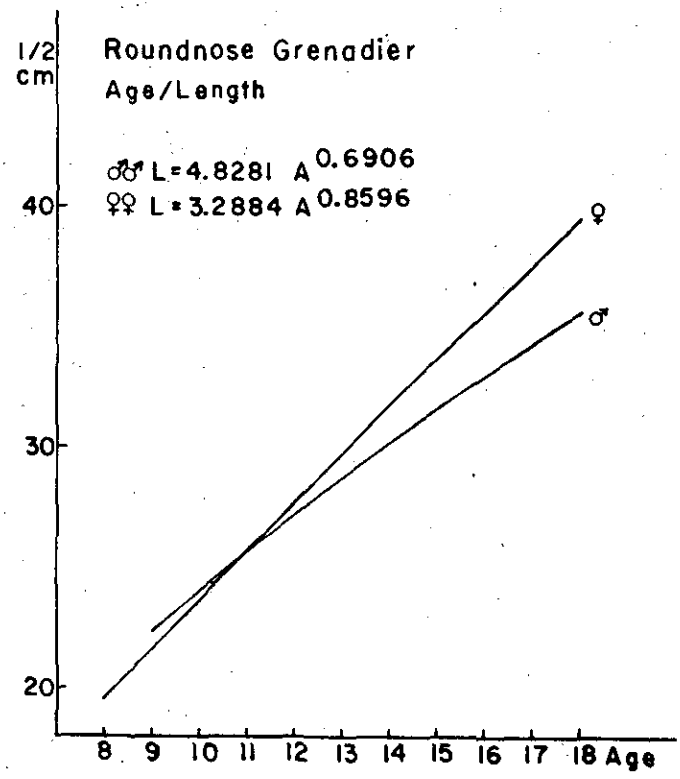


Fig. 7

Roundnose grenadier. Length at age for males and females separately

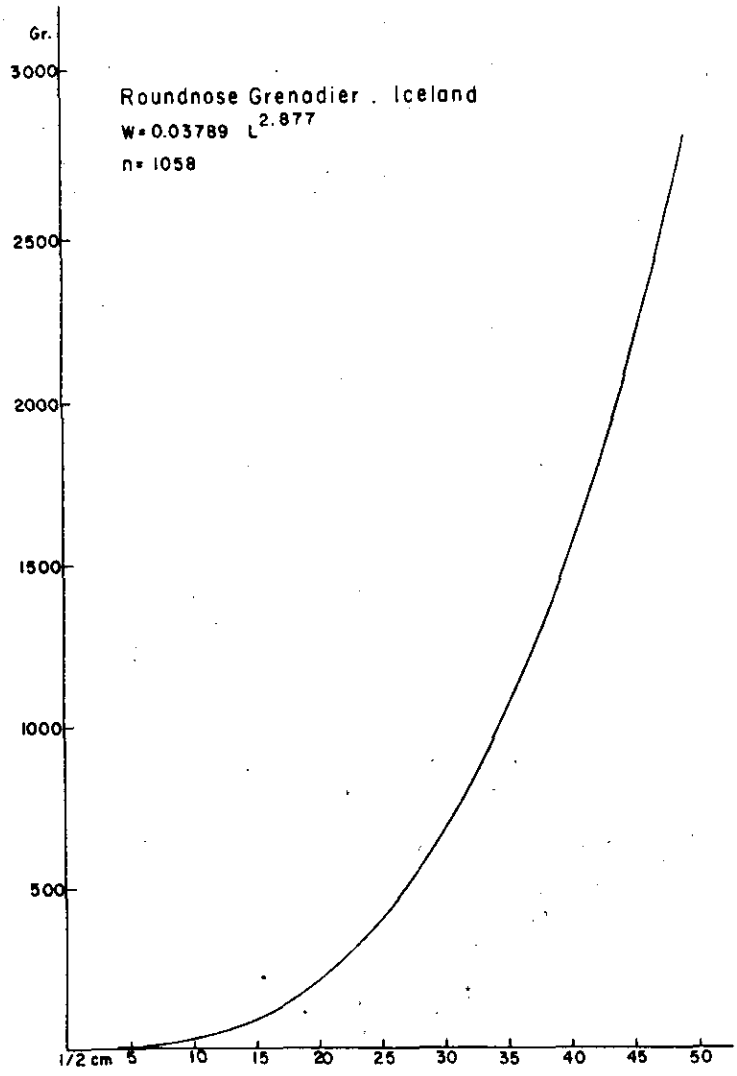


Fig. 8. Roundnose grenadier. Weight at length for both sexes combined.

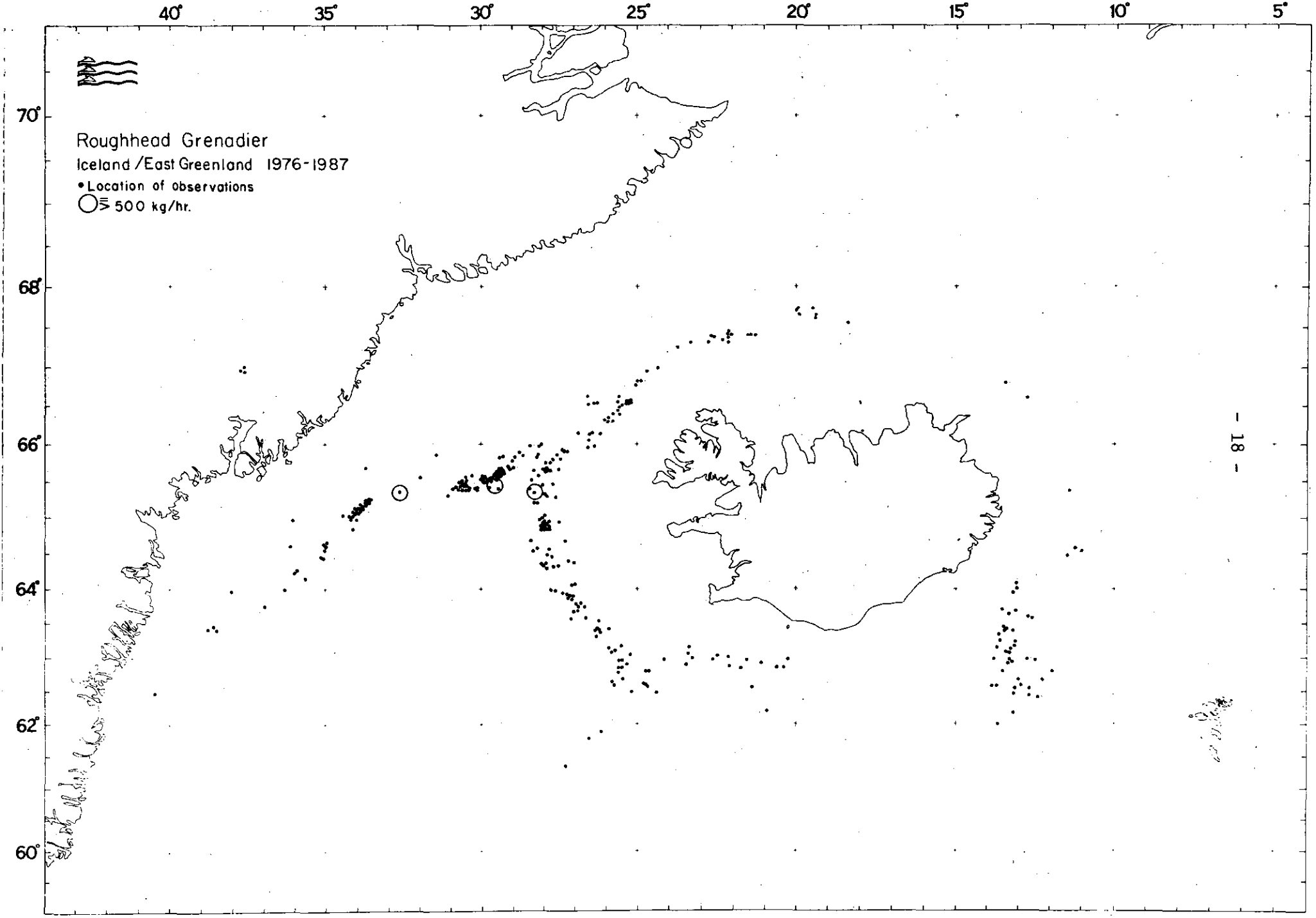




Fig. 9. Roughhead grenadier. Distribution in Icelandic and East Greenland waters based on catches from research cruises

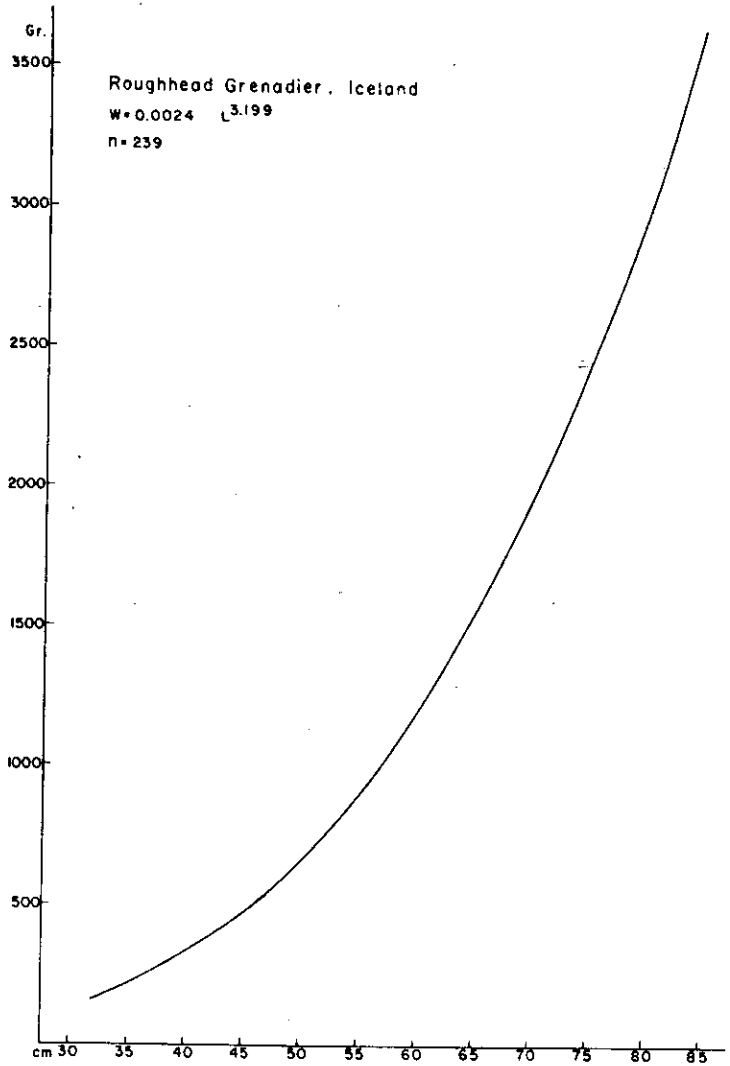


Fig. 10. Roughhead grenadier. Weight at length for both sexes combined.

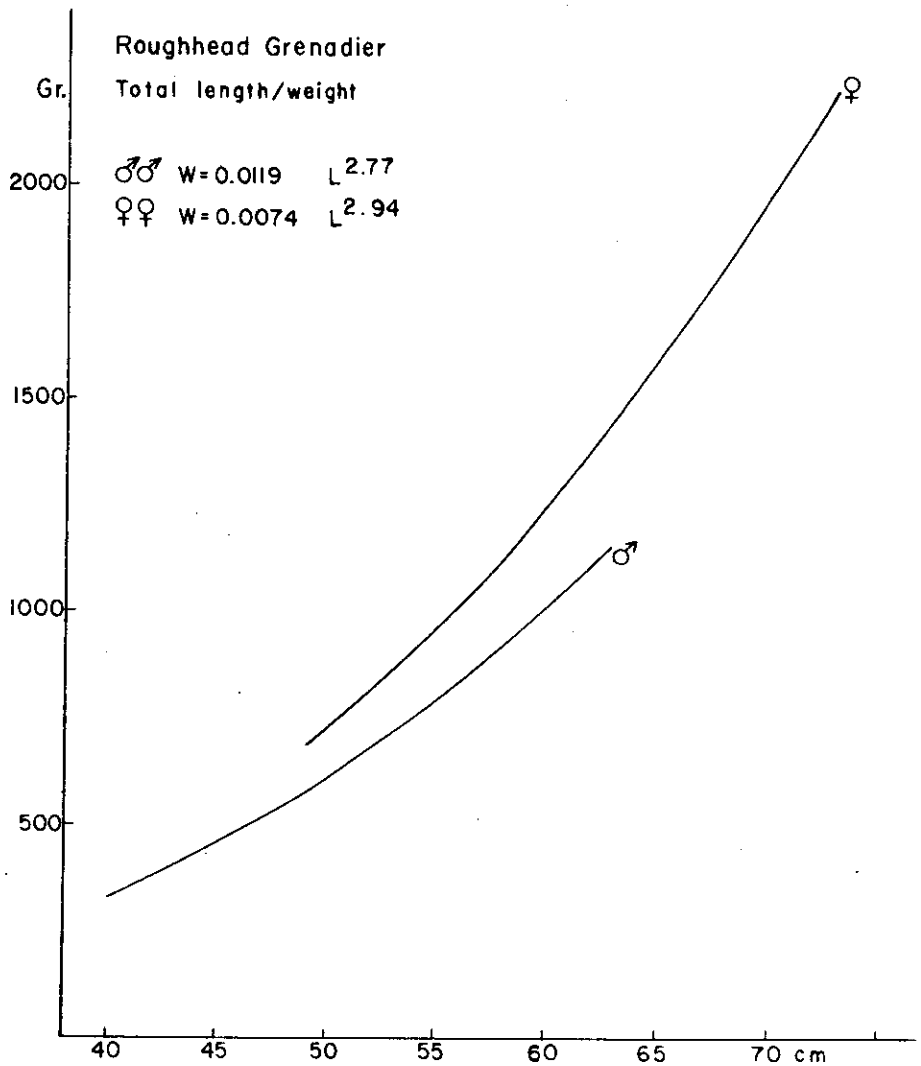


Fig. 11. Roughhead grenadier. Weight at length for males and females separately