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Investigations on the Common Grenadier *Nezumia bairdi* (Goode et Bean)
in Northwest Atlantic in 1969-1983

by

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ABSTRACT

The distribution of the catches by area, depth and in relation to water temperature, length and sex composition, feeding and fatness characteristics of common grenadier are given on the basis of the data on demersal fish trawl surveys in 1972-1983 and on the catches taken by research vessels in 1969-1983. The common grenadier was taken as by-catch with commercial fish near the continental slope and in the deepwater deeps of the shelf. The catches increased with depth, they were higher in the day-time. The average length of fish in the northern Newfoundland Area was larger than that in the southern Newfoundland Area. The females were more abundant and larger than the males. The length-weight relationship of males and females with the equal length is similar. Amphipods, shrimps, bivalves and Ophiuræ mostly often made up the food. Food content essentially varied with growth of fish. Relative liver weight (fatness) of females was higher than that of males, it sharply increased with length growth of fish. No direct fishery was conducted.

SPECIAL SESSION ON DEEPWATER FISHES

INTRODUCTION

The common grenadier inhabit the Northwest Atlantic waters off Labrador, Newfoundland, the deep waters of Gulf of St. Law-

rence and Fundy Bay up to Georges Bank and further southward. They were caught also in the area off the Azores (Parr, 1946).

The fishes of that species were caught in the depths from 16 to 2250 m, but the most abundant catches were taken in the 90-180 m depth (Leim and Scott, 1966).

Houston (Houston, 1983) stated that common grenadier as roughhead grenadier Macrourus berglax, close to it by species, were abundant in the Newfoundland Area. Tens and thousands of fish of that species were often taken with bottom trawls in the Soviet trawl fishery on cod, redfish and flounders in the areas off Labrador and Newfoundland.

The catches taken by the Canadian research vessels on the southwestern slope of the Grand Bank constituted, on the average, 36 kg per half-hour trawling (Parsons, 1975). No direct fishery was conducted.

The information about common grenadier biology in the literature is almost absent. The aim of this paper is to summarize the results of observations for many years in the Northwest Atlantic and to review the information in literature for studying the ecology and possibilities of commercial use of this fish.

MATERIALS AND METHODS

The data were collected by the research vessels in the period from 1969 to 1983 in the subareas of Newfoundland and Labrador. The data on trawl survey on demersal fish abundance assessment, conducted annually in summer in 1972-1983 on the Grand Bank and in the South Labrador zone by grid of stations occupied the shelf and a part of the continental slope, were also used. Small-meshed netting (mesh size - 10-12 mm) was inserted into the valid trawl, the insertion was 19 m long. The duration of valid trawlings was 1 hour. The average catches by squares, occupying 20' by latitude and 30' by longitude, were estimated. The catches were distributed within 100 m depth ranges taking into account

near-bottom water temperature and time of the day.

The analysis of the catches was the following. The whole (zoological) length of fish was measured with accuracy to 1 cm, the sex was determined. While studying the feeding the fish with not everted stomachs were analysed. The invertebrates and fish found in stomachs were determined with accuracy to genus, more often, to family, order or class. The occurrence frequency of separate components in stomachs was estimated, i.e. the ratio of number of the stomachs, expressed in percent, containing any food component, to the total number of all stomachs analysed, excluding the empty ones. The degree of stomach fullness was estimated visually by the 5-point scale: 0 - the lack of food, 1 - the availability of food, 2 - weak fullness, 3 - full stomach, 4 - extended stomach. The mean degree of stomach fullness was found as the arithmetical average from points of fullness of stomachs analysed. The coefficient of food similarity was estimated by the method suggested by K.P. Yanulov (Yanulov, 1963).

The length-weight relationship of common grenadier is expressed by the formula $W = aL^b$, where W - the fish weight in grams, L - length in cm.

The fatness was determined in 458 specimens, i.e. the liver weight in relation to fish weight, expressed in percent.

The length frequencies and relative liver weight curves in figures are smoothed. The smoothing was made by the formula $B = \frac{a + 2b + c}{4}$, where a, b, c - prior, average and subsequent members of frequency, B - the estimated one.

DISTRIBUTION OF CATCHES BY AREA AND DEPTH

During demersal fish trawl survey in the areas off Newfoundland and Labrador the common grenadier occurred in the catches everywhere near the continental slope and deepwater deeps of the shelf, the greatest catches were taken in the southern part of the Grand Bank (Fig.1). The catches in the depths less than 300 m were equal to smaller than 10 specimens per hour trawling. The catches increased with greater depth of trawling (Fig.2).

Common grenadier were caught at the near-bottom water temperature from -1° to $+9^{\circ}\text{C}$, they were taken in the greatest numbers at water temperature of $7-8^{\circ}\text{C}$ in the day-time (from 08.00 to 12.00 hrs)

LENGTH COMPOSITION OF CATCHES

Data were mainly collected on the Grand Bank. Length compositions of the catches in different divisions were unequal. The largest fishes were taken in Divs. 2J, 3K, 3L (Table 1).

The decrease in length composition of common grenadier was observed by the NAFO Divisions from the north to the south (Fig.3).

In different divisions 2550 specimens, by males and females separately, were totally measured. On the average, 34.6% of males and 65.4% of females were found in the catches. The females were considerably larger (Fig.4). Mean length of males was 29.6 cm, of females - 31.7 cm. No any variations in length composition of catches or sex relationship of fish with increase of the trawling depth were observed.

LENGTH-WEIGHT RELATIONSHIP

Scanty data on length-weight relationship are available. Data were collected in 1969 and 1979 in Divs. 3LNOP (Table 2).

The comparison between the length-weight relationships of common grenadier caught in different divisions did not show any discrepancies, therefore the measurements results were combined to obtain the total characteristics of changing the fish weight with their length increase (Table 3).

As it is seen from Table 3 and also from Fig.5, where estimated data are given, the relationship between length and weight of males and females at their equal length had no differences

AGE AND GROWTH

The age was determined in 60 males and 133 females of common grenadier caught in the Cabot Strait in October 1969. The specimens of 20-38,5 cm long and 22.9-193.5 g by weight were from 3 to 11 years. According to the estimated data the males at age of 6 were 27 cm long and 55 g by weight, and the females - 29 cm and 70 g; at the sixth year the males increase the length by 1.9 cm and weight by 11.5 g, the females - by 2.5 cm and 18.5 g respectively (Savvatimsky, 1975).

SEX RELATION, FEEDING, FATNESS

The catches of common grenadier in all divisions were predominantly consisted of the females (on the average, 65.4%), the greatest relative number of females were registered in the catches taken in Divs. 2J, 3K, 3P (Table 4).

Only two indications are known from the scientific literature that common grenadier feed on Euphausiidae and Amphipods (Leim and Scott, 1966) and that the food is more various: cumaceans (35.6%), Amphipods (23.9%), Polychaeta (17.0%), euphausiids (10.5%), bivalves (7.5%) dominate, and also mysids, echinoderms, isopods, copepods, tanaids, ostracods, decapoda crustaceans occur in small numbers (Houston, 1983).

269 specimens of common grenadier excluding 139 specimens with ejected stomachs (41.3%) from the Newfoundland Area in September-October 1969 and in May 1979 were taken for qualitative feeding analysis. Different demersal, near-bottom and pelagic organisms composing the food were found in the stomachs (Table 5).

Amphipods (17.6%), shrimps (13.3%), bivalves (8.6%) and Ophiura (7.1%) occurred in the food mostly often. The females were larger than males, the larger food was more available for them as shrimps (14.7%), hermit crabs (6.0%), bivalves (11.3%).

In males these components in dissected stomachs occurred more rarely (10.0%, 1.7% and 1.7% respectively). The coefficient of food similarity between males and females was 62.9.

Common grenadier is often caught together with roughhead grenadier close to it by species. The distributions by area and depth of these two species in the Newfoundland Area almost coincide. In spite of their similar food content, there are some differences. So, the occurrence frequency of Amphipods in common grenadier - 17.6%, but in roughhead grenadier - 9.6%; of Ophiura - 7.1% and 26%, of shrimps - 13.3% and 8.9% respectively. Therefore, the coefficient of food similarity between these fishes is low: 23.7.

Only fragmentary data on common grenadier fatness were collected together with age samples in the Newfoundland Area in 1969 and 1979. The average fatness by all the samples (458 spec.) constituted 9.1%. The average fatness for the females (9.3%) was higher than that for males (8.3%), at the equal length of fish the fatness of the males was higher compared to that of females. Both for males, and females the fatness sharply increased with their length growth (Table 6, Fig.6).

RESULTS AND DISCUSSION

Common grenadier is a fairly abundant fish in the areas off Labrador and Newfoundland, inhabit the below part of the shelf and adjacent areas of the continental slope. The distribution of the catches and differences in length compositions of the catches in the northern and southern parts of the area surveyed mainly coincide with the results of investigations carried out by Parsons (Parsons, 1975) and cannot be explained yet because of scanty data. The greatest catches taken by the Canadian research vessel were taken at the near-bottom water temperature from 3.0 to 4.0°C (Parsons, 1975), the increase in catches were observed by Soviet specialists at the water temperature of 7-8°C.

The increase in the catches taken with bottom trawl in the day-time and the decrease in them at night, apparently was the consequence of partial migration of the grenadier at night into the water stratum.

The variations in fatness and also the length-weight relationship for males and females common grenadier with their growth are similar to those of close species - roughhead grenadier, inhabited together with common grenadier. Their food is mainly consisted of the demersal organisms, the types are various. Houston (Houston, 1983) stated that benthic organisms for common grenadier constituted 86.0%, in roughhead grenadier - 91.6%. In spite of the fact that the areas and distribution range by depth of those two species to a great extent coincided, there was no food competition between them or it was insignificant, that illustrated low coefficient of food similarity (23.7).

Wide food spectrum and variations in food content with growth of common grenadier was considered to be the adaptation to the inhabitable conditions in great depth, where the food resources were limited.

Common grenadier is the most abundant in the southern part of the Grand Bank. To Parsons' opinion (Parsons, 1975), this species because of not high abundance and small sizes is not available for commercial use. It should be noted that investigations were conducted only within the upper part of the range of common grenadier vertical extension, therefore, the data obtained are not enough for final conclusions on their commercial use.

Nevertheless, it should be noted that this fish sometimes constituted great by-catch during the bottom trawl fishery of traditional fishing objects, and, probably, can be used for fish meal and food production.

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Table 1 Average length of common grenadier in different NAFO Divs. in 1969-1983

Division	Average length, cm:	Number of fish, spec.
2J	36.3	437
3K	35.4	206
3L	31.9	1211
3M	28.8	1523
3N	28.4	1495
3O	25.7	1663
3P	28.7	365
4W	31.4	40
All divisions	29.2	6940

Table 2 The number of males and females common grenadier, the length and weight of which were measured

Sex	Division				Total
	3L	3N	3O	3P	
Males	26	4	39	60	129
Females	69	9	68	183	329
Total	95	13	107	243	458

Table 3 Length-weight relationship of common grenadier in Divs. 3LNOP in 1969, 1979.

Length, cm	Males		Females	
	Average weight, g	Number, spec.	Average weight, g	Number, spec.
19	-	-	18,0	1
20	-	-	26,5	7
21	25,0	2	25,3	6
22	30,0	2	27,4	5
23	39,0	5	31,0	2
24	41,3	11	36,4	5
25	42,7	13	45,6	5
26	50,1	15	44,5	15
27	58,8	15	51,6	12
28	63,7	29	62,6	17
29	76,4	13	71,2	37
30	75,6	10	83,0	28
31	92,8	7	91,1	25
32	91,7	3	93,8	34
33	110,0	1	108,7	41
34	111,7	3	119,4	29
35	-	-	132,8	28
36	-	-	144,6	12
37	-	-	153,3	9
38	-	-	170,0	6
39	-	-	174,2	4
40	-	-	195,0	1

Table 4 Relative number of common grenadier females from the catches in different divisions in 1969-1983

Number of fish	Division								All Divs.
	2J	3K	3L	3M	3N	3O	3P	4W	
No. of males and females, spec.	428	157	396	661	386	239	243	45	2555
No. of females, %	73.4	75.2	65.7	61.0	51.3	69.5	75.3	64.4	65.4

Table 5 Occurrence frequency (%) of various food types in the stomachs of males and females common grenadier in Divs. 3L, 3N, 3O, 3P in 1969, 1979

Food type	Males	Females	Males and females
Polychaete	20,0	28,0	25,7
Other worms	1,7	3,3	2,9
Calanus	-	0,7	0,5
Amphipods	20,0	16,7	17,6
Euphausiids	3,3	2,0	2,4
Cumaceans	1,7	-	0,5
Themisto	16,7	1,3	5,7
Sagitta	-	1,3	0,9
Shrimp	10,0	14,7	13,3
Hermit crab	1,7	6,0	4,8
Ophiura	8,3	6,7	7,1
Bivalve	1,7	11,3	8,6
Gastropod	-	0,7	0,5
Digested food	40,0	36,7	37,6
Digested fish	3,3	2,0	2,4
Ground	1,7	0,7	0,9
Number of stomachs excluding the empty ones	60	150	210
Number of empty stomachs	20	39	59
Average degree of stomach fullness	1,3	1,5	1,4

Table 6. Common grenadier fatness in the Newfoundland Area
 In September-October 1960, in May 1979, %.

Division:	Sex	Length, cm										Number of fish, spec.
		18-20	21-23	24-26	17-29	30-32	33-35	36-38	19-41	18-41		
3L	Males	-	3,8	6,3	7,6	10,3	8,7	-	-	8,4	26	
3N	Males	-	-	7,9	14,9	-	12,6	-	-	12,9	4	
3O	Males	-	4,2	4,2	8,6	8,1	2,5	-	-	6,6	39	
3P	Males	-	4,0	5,9	9,9	10,0	-	-	-	8,8	60	
3L	Females	-	4,6	4,7	6,0	9,5	8,5	10,0	11,8	8,9	69	
3N	Females	-	-	-	-	3,3	10,4	13,1	-	10,4	9	
3O	Females	2,9	3,3	5,0	5,4	6,3	7,9	16,1	9,2	7,1	68	
3P	Females	5,9	3,8	4,6	7,0	10,2	11,8	12,5	13,7	10,2	183	
All	Males	-	4,0	5,4	9,4	9,7	8,5	-	-	8,3	129	
Divs.	Females	4,5	3,9	4,8	6,4	9,3	10,2	11,3	12,0	9,3	329	
All	Males and											
Divs.	Females	4,5	4,0	5,1	7,8	9,4	10,1	11,3	12,0	9,1	458	

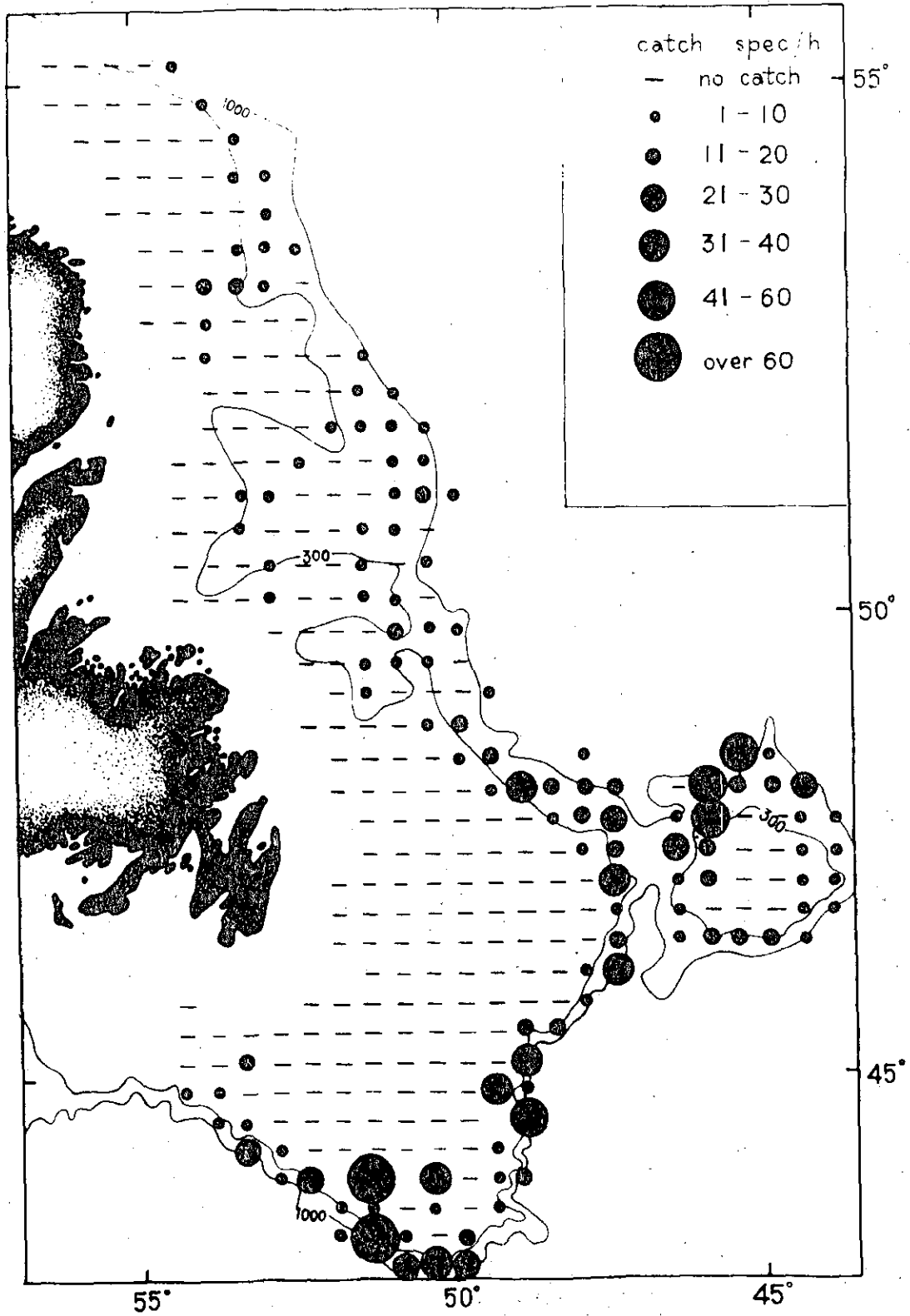


Fig. 1 Distribution of common grenadier average catches taken with bottom trawl during trawl surveys on demersal fish abundance assessment in 1972-1983.

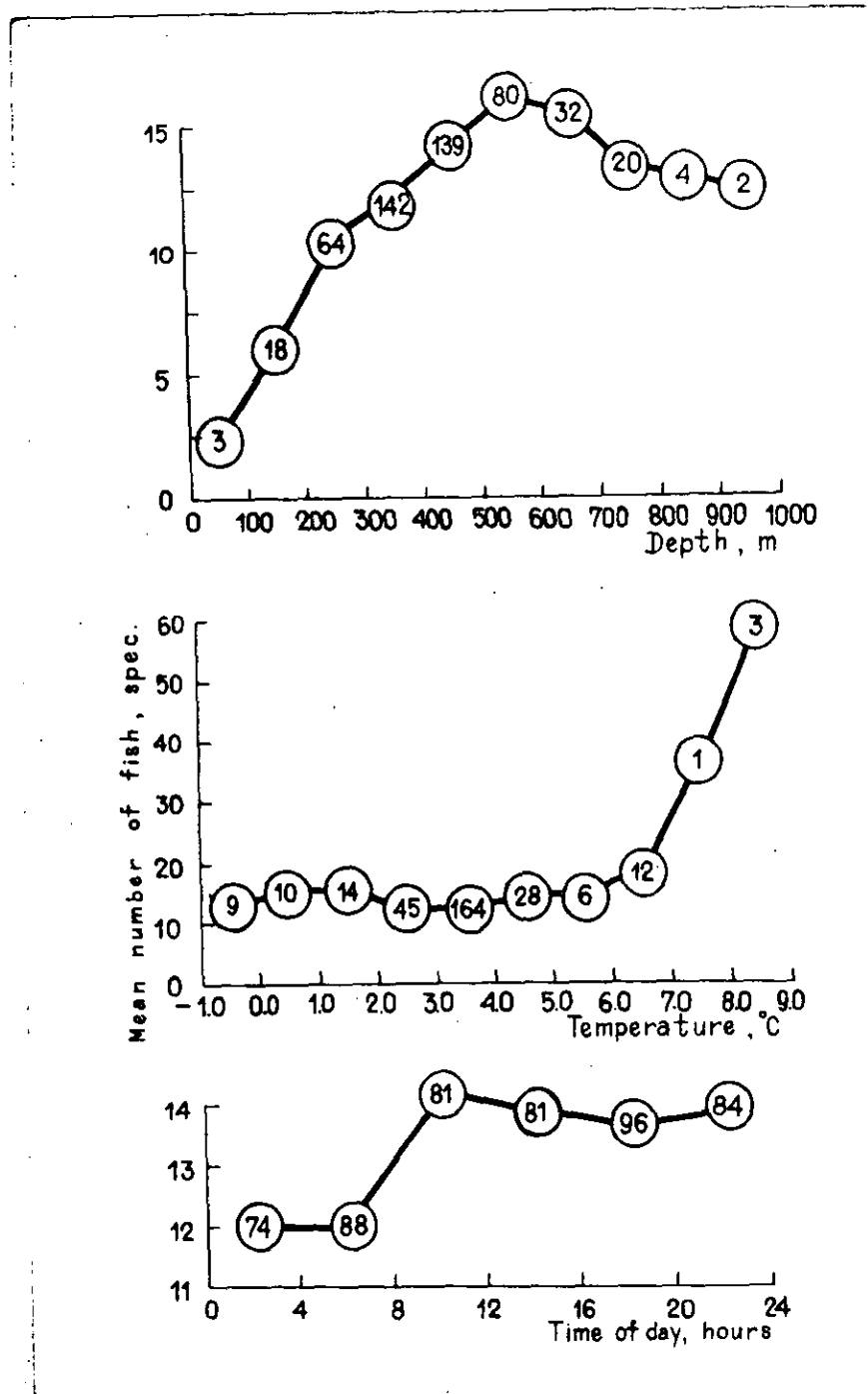


Fig. 2 Common grenadier average catches taken with bottom trawl per hour trawling by depth, time of day and in relation to near-bottom water temperature in 1972-1983 (smoothed curves, figures in circles - number of catches).

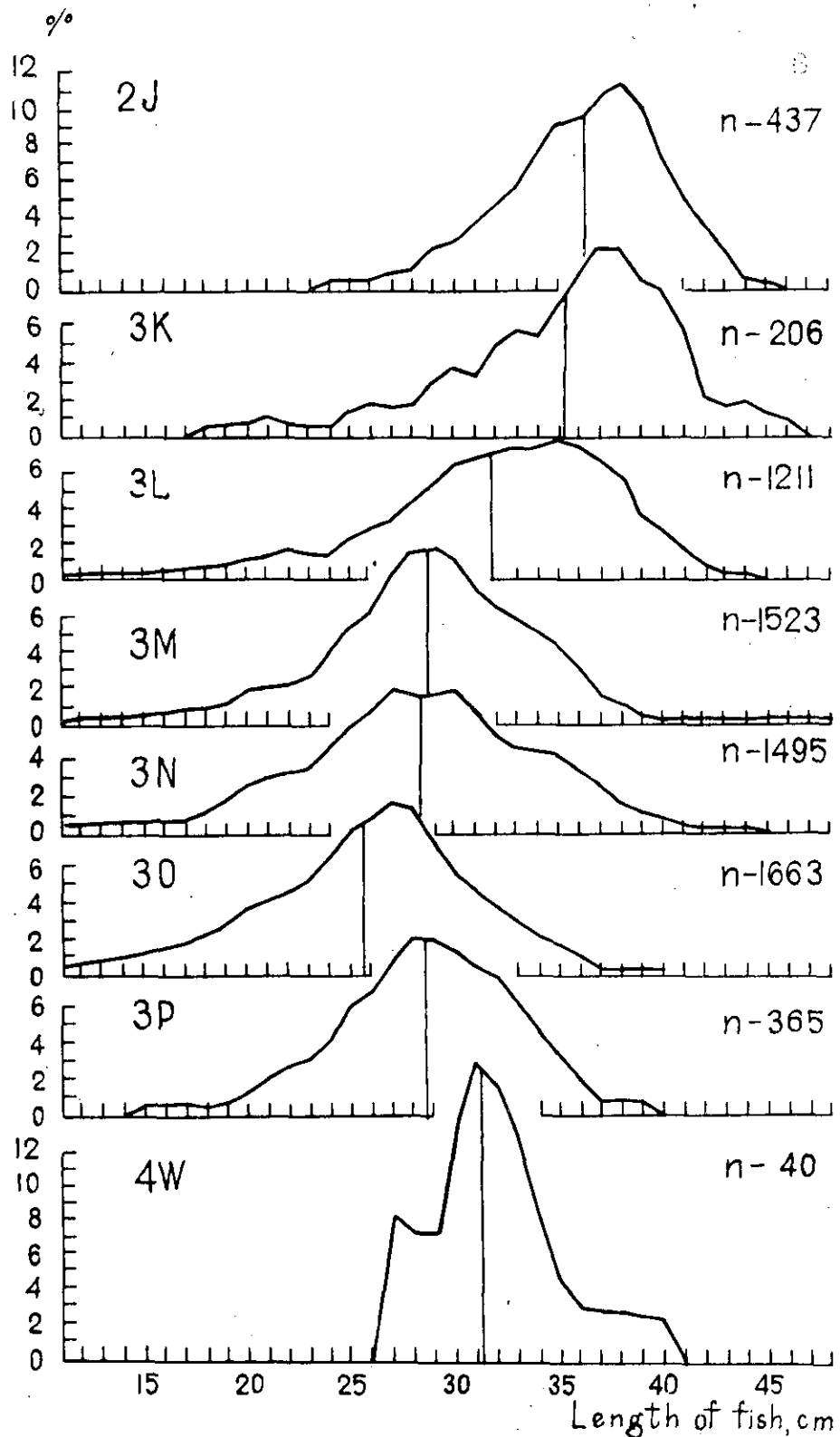


Fig. 3 Length composition from common grenadier catches taken with bottom trawl in the areas off Newfoundland and South Labrador in 1969-1983 (smoothed curves, mean fish length is shown by vertical lines).

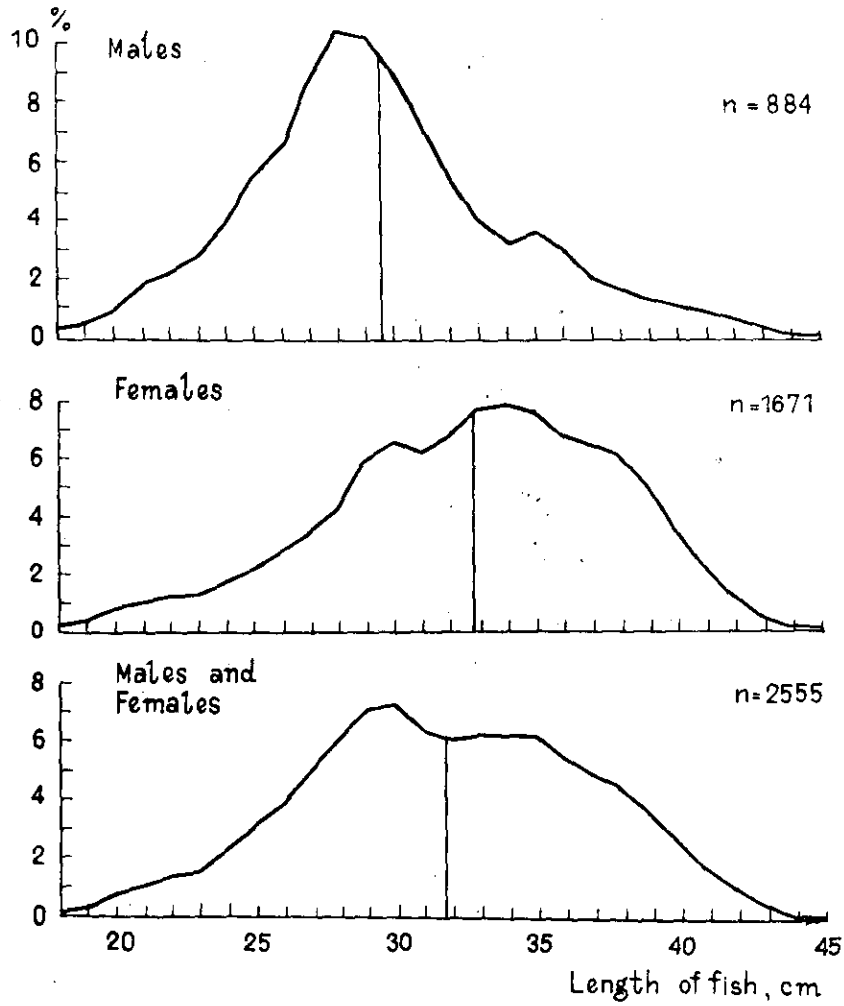


Fig. 4 Length composition from common grenadier catches (males and females) in the areas off Newfoundland and South Labrador in 1969-1983 (smoothed curves, mean fish length is shown by vertical lines).

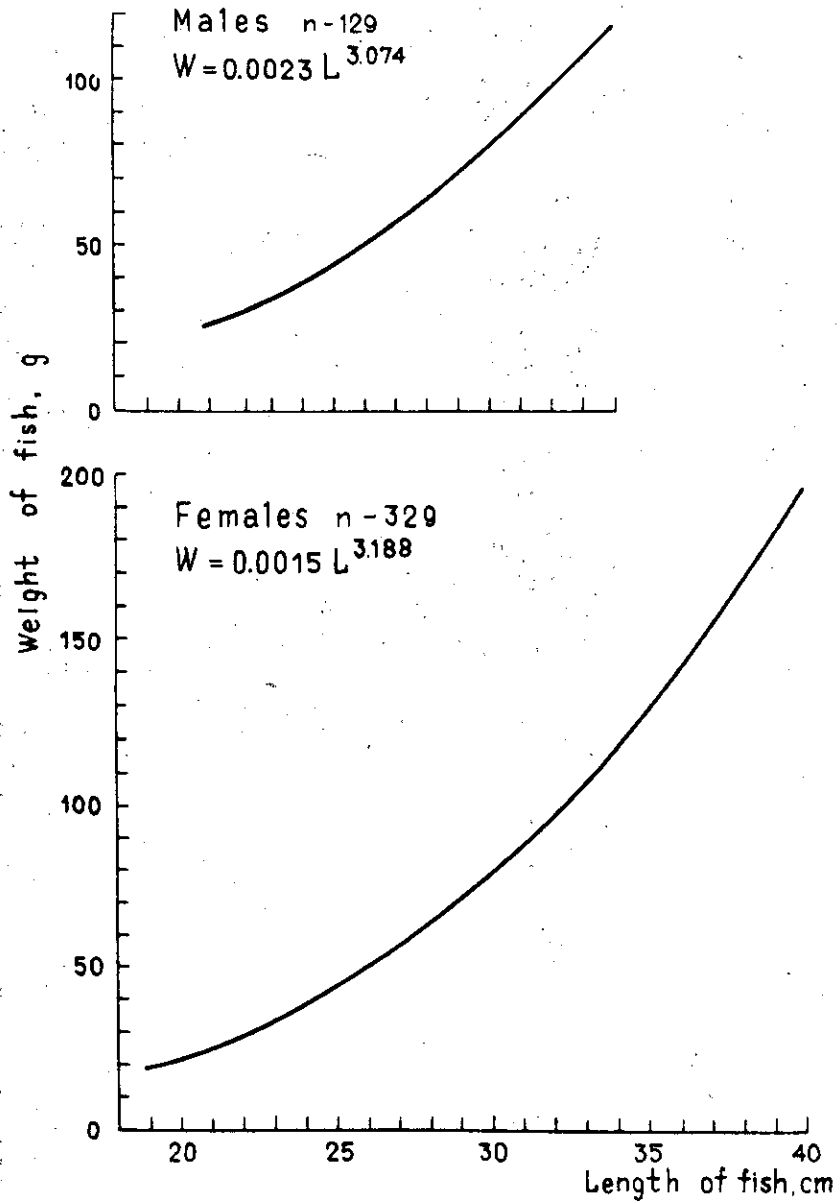


Fig. 5 Length-weight relationship for common grenadier in the Newfoundland Area in 1969, 1979 (W - weight in g, L - length in cm, n - number of fish).

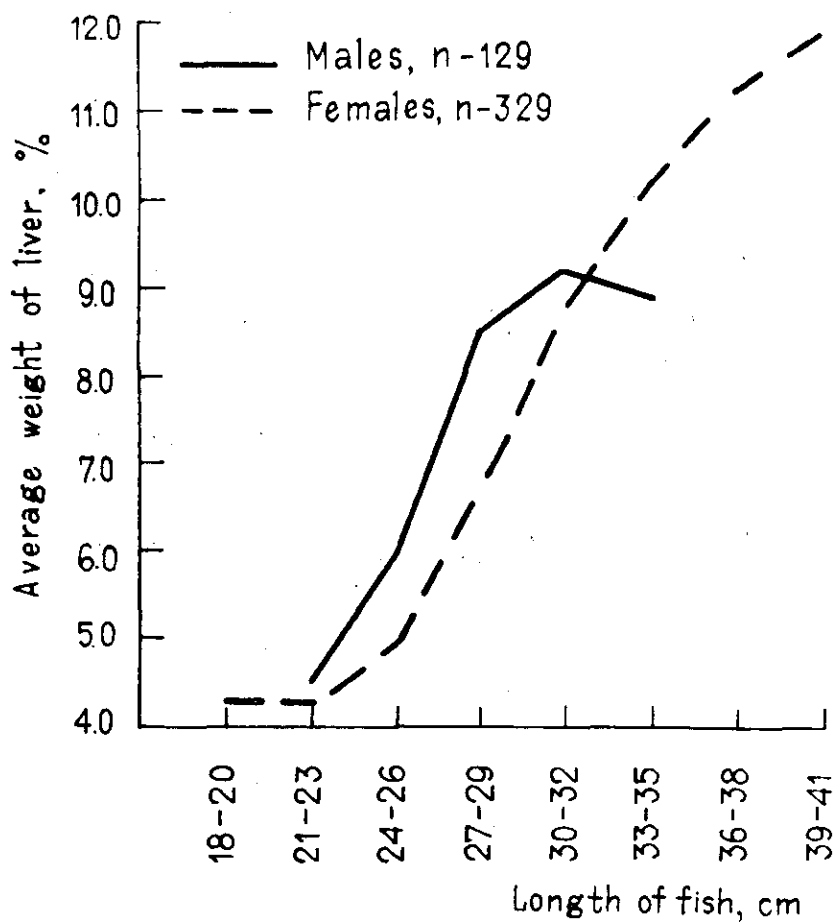


Fig. 6 Average fatness of common grenadier (males and females) by length groups in the Newfoundland Area in 1969, 1979 (smoothed curves, n - number of fish).