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Causes of Decrease in Total Catch of Roundnose Grenadier (*Coryphaenoides rupestris* Gun.) in the Northwest Atlantic in 1979-1990

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ABSTRACT

The 1990 trawl survey in NAFO Subareas 0, 1, 2, 3 found no roundnose grenadier concentrations at depths of less than 1000-1200 m. Like in earlier years an increase in catches and length of roundnose grenadier was observed with increasing depth of fishery. The survey in Divs. 0B, 2G, 3K estimated the mean length of roundnose grenadier at 49.3 cm and the mean age at 8.1 which is a bit lower than in 1989. No relations were found between the decrease in the total catch of roundnose grenadier and in the roundnose grenadier percentage in research catches and water temperatures in the distribution area of this species. Close correlation was revealed between the roundnose grenadier percentage in catches taken from 500-1200 m and the total catch for 1972-1988. The decrease in the total catch of roundnose grenadier seems to have been caused by a drop in percentage of this species in catches and the absence of commercial concentrations from depths within reach of the bottom trawl fishery.

INTRODUCTION

In 1967-1979 the total catch of roundnose grenadier in the NW Atlantic amounted to tens of thousands of tonnes per year. After 1979 there was a drastic drop in the total catch and CPUE. In recent years the catch has still remained low. The trawl surveys for bottom fishes made yearly in the fall-winter period off Baffin Island, Labrador, and Newfoundland indicate the occurrence of roundnose grenadier concentrations in great depths and scarcely within reach of the bottom trawl fishery. The present paper aims at analysis of the 1990 trawl survey data and comparison of these to earlier data to find the reasons of the decreased catch in the roundnose grenadier fishery.

MATERIALS AND METHODS

The paper uses the results from the trawl surveys for bottom fishes made on a yearly basis in the fall-winter period. Age composition

of the 1984-1990 catches was obtained by applying combined (1969-1990) age-length key to the length frequencies for the years in question (Table 1). The absence of considerable variations in growth rate of roundnose grenadier over these years made us think possible combining the age-length keys for a number of years. Age of roundnose grenadier was read on scales taken between the dorsal fins a little above the lateral line. The scales were examined under polarized transmitted light.

The length frequencies and percentages presented in figures had been preliminarily smoothed using the formula $B = \frac{a+2b+c}{4}$, where a, b, c are preceding, medium, and succeeding terms of the series, B is a calculating term. The total catch of roundnose grenadier in Subareas 0, 2, 3 in 1972-1988 was taken from a paper by P. Savvatimsky (1990).

The mean water temperature in 200-500 m and 500-1000 m over a part of the standard hydrographic transect 8A (sector C) on the continental slope east of the Hamilton Bank was accepted as a characteristic of thermal conditions. Long-term variations in this characteristic were found from yearly observations made on the transect in late October - early November in 1964-1990. Processing methods applied to the cast data were described in earlier papers (Savvatimsky, 1986, 1987).

RESULTS AND DISCUSSION

Special trawlings on a 100 m depth basis were made by RV "Kapitan Shaitanov" on 20 to 28 September 1990 in Div. 3K within the depth range of 550 to 1450 m to study the vertical distribution of bottom fishes. No roundnose grenadier occurred in catches from less than 700 m, the catches from 1001-1200 m were 40 to 100 kg/hour tow and amounted to 570 kg from depths greater than 1400 m.

Research off West Greenland (Divs. 1B, 1C, 1D) were done from 8 to 23 October. The trawl survey covered the depth range of 210 to 1490 m. The catches of roundnose grenadier were small beginning from 710 m. The largest catch of 990 kg (77% of the total catch) was hauled from 1140 m depth near the Fyllas Bank (Div. 1D).

The trawl survey in Div. 0B was conducted from 25 October to 9 November through the depths ranging from 230 to 1330 m. No roundnose grenadier were seen in catches from depths less than 720 m, in catches from deeper layers they occurred as bycatch to Greenland halibut. The largest catch of roundnose grenadier amounted to 179 kg and was hauled from 1330 m depth.

The trawl survey in Div. 2G was conducted from 23 to 29 November to cover the depth range from 550 to 1380 m. No roundnose grenadier were present in catches from depths less than 920 m, in deeper layers they were found in minor numbers. The largest catch was 733 kg taken from 1300 m.

Thus, the 1990 trawl survey showed the absence of roundnose grenadier concentrations from depths of less than 1200-1300 m throughout the covered area.

According to the 1990 trawl survey in Divs. 0B, 2G, and 3K the mean length of roundnose grenadier in bottom trawl catches was 49.3 cm (Table 2) and the mean age was 8.1 (Table 3) which is a little below the earlier years. The mean length and mean age of roundnose grenadier vary from year to year depending on depth of fishing and, probably, vertical migrations of fish. In 1990, like in previous years, a drastic increase was seen in length of female and male roundnose grenadier with increasing depth of fishing in all the areas surveyed (Table 4). In general, in Divs. 0B, 2G, 3K the mean length of males and females increased from 30-31 cm in hauls from 701-800 m to 56-60 cm from 1401-1500 m. The length composition of catches varying with depth is clearly seen in Figs. 1 and 2 that show deviations from the means. These variations are similar to those observed in the 1988 and 1989 surveys (Savvatimsky, 1989, 1990) as well as in 1983-1987 (Savvatimsky, 1988) revealing all over the survey area and, obviously, incident to the roundnose grenadier.

Length composition and the roundnose grenadier percentage in catches appear to be governed by the vertical migrations. As noted, in 1990 the mean length and age of this fish estimated in the survey areas were below the 1989 values. The roundnose grenadier percentage in catches from depths less than 1200 m in 1990 was also lower than in previous years (Tables 5, 6, Fig. 3). Obviously, in 1990 the main concentrations of roundnose grenadier composed, predominantly, of large fish were distributed in great depths and, therefore, out of reach of the bottom fishery.

An opinion exists that the considerable cooling in the continental slope waters recorded in the NW Atlantic in the early 1970's affected the distribution of bottom fishes, namely, Greenland halibut, roundnose grenadier, and redfish (Ernst, 1984; Savvatimsky, 1986, 1987; Chumakov, Savvatimsky, 1984, 1987, 1990). These species moved into greater depths to become less accessible for bottom trawls. This event proved to be especially meaning for roundnose grenadier living throughout a very wide depth range from 183 down to 2195 m (Wheeler, 1969) or according to some recent data, to 2500 m (Atkinson et al., 1981) and 3000 m (Sahrhage, 1986). The migrations of roundnose grenadier into deeper layers are likely to be one of the reasons of the decreased total catch of this species. Some variations in length and sex composition of research catches of roundnose grenadier were also recorded in recent years which may be associated with the vertical migrations (Savvatimsky, 1986, 1987). So far it has remained unclear to what extent the water cooling accounted for the roundnose grenadier migrations and, therefore, contributed to the catch drop, but, for example, sex ratio of catches is known

to be subject to seasonal and year-to-year fluctuations and dependent on variations in water temperatures (Savvatimsky, 1982). Variations were also found in roundnose grenadier-Greenland halibut ratio in catches depending on water temperatures in their habitat (Konstantinov and Noskov, 1977; Burmakin, 1978).

Analysis of data from the hydrographic transect 8A lying across the continental slope off southern Labrador implied that in 1990 water temperatures in 200-500 m and 500-1000 m would be close to the long-term mean to exceed it in 1991 (Chumakov and Savvatimsky, 1987, 1990; Savvatimsky, 1988). Conditions for the roundnose grenadier fishery were, therefore, expected to improve. But it did not happen. In 1990, the same as in 1989, water temperatures in these depths were below the long-term mean (Fig. 4). This must have driven the roundnose grenadier concentrations into great depths, thus making the fishery difficult.

Presently, little is known about the influence of water temperatures on roundnose grenadier behaviour. Comparing the water temperatures from transect 8A (sector C) to the roundnose grenadier percentage in catches for 1971-1990 did not find any correlation. It may only be stated that beginning in 1975 there occurred an abrupt decline in the roundnose grenadier percentage in catches taken from the depth range of 500-1400 m (Fig. 5). In 1980-1985 the roundnose grenadier percentage in catches was very low to go up after 1985 and go down about 1990. The most essential rise in the roundnose grenadier percentage recorded in 1986-1989 was associated with the catches from deeper than 1000 m.

Close correlations were derived between the roundnose grenadier percentage in catches from 501-1000 m and 1001-1200 m and the total catch in Subar. 0, 2, 3 in 1972-1988. At linear relationship $Y=a+bx$, the correlation coefficients are $r = 0.919$ and $r = 0.901$, respectively (Table 7, Figs. 6, 7), and at $Y= \exp (a+bx)$, they are $r=0.861$ and $r=0.942$, respectively. Yet higher correlation coefficients were derived from comparing the roundnose grenadier percentage in catches through the whole depth range (501-1200) which is normally covered by the fishing fleets to the total catch: $r=0.948$ and $r=0.927$ (Fig. 8).

Thus, the total catch of roundnose grenadier dropped in 1979 to remain low during the following years just due to decline in the percentage of this species in catches and the absence of commercial concentrations from depths within reach of the bottom fishery. The causes of this have not been elucidated as yet.

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Table 1

Combined length-age key of Roundnose grenadier from Div. 3K, 1969-1990

Age, years

L,sm\A.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	NN	W.aver
18-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	43
24	1	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	72
27	2	7	4	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	84
30	0	15	9	10	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	84
33	0	12	37	27	14	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	112
36	0	8	37	57	18	10	10	0	2	0	0	0	0	0	0	0	0	0	0	0	0	142	142
39	0	0	13	54	63	19	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	163	167
42	0	0	4	32	82	45	17	12	15	1	0	0	0	0	0	0	0	0	0	0	0	208	210
45	0	0	0	19	56	111	40	31	8	4	0	0	0	0	0	0	0	0	0	0	0	269	245
48	0	0	0	3	37	96	105	44	21	10	4	1	0	1	0	0	0	0	0	0	0	322	289
51	0	0	0	1	8	61	128	85	40	10	7	3	1	0	0	0	0	0	0	0	0	336	345
54	0	0	0	0	0	18	92	143	90	29	22	2	3	0	0	0	0	0	0	0	0	399	401
57	0	0	0	0	0	2	50	100	137	68	50	11	5	0	0	0	0	0	0	0	0	423	465
60	0	0	0	0	0	1	9	52	108	141	46	20	3	0	0	0	0	0	0	0	0	383	525
63	0	0	0	0	0	0	4	16	64	71	102	45	11	4	0	0	0	0	0	0	0	337	593
66	0	0	0	0	0	0	2	6	28	66	105	83	27	7	3	1	0	0	0	0	0	328	675
69	0	0	0	0	0	0	0	4	8	33	51	72	60	15	6	5	0	0	0	0	0	254	721
72	0	0	0	0	0	0	0	0	2	11	29	46	48	48	14	5	0	0	0	0	0	203	801
75	0	0	0	0	0	0	0	0	0	4	13	28	37	36	21	7	0	0	0	0	0	146	831
78	0	0	0	0	0	0	0	0	0	0	3	11	26	16	19	16	5	0	0	0	0	96	911
81	0	0	0	0	0	0	0	0	0	0	0	1	5	18	10	7	4	1	0	0	0	46	988
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	10	1	1	1	0	21	1062
87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	3	2	1	0	0	14	1196
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	1	7	1116
93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1092
96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99-101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1827
NN	4	43	107	209	282	372	458	498	523	468	432	326	226	152	82	55	16	5	2	0	1	4261	
W.av.,g	71	109	136	175	225	284	362	425	496	588	660	754	848	959	1031	1097	1276	1493	1614	0	1595		
L.av.,sm	24.8	31.3	34.5	37.8	42.0	46.2	50.5	53.8	57.1	61.1	63.8	67.4	70.8	74.2	76.5	78.3	83.4	87.0	92.5	0	90.0		

Table 2 Length composition of research catches of roundnose grenadier in the NW Atlantic (Subareas 0, 2, 3) in 1984-1990.

Length, cm	1984	1985	1986*	1987*	1988	1989	1990*
21-23	-	0.4	0.3	0.2	1.4	0.1	1.8
24-26	0.1	0.9	0.7	0.3	1.9	1.3	2.3
27-29	0.3	1.7	1.8	0.8	2.2	2.4	2.9
30-32	0.5	1.6	1.6	2.5	3.2	2.3	3.4
33-35	1.2	2.9	2.9	4.2	6.6	3.1	4.0
36-38	2.1	4.4	3.8	5.8	8.9	4.5	5.2
39-41	2.2	5.8	5.0	6.6	9.6	5.9	6.9
42-44	3.9	7.5	6.0	8.3	11.8	8.0	7.9
45-47	6.0	9.1	6.6	8.4	9.5	8.8	9.9
48-50	7.9	10.2	9.2	10.6	10.0	10.1	10.6
51-53	8.4	9.7	9.0	8.8	8.4	8.3	8.3
54-56	11.2	10.5	8.8	9.6	7.5	9.3	7.6
57-59	11.0	9.0	9.8	9.8	7.2	8.9	7.6
60-62	10.4	6.8	7.9	6.9	4.0	6.9	6.6
63-65	10.1	7.0	8.4	7.2	3.6	6.8	4.9
66-68	7.5	4.5	5.9	3.9	2.0	4.4	3.9
69-71	5.6	3.4	4.1	2.5	1.1	3.1	2.6
72-74	3.9	2.1	3.1	1.6	0.8	2.4	1.5
75-77	3.0	1.2	1.9	1.0	0.2	1.4	1.1
78-80	2.0	0.7	1.3	0.6	0.1	1.1	0.6
81-83	0.8	0.3	0.5	0.3	-	0.4	0.2
84-86	0.8	0.2	0.7	0.2	-	0.3	0.1
87-89	0.4	0.1	0.3	-	-	0.1	0.1
90-92	0.4	-	0.2	-	-	-	-
93-95	0.2	-	0.1	-	-	-	-
Mean length, cm	58.3	52.2	54.3	51.4	46.5	51.9	49.3
Nos of fish	11796	5837	6679	9996	11931	12797	15035

*Subarea 1 data included

Table 3. Age composition of research catches of roundnose grenadier in the NW Atlantic (Subareas 0, 2, 3) in 1984-1990.

Age	1984	1985	1986*	1987*	1988	1989	1990*
2	0.3	I.9	I.6	0.6	I.9	0.6	2.4
3	I.I	2.7	2.8	3.6	4.2	3.0	3.6
4	I.8	3.5	3.3	6.3	8.9	5.I	6.I
5	3.6	6.4	5.6	9.4	I3.I	8.4	9.5
6	6.I	8.0	6.6	9.0	I2.2	8.9	I0.9
7	9.7	II.9	9.9	I0.9	I2.7	I0.8	I2.5
8	I2.5	I3.6	I2.2	I3.2	I3.4	I3.2	I2.I
9	I3.4	I3.0	I2.2	I2.6	II.2	I2.4	II.I
I0	I2.8	II.8	I2.0	II.0	8.9	II.2	I0.0
II	II.2	8.9	I0.0	8.5	5.5	8.7	7.5
I2	9.8	7.5	8.9	6.6	4.I	7.2	6.0
I3	6.5	5.I	6.3	3.9	2.I	4.6	3.8
I4	4.7	2.7	3.7	2.I	I.0	2.8	2.2
I5	2.8	I.5	2.4	I.I	0.4	I.6	I.2
I6	I.8	0.8	I.4	0.6	0.2	0.9	0.6
I7	I.I	0.4	0.9	0.4	0.I	0.6	0.4
I8	0.5	0.I	0.2	0.I	-	0.I	0.I
I9	0.3	0.I	0.I	-	-	0.I	-
Mean age	9.8	8.7	9.2	8.3	7.4	8.6	8.I
Nos of fish	II796	5837	6679	9996	II93I	I2797	I5035

*Subarea 1 data included

Table 4. Mean length and percentage of male and female roundnose grenadier at various depths in Sub. 0, 1, 2 and Div. 3K in 1990.

Subarea or Div.	Depth, m	Males		Females		Female percentage
		mean length cm	Nos of fish	mean length cm	Nos.of fish	
	701-800	31.4 ± 0.6	267	29.4 ± 0.7	141	34.6
	801-900	34.2 ± 0.3	490	33.6 ± 0.5	170	25.8
	901-1000	28.9 ± 0.6	128	28.4 ± 0.8	75	36.9
	1001-1100	44.2 ± 0.6	237	43.6 ± 1.1	94	28.4
I	1101-1200	42.6 ± 0.4	431	43.3 ± 0.5	217	33.5
	1201-1300	45.9 ± 0.5	580	50.0 ± 0.7	296	33.8
	1301-1400	52.2 ± 0.5	376	54.1 ± 0.6	287	43.3
	1401-1500	56.3 ± 1.0	145	59.8 ± 1.1	146	50.2
	701-800	25.3 ± 1.6	19	28.5 ± 2.7	12	38.7
	901-1000	36.0 ± 2.5	21	41.0 ± 3.1	15	41.7
0B	1001-1100	46.0 ± 0.7	252	43.6 ± 1.1	104	29.2
	1101-1200	52.3 ± 1.8	10	55.9 ± 3.8	7	41.2
	1201-1300	34.0 ± 9.0	2	60.2 ± 2.2	4	66.7
	1301-1400	56.5 ± 0.7	209	58.0 ± 0.8	176	45.7
	901-1000	38.2 ± 0.5	465	36.9 ± 0.9	176	27.5
	1001-1100	44.1 ± 0.6	318	44.7 ± 0.9	163	33.9
2G	1101-1200	49.1 ± 0.4	453	51.0 ± 0.7	184	28.9
	1201-1300	50.9 ± 0.6	346	51.1 ± 0.6	221	39.0
	1301-1400	50.0 ± 0.6	312	53.3 ± 0.8	165	34.6
	701-800	32.0 ± 0.8	106	31.5 ± 0.9	43	29.0
	801-900	44.5 ± 0.6	206	43.8 ± 1.0	88	30.0
	901-1000	47.8 ± 0.6	219	49.3 ± 0.8	127	36.7
3K	1001-1100	47.3 ± 0.5	550	48.2 ± 0.8	242	30.5
	1101-1200	52.3 ± 0.2	2167	55.2 ± 0.4	1025	32.0
	1201-1300	54.8 ± 0.4	580	57.1 ± 0.7	295	33.8
	1301-1400	56.6 ± 0.4	545	59.1 ± 0.5	397	42.2
	1401-1500	56.7 ± 0.5	413	59.4 ± 0.7	317	43.4
	701-800	31.5 ± 0.5	392	29.8 ± 0.5	196	33.3
	801-900	37.3 ± 0.4	696	37.1 ± 0.6	258	27.0
	901-1000	39.2 ± 0.4	833	39.4 ± 0.6	393	32.1
I, 0,	1001-1100	45.8 ± 0.3	1357	45.7 ± 0.5	603	30.8
2, 3K	1101-1200	50.4 ± 0.2	3061	52.9 ± 0.3	1433	31.9
	1201-1300	50.5 ± 0.3	1508	52.9 ± 0.4	816	35.1
	1301-1400	54.0 ± 0.3	1442	56.6 ± 0.3	1025	41.6
	1401-1500	56.6 ± 0.4	558	59.5 ± 0.6	463	45.4

Table 5. Distribution and composition of catches from various depths in the trawl survey by RV "Kapitan Shaitanov" in 1990

Subarea, Div.	Depth, m	Mean catch, kg/hr	Nos of catches	Catch composition by weight,%			
				Greenl. halibut	Redfish (S.ment	rnose grenad.	others
	201-300	55.0	3	6.1	25.4	-	68.5
	301-400	28.2	6	15.4	49.7	-	34.9
	401-500	48.6	5	19.8	65.8	-	14.4
	501-600	-	-	-	-	-	-
	601-700	73.1	10	80.3	18.2	-	1.5
	701-800	106.2	5	64.0	21.7	8.1	6.2
I	801-900	283.6	5	48.9	-	50.7	0.4
	901-1000	252.0	2	96.4	-	3.6	-
	1001-1100	443.5	2	88.6	-	9.9	1.5
	1101-1200	942.5	2	33.1	-	66.9	-
	1201-1300	248.3	3	46.6	-	51.7	1.7
	1301-1400	262.7	3	56.5	-	43.5	-
	1401-1500	296.3	3	82.1	-	17.9	-
	201-300	1.7	6	90.0	-	-	10.0
	301-400	11.2	11	78.0	16.3	-	5.7
	401-500	26.1	13	53.5	44.4	-	2.1
	501-600	20.0	6	85.8	14.2	-	-
	601-700	128.7	6	66.3	33.4	-	0.3
0B	701-800	68.0	1	69.1	28.0	2.9	-
	801-900	90.0	3	100.0	-	-	-
	901-1000	92.3	6	98.6	-	1.1	0.4
	1001-1100	323.2	4	88.5	-	8.0	3.5
	1101-1200	231.7	4	99.2	-	0.8	-
	1201-1300	32.0	1	93.8	-	6.2	-
	1301-1400	233.5	2	57.8	-	42.2	-
	501-600	50.0	3	65.4	27.3	-	7.3
	601-700	25.0	1	40.0	56.0	-	4.0
	701-800	-	-	-	-	-	-
	801-900	107.0	2	91.6	6.5	-	1.9
2G	901-1000	166.2	4	76.3	-	23.6	0.1
	1001-1100	195.2	4	77.4	-	20.9	1.7
	1101-1200	256.0	3	52.1	-	47.9	-
	1201-1300	787.5	2	47.2	-	52.8	-
	1301-1400	309.5	2	33.9	-	66.1	-

Table 5 (continued)

Subarea, Division	Depth, m	Mean catch, kg/hr	Nos of catches	Catch composition by weight,%			
				Greenl. halibut	Redfish (ment.)	Rnose grenad.	others
	501-600	329.0	3	7.5	87.8	-	4.7
	601-700	362.7	3	4.7	92.2	-	3.1
	701-800	176.0	3	80.9	7.0	3.2	8.9
	801-900	263.0	3	69.0	0.2	16.4	14.4
3K	901-1000	287.0	3	81.5	-	13.4	5.1
	1001-1100	370.3	3	44.8	-	53.5	1.7
	1101-1200	301.6	20	72.3	-	27.0	0.7
	1201-1300	372.3	3	18.4	-	81.4	0.2
	1301-1400	371.7	3	17.4	-	81.9	0.7
	1401-1500	327.0	3	6.2	-	93.1	0.7
	201-300	19.4	9	10.9	24.0	-	65.1
	301-400	17.2	17	41.8	35.6	-	22.6
	401-500	32.4	18	39.5	53.3	-	7.2
	501-600	104.8	12	21.9	73.6	-	4.5
	601-700	130.8	20	44.4	53.8	-	1.8
	701-800	125.2	9	72.2	15.2	5.5	7.1
1, 0, 2,	801-900	207.0	13	63.3	0.6	31.5	4.6
3K	901-1000	172.3	15	86.7	-	11.5	1.8
	1001-1100	313.2	13	74.5	-	23.3	2.2
	1101-1200	331.5	29	65.6	-	34.0	0.4
	1201-1300	385.4	9	38.3	-	61.3	0.4
	1301-1400	298.9	10	37.4	-	62.3	0.3
	1401-1500	311.7	6	42.3	-	57.3	0.4

Table 6. Distribution and composition of catches from various depths in trawl survey in Divs. 0B, 2G, 3K in 1989,1990.

Year	Depth, m	Mean catch, kg/hr	Nos of catches	Catch composition by weight,%			
				Greenl. halibut	Redfish (ment)	Rnose grenad.	others
	201-300	0.9	4	44.4	-	-	55.6
	301-400	16.4	12	95.0	2.0	-	3.0
	401-500	54.5	24	62.8	35.3	-	1.9
	501-600	233.1	17	24.0	71.3	3.5	1.2
	601-700	154.0	13	55.0	43.5	-	1.5
1989	701-800	158.7	13	45.3	10.3	38.5	5.9
	801-900	109.4	9	81.6	-	7.6	10.8
	901-1000	436.9	12	47.4	-	51.7	0.9
	1001-1100	473.4	19	45.7	-	53.9	0.4
	1101-1200	836.8	10	37.3	-	62.3	0.3
	1201-1300	604.3	16	22.4	-	77.5	0.1
	1301-1400	195.8	2	39.1	-	60.9	-
	1401-1500	232.3	1	4.3	-	95.7	-
	201-300	1.7	6	90.0	-	-	10.0
	301-400	11.2	11	78.0	16.3	-	5.7
	401-500	26.2	13	53.5	44.4	-	2.1
	501-600	104.7	12	21.9	73.6	-	4.5
	601-700	188.5	10	30.4	67.6	-	2.0
	701-800	149.0	4	79.5	9.4	3.2	7.9
1990	801-900	159.1	8	79.3	1.3	10.1	9.3
	901-1000	160.0	13	84.4	-	13.4	2.2
	1001-1100	289.6	11	70.5	-	27.0	2.5
	1101-1200	266.5	29	73.5	-	26.0	0.5
	1201-1300	454.0	6	36.0	-	63.9	0.1
	1301-1400	314.4	7	30.6	-	69.0	0.4
	1401-1500	327.0	3	6.2	-	93.1	0.7

Table 7. International catch of roundnose grenadier and the percentage of this species in research catches from depths 501-1000, 1001-1200 and, 501-1200 m in Subareas 0, 2, 3 in 1972-1988.

Year	Total catch, 000 t	Roundnose grenadier percentage by weight		
		Depth 501-1000 m	Depth 1001-1200 m	Depth 501-1200 m
1972	30.2	77.9 (189)	100.0 (1)	81.6 (190)
1973	18.6	69.6 (312)	99.1 (40)	78.0 (352)
1974	31.1	76.9 (276)	97.7 (33)	82.9 (309)
1975	27.6	78.2 (218)	91.8 (45)	82.1 (263)
1976	23.2	50.2 (249)	89.9 (8)	63.0 (257)
1977	16.1	12.4 (197)	78.3	12.4 (197)
1978	20.7	42.1 (18)	66.7 (3)	49.1 (21)
1979	7.9	30.4 (159)	60.1 (10)	35.3 (169)
1980	2.1	7.5 (66)	16.9 (13)	10.1 (79)
1981	7.2	12.1 (34)	29.7 (4)	9.7 (38)
1982	4.4	8.6 (119)	42.6 (32)	10.0 (151)
1983	3.6	7.2 (123)	17.2 (44)	10.1 (167)
1984	3.9	17.6 (77)	22.1 (28)	18.9 (105)
1985	5.0	2.4 (69)	28.4 (28)	11.1 (97)
1986	7.4	22.8 (62)	56.4 (10)	32.4 (72)
1987	8.3	17.2 (50)	59.6 (30)	29.3 (80)
1988	6.4	15.9 (78)	52.7 (39)	28.2 (117)

Remark: Figures in brackets refer to numbers of research catches

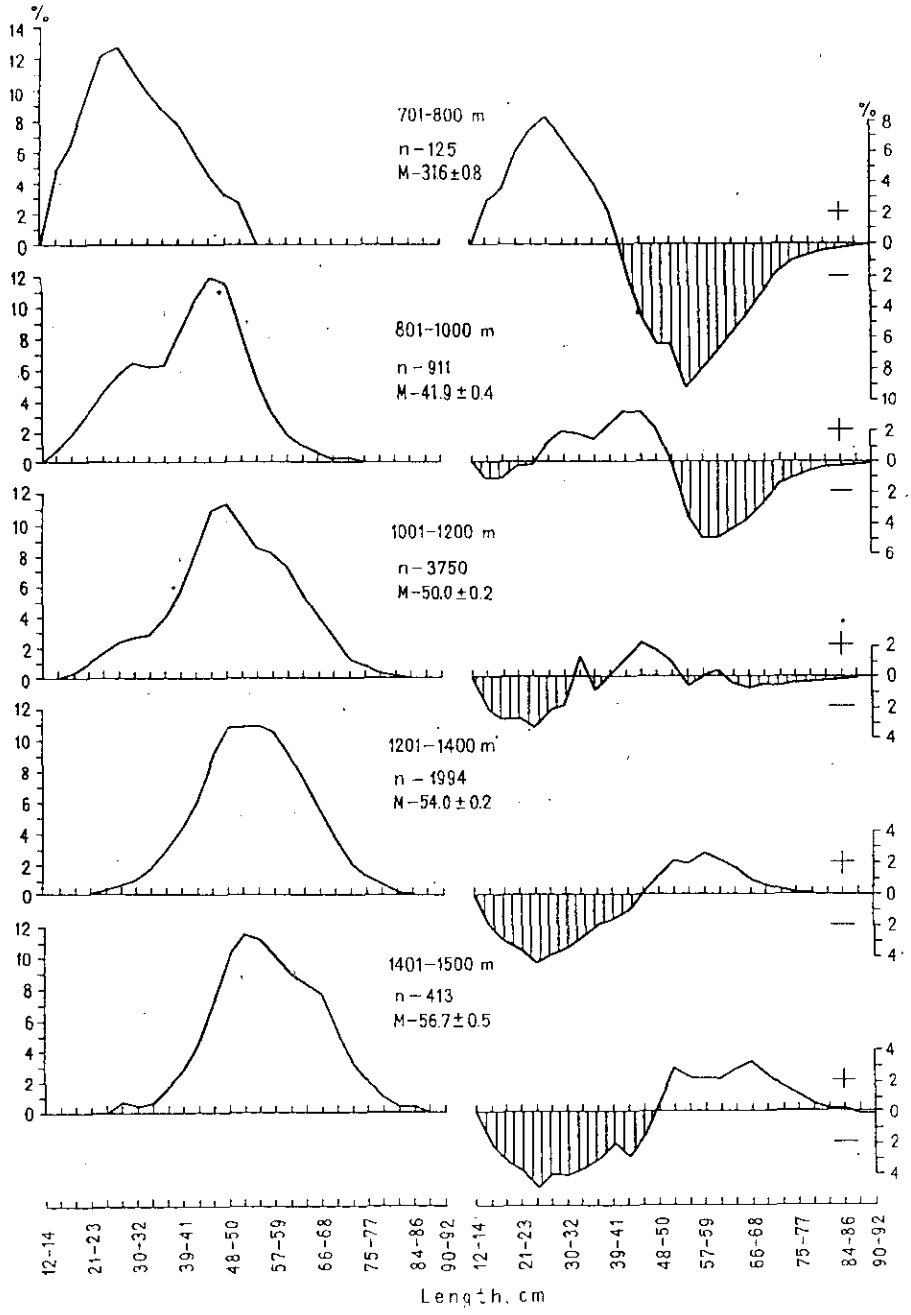


Fig. 1. Length composition of male roundnose grenadier at various depths in Divs. 0B, 2GH, and 3K in 1990 from the trawl survey by RV "Kapitan Shaitanov" (smoothed frequencies, n - numbers of fish, M - mean length of fish).

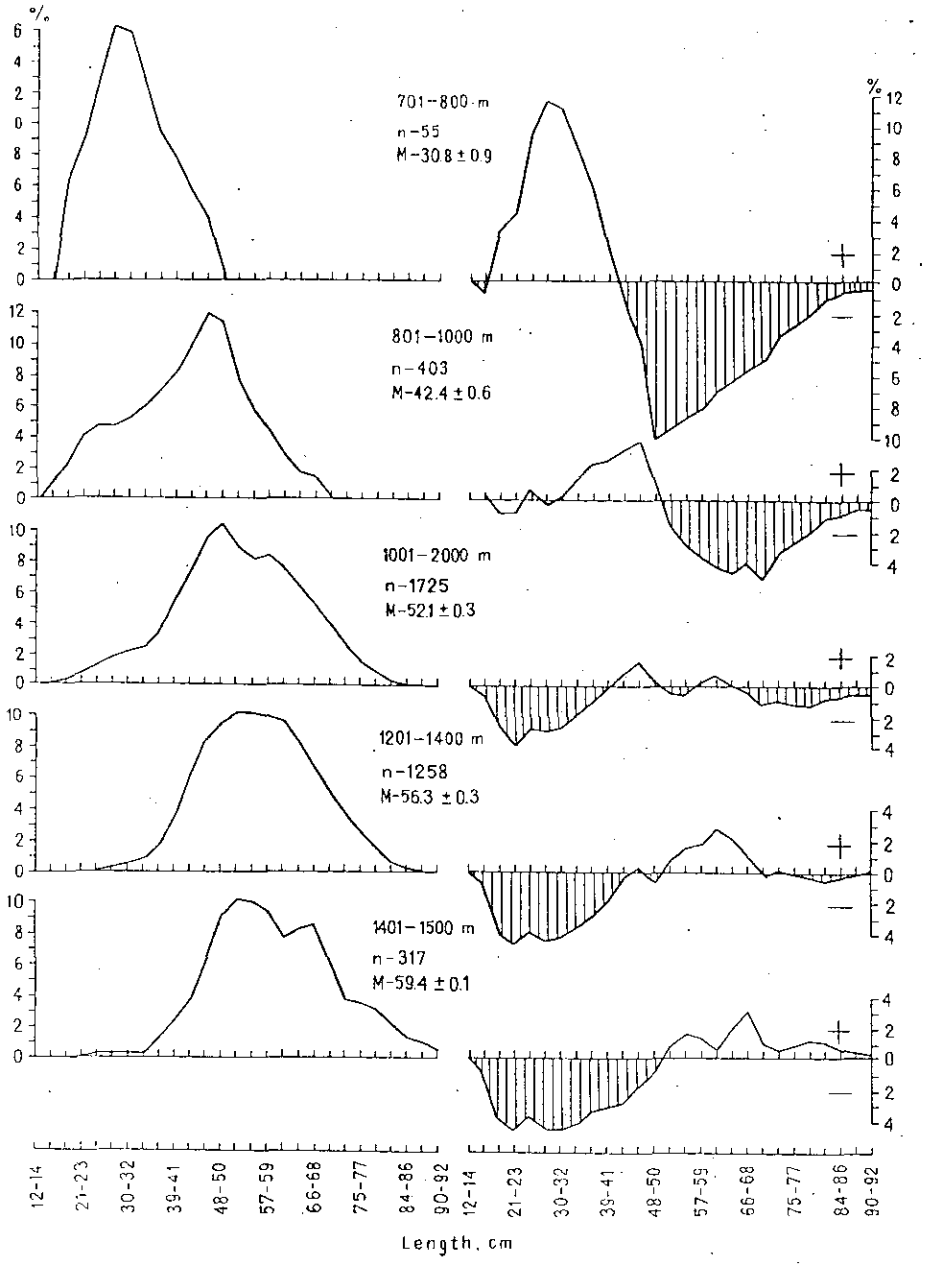


Fig. 2. Length composition of female roundnose grenadier at various depths in Divs. 0B, 2GH, and 3K in 1990 from trawl survey by RV "Kapitan Shaitanov" (smoothed frequencies, n - numbers of fish, M - mean length of fish).

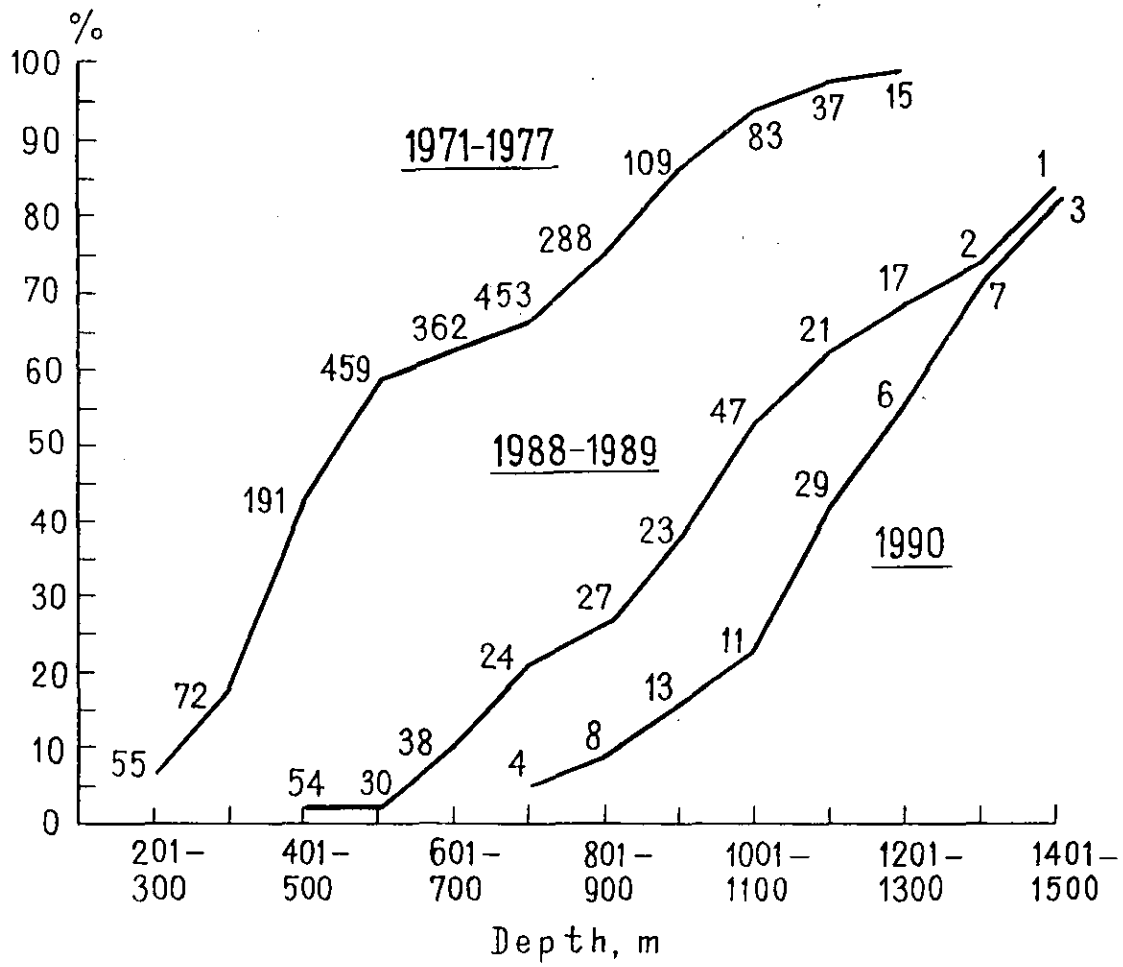


Fig. 3. Roundnose grenadier percentage by weight in bottom trawl research catches from various depths in Subareas 0, 2 and Div. 3K in 1971-1977, 1988-1989 and 1990 (smoothed series, figures over the curves are number of catches).

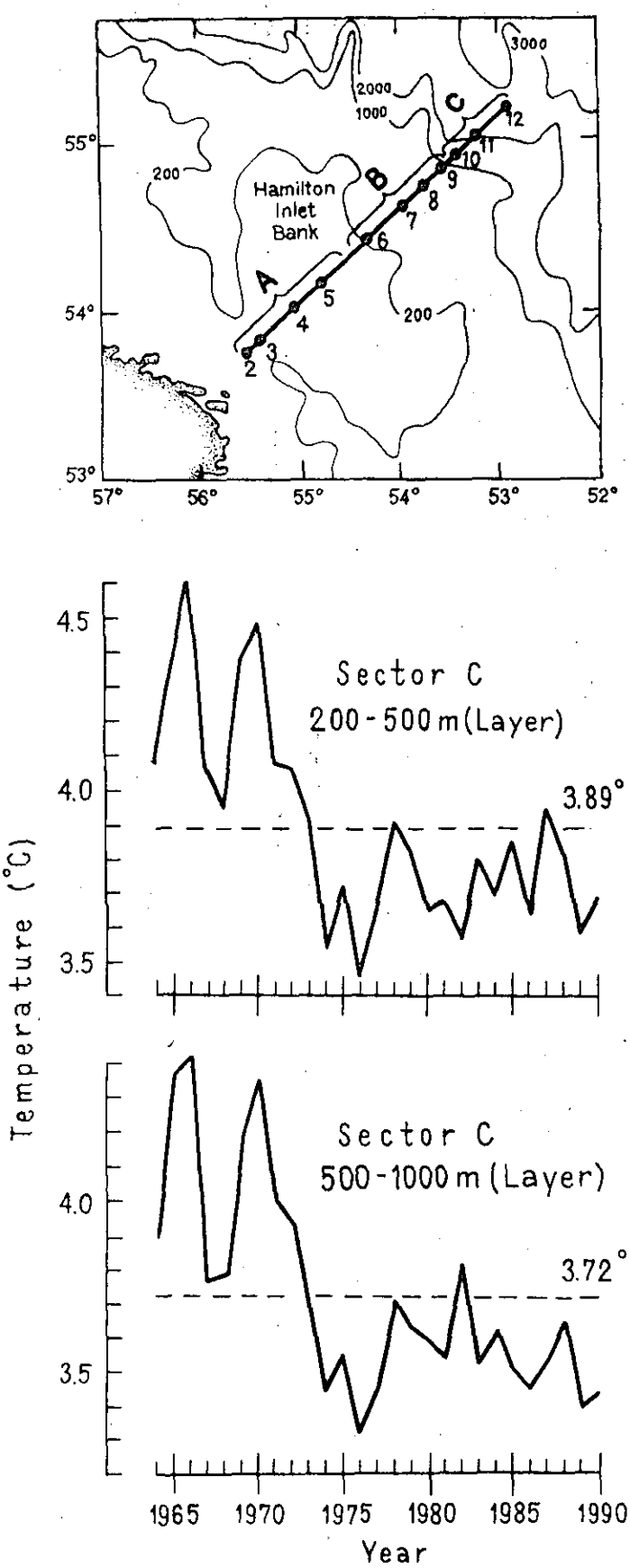


Fig. 4. Position of standard hydrographic transect 8A and mean water temperatures as of November, 1 for each year in 200-500 m and 500-1000 m within sector C. Dashed line shows mean water temperature for 1964-1990.

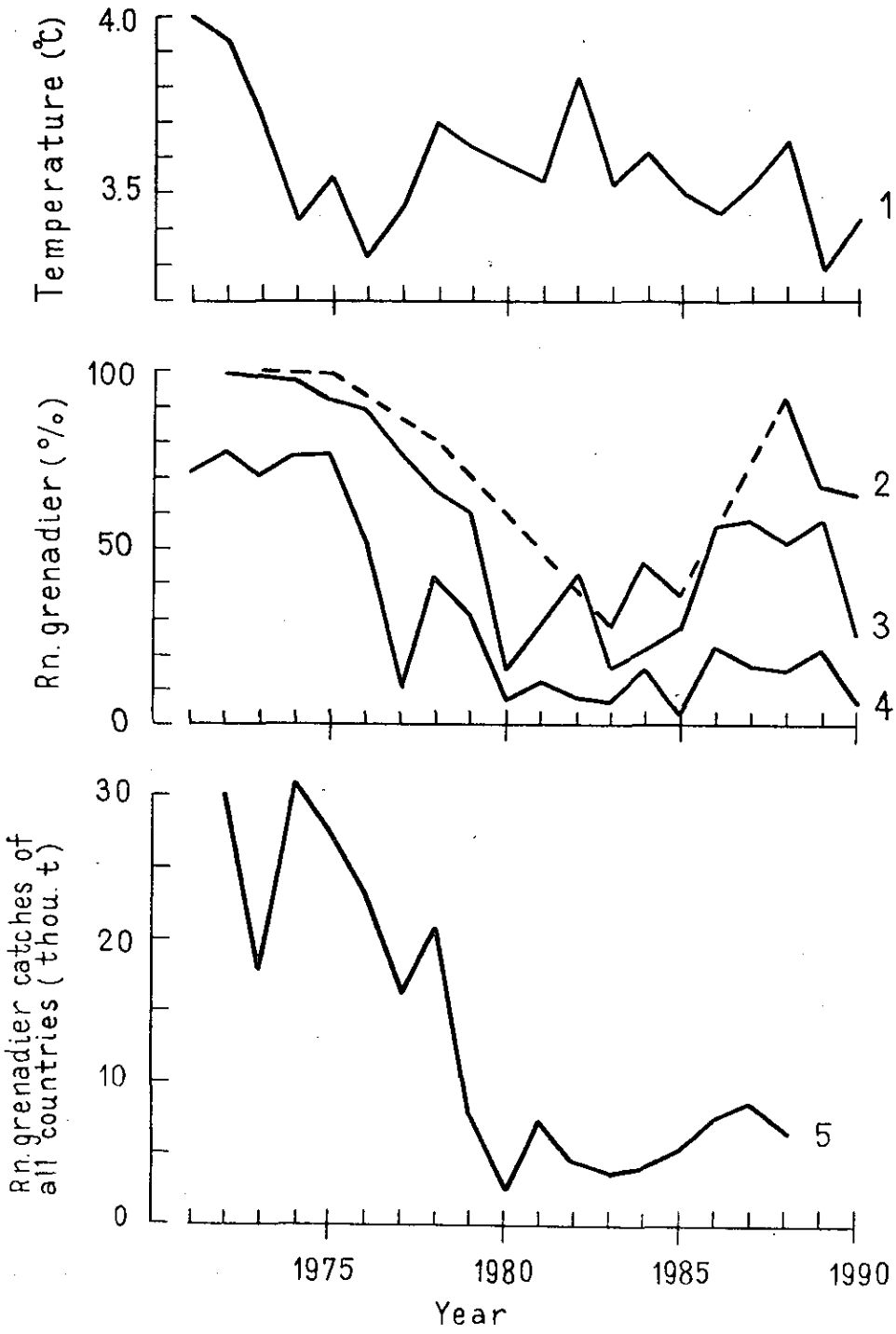
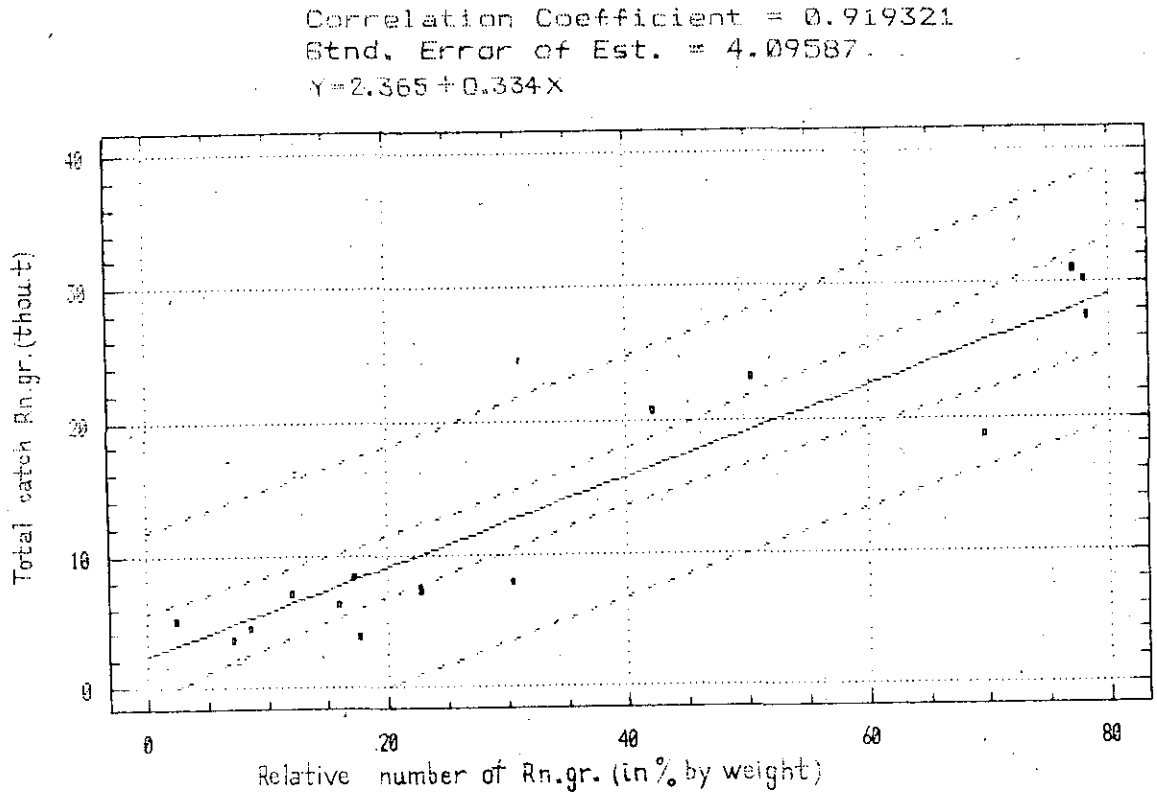


Fig. 5. Mean water temperature in 500-1000 m on hydrographic transect 8A, sector C (I), roundnose grenadier percentage by weight in total catch of Subareas 0, 2, 3 at depth 1201-1400 m (2), 1001-1200 m (3), 501-1000 m (4) and total catch of roundnose grenadier (5).



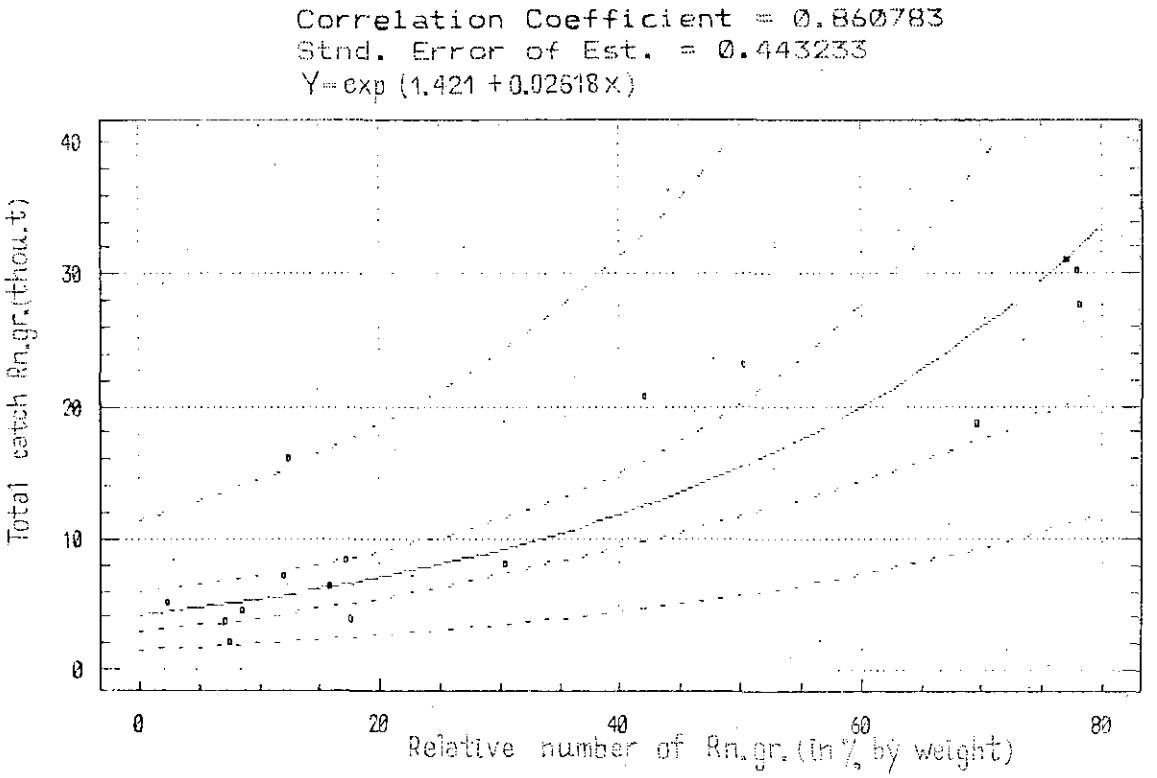


Fig. 6. Relationship between roundnose grenadier percentage in research catches from 501-1000 m depth and total catch of roundnose grenadier in Subareas 0, 2, 3 in 1972-1988.

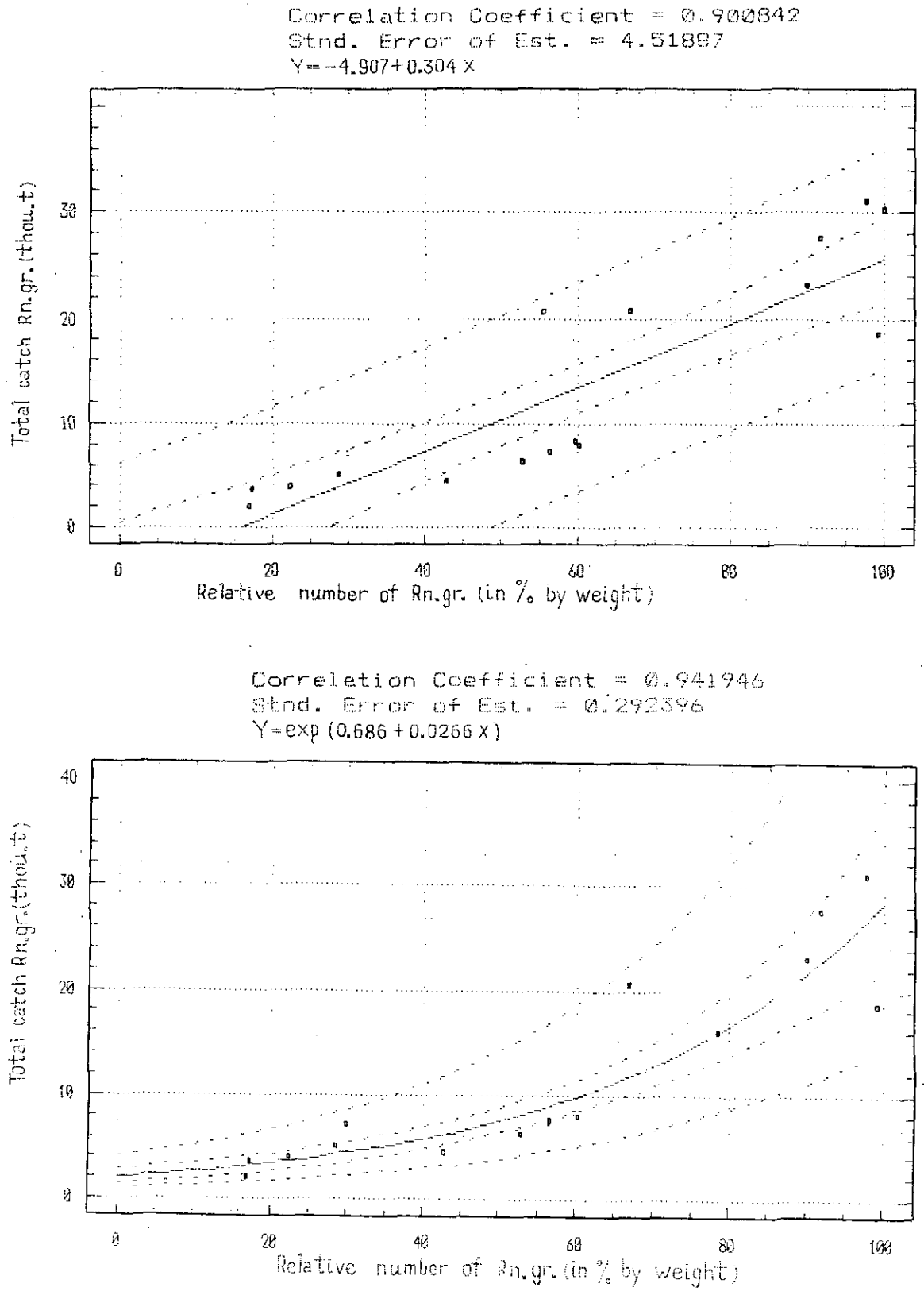
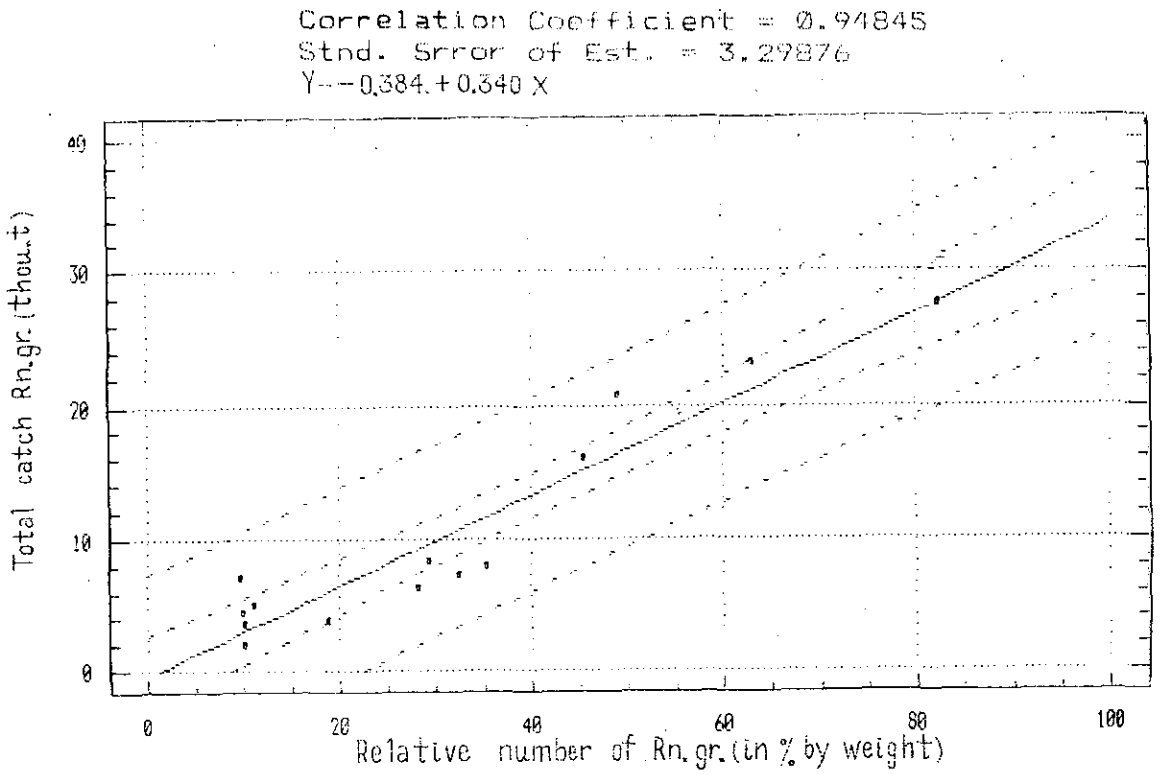


Fig. 7. Relationship between roundnose grenadier percentage in research catches from 1001-1200 m depth and total catch of roundnose grenadier in Subareas 0, 2, 3 in 1972-1988.



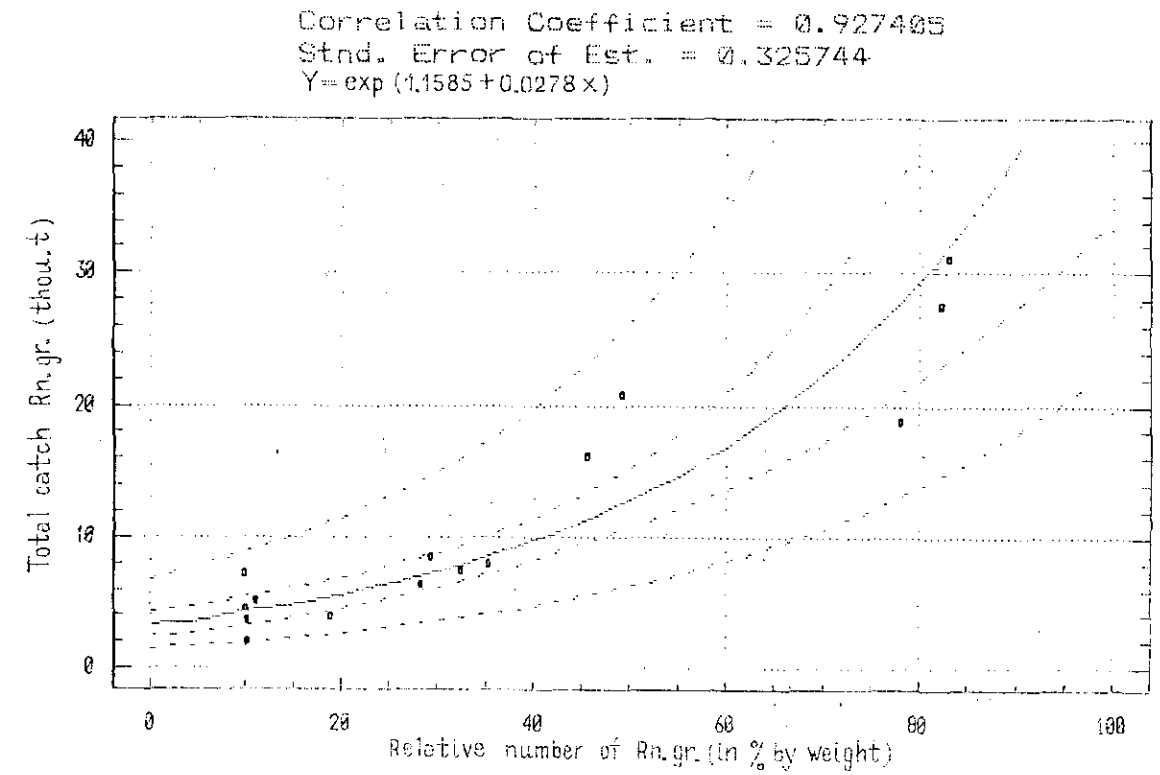


Fig. 8. Relationship between roundnose grenadier percentage in research catches from 501-1200 m depth and total catch of roundnose grenadier in Subareas 0, 2, 3 in 1972-1988.