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On Correlation Between Total Length and Pre-anal Length of Roundnose Grenadier (*Coryphaenoides rupestris*) in the North Atlantic

by

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ABSTRACT

The problem how to take mass length measurements of roundnose grenadier appears still unsettled. Some authors suggested that a pre-anal length of roundnose grenadier be measured in place of total length, but this may make it difficult the conversion to total length and comparison of data from two ways of measurement, because pre-anal length is different in males and females of the same size and its absolute and relative values vary unevenly with increasing fish size. Additionally, the variation range of pre-anal length is greater than that of total length, that is why total length measurements are more accurate.

INTRODUCTION

Problems related to length measurements of roundnose grenadier had arisen when determining length-weight and age compositions of catches of roundnose grenadier for evaluation of the stock status and optimum catch. A great number of fish had their whip-shaped tails broken, which made it difficult total length measurements. Many researchers had been hampered by the problem of selection of fish with complete tails from catches, when measurements of numbers of fish were taken. When it is difficult or impossible to measure total length of fish, normally a partial length is taken (that of head, to the end of caudal peduncle, to beginning of one of fins etc.). This way of measurement is quite appropriate provided that a species of fish is identified, because interspecific morphological features of fish are notably different in most cases. However, before analysing the results of partial length measurements to stu-

dy the dynamics of size-weight and age composition, it should be investigated if these are correlated with total length measurements. That is the aim of the present paper.

In 1976 Jensen (1976) suggested to measure roundnose grenadier from tip of the snout to the beginning of the anal fin, i.e. to record pre-anal length to the nearest 0.5 cm, he presented a formula for conversion of pre-anal length to total length. Some papers on the problem had been provided by researchers from different countries in subsequent years. An overview of information presented in those papers was given by Atkinson (1980), and no pronounced differences in pre-anal lengths of males and females of the same size were reported. Atkinson (1979) pointed out that the results of studies of roundnose grenadier by Canadian scientists evidenced that there might be differences in pre-anal lengths of males and females of the same total length and that the formula suggested by Jensen should be used with caution.

Soviet investigations carried out on limited material confirmed a point-view of Atkinson that pre-anal length might be different in males and females of roundnose grenadier with the same total length (Savvatimsky, 1981). Material presented in the given paper allowed to estimate these differences, to determine variations in pre-anal length with increasing fish size.

MATERIAL and METHODS

Three sets of measurements of pre-anal length and total length were obtained from males and females of roundnose grenadier sampled with the bottom trawl in three areas in the North Atlantic (Table 1).

Fish with complete tails were selected. Their total lengths were measured to the nearest 1 cm and pre-anal lengths (i.e. from the tip of the snout to the first ray of the anal fin along the median axis of the body) to the nearest 1 mm. All total length measurements were reported in 3 cm groupings: 30-32, 33-35, 36-38 etc. to make data processing easier (Tables 2-4). Weight measurements were made to the nearest 10 g. To estimate the variation in pre-anal length and total length fish measured were reported in 100 g groupings: 0-100, 101-200, 201-300 etc. Only those length and weight groupings were compared and analysed which contained

measurements of over 8-10 individuals.

Besides the aforesaid material Fig.2 contains also sets of pre-anal and total length measurements of roundnose grenadier caught on 24-26 November, 1979 in Div. 2G and 22-25 November, 1980 south-west of the Faeroes (Savvatimsky, 1981).

Curves in Figs. 1 and 2 are smoothed following the method described in earlier papers (Savvatimsky, 1981).

RESULTS

Tables 2-4 show means of pre-anal length, with total lengths being identical. It can be seen that pre-anal length of females is in most cases greater than that of males. Fig.1 shows more pronounced variations, pre-anal length measurements are smoothed. It should be noted that in sample No.1 which contained mostly small fish these variations were insignificant. Differences in pre-anal lengths of males and females in samples Nos. 2 and 3 which had larger fish were more pronounced(Fig.1). It may be thus inferred that with total length increasing differences in pre-anal lengths of males and females become greater. This was confirmed by results of the study of 5 samples collected in different areas of the North Atlantic (Fig.2).

It is worth attention that with total length increasing the absolute value of pre-anal length grows and relative one (% of total length) declines, this occurs differently in males and females. Evidently a curvilinear relationship exists between such variations (Fig.2).

In order to find if the difference in pre-anal lengths of males and females was significant, a check was made of the significance of the difference between selected means, pre-anal length being expressed in per cent of total length. Estimated values of significance criterion at 95% probability were much higher for samples Nos. 2 and 3 containning larger fish than for sample No.1 (Table 5), differences being considered statistically reliable. These calculations showed again increasing differences in pre-anal lengths of males and females of roundnose grenadier with increasing fish size.

Results of comparison of length measurements from the whole

sample are not always reliable because there are different sized individuals in it. In this case difference may be recorded in pre-anal length due to different size of males and females. To obtain more reliable values, narrow total length ranges covering largest fish were selected from samples. A correlation between absolute and relative pre-anal lengths of males and females evidenced the differences in all instances be statistically reliable at 95% probability (Table 6).

Our studies show that total length measurements are more accurate, because pre-anal length is small compared to total length (18-25%) and evidently it is not sufficient to measure it to the nearest 0.5 cm. Variations in pre-anal lengths of males and females with total lengths being identical are rather great: 2-3 cm in small fish and 5 cm and more in larger individuals. For example, males of roundnose grenadier from the Hatton bank with total lengths of 87-89 cm had pre-anal lengths of 15.0 cm to 19.8 cm, and with total lengths of 90-92 cm - pre-anal lengths of 15.9 cm to 24.0 cm. The correlation between total length and pre-anal length measurements from two samples divided into 100 g groupings evidenced that both in males and females variation coefficients of pre-anal length frequencies were in all instances much higher than of total length (Tables 7-8).

CONCLUSION

There exist real differences in pre-anal lengths of males and females of roundnose grenadier from the North Atlantic, their total lengths being identical. These differences grow greater with the linear size of fish increasing, but differently in males and females. Variations in pre-anal lengths of males and females with the same total length are significant and become stronger with growth of fish length. Variation coefficients of pre-anal length frequencies for fish within the same weight grouping are much higher than those of total length frequencies. That is why, it is doubtful whether there is reason to measure pre-anal length of roundnose grenadier in place of total length.

References

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Table 1. General information.

Sample No.	Date	Area	Latitude N	Longitude W	Depth m	Number of individuals	
						Males	Female
1	14 Jan 1984	Div.3K	50°36'	50°42'	640-650	250	150
2	4 Dec 1983	Div.2G	58°14'	59°37'	1000-1010	220	180
3	9 Oct 1983	Hatton bank	57°02'	19°56'	840-920	275	125

Table 2. Pre-anal length (aA) of males and females of roundnose grenadier in Div. 3K on 14.January 1984.

Length, cm	Males			Females		
	aA, cm	aA, %	Number	aA, am	aA, %	Number
27-29	6,6	23,7	2	-	-	-
30-32	7,1	22,9	1	-	-	-
33-35	7,2	21,3	2	7,3	21,6	2
36-38	8,3	22,6	6	8,5	23,0	6
39-41	8,7	21,8	14	9,1	22,8	9
42-44	9,6	22,3	15	9,5	22,1	13
45-47	10,0	21,7	18	10,3	22,3	16
48-50	10,3	21,1	36	10,5	21,5	20
51-53	10,8	20,8	25	11,0	21,1	13
54-56	11,4	20,7	40	11,6	21,0	16
57-59	12,0	20,7	44	12,2	21,1	24
60-62	12,7	20,8	14	12,5	20,4	11
63-65	13,3	20,8	8	13,2	20,7	5
66-68	13,4	20,0	12	14,2	21,2	8
69-71	13,7	19,6	5	14,5	20,7	4
72-74	14,9	20,5	4	14,8	20,3	1
75-77	14,2	18,7	4	15,4	20,3	2

Table 3. Pre-anal length (aA) of males and females of roundnose grenadier in Div.2G on 4 December, 1983

Length, cm	Males			Females		
	aA, cm	aA, %	Number	aA, cm	aA, %	Number
33-35	7,1	21,0	4	6,5	19,1	1
36-38	7,8	21,1	2	-	-	-
39-41	8,9	22,2	1	8,9	22,2	3
42-44	8,6	19,9	8	8,8	20,6	2
45-47	9,6	20,9	12	9,8	21,4	6
48-50	9,8	20,0	16	10,1	20,7	7
51-53	10,7	20,5	17	11,0	21,1	16
54-56	11,3	20,5	25	11,5	21,0	24
57-59	11,7	20,1	29	11,8	20,4	21
60-62	12,3	18,4	19	12,9	21,1	12
63-65	12,8	19,9	22	13,3	20,7	16
66-68	13,2	19,7	26	13,5	20,1	20
69-71	13,6	19,4	11	14,2	20,2	11
72-74	14,4	19,7	12	15,0	20,6	17
75-77	14,7	19,3	9	14,7	19,3	7
78-80	15,6	19,7	4	15,9	20,2	4
81-83	14,8	18,0	3	16,9	20,6	7
84-86	-	-	-	18,0	21,2	1
87-89	-	-	-	19,0	21,6	2
90-92	-	-	-	18,9	20,5	1
93-95	-	-	-	21,5	22,9	1
96-98	-	-	-	20,2	20,8	1

Table 4. Pre-anal length (aA) of males and females of roundnose grenadier from the Hatton bank on 9 October, 1983

Length cm	Males			Females		
	aA, cm	aA, %	Number	aA, cm	aA, %	Number
33-35	8,7	25,6	I	-	-	-
36-38	8,6	23,4	2	-	-	-
39-4I	-	-	-	-	-	-
42-44	9,7	22,7	2	-	-	-
45-47	I0,0	2I,7	I	-	-	-
48-50	II,5	23,5	2	-	-	-
5I-53	I2,6	24,2	I	-	-	-
54-56	II,6	2I,I	3	-	-	-
57-59	I2,5	2I,6	8	-	-	-
60-62	I3,2	2I,6	4	-	-	-
63-65	I3,5	2I,0	II	-	-	-
66-68	I4,3	2I,3	6	-	-	-
69-7I	I4,7	2I,0	I5	-	-	-
72-74	I5,I	20,7	20	I4,7	20,I	2
75-77	I5,4	20,3	2I	I6,5	2I,7	6
78-80	I6,I	20,4	40	I7,I	2I,7	5
8I-83	I6,9	20,6	29	I7,8	2I,7	I3
84-86	I7,3	20,4	44	I7,8	2I,0	II
87-89	I7,8	20,2	29	I8,5	2I,I	I6
90-92	I8,3	20,I	20	20,0	22,0	I8
93-95	I9,3	20,5	8	20,0	2I,2	24
96-98	I9,6	20,2	5	20,4	2I,I	I4
99-I0I	20,3	20,3	2	2I,4	2I,4	8
I02-I04	20,0	I9,4	I	2I,2	20,5	3
I05-I07	-	-	-	23,5	22,2	3
I08-II0	-	-	-	2I,8	20,0	2

Table 5. Differences in pre-anal lengths (% of total length) of males and females of roundnose grenadier from samples collected in Divs. 3K, 2G and Hatton bank.

Sample No.	Number of total length groupings	Total length groupings cm	Sex	Number of fish, spec.	M ± m	S ± s	V ± v	Number of degrees of freedom	T	Significance of differences (+, −)
I	I2	from 36-38	males	237	2I,02±0,22	0,77±0,I6	3,66±0,78	22	I,44	−
		to 69-7I	females	I45	2I,47±0,2I	0,74±0,I5	3,43±0,73			
2	I2	from 45-47	males	202	I9,93±0,I2	0,40±0,08	2,03±0,43	22	3,99	+
		to 78-80	females	I6I	20,56±0,I0	0,36±0,07	I,76±0,37			
3	II	from 72-74	males	2I9	20,26±0,08	0,28±0,06	I,37±0,3I	20	I0,I7	+
		to I02-I04	females	I20	2I,32±0,06	0,20±0,04	0,95±0,2I			

Note: M ± m - mean pre-anal length and error

S ± s - standard deviation and error

V ± v - variation coefficient and error

T - confidence criterion

Table 6. Differences in pre-anal lengths (aA in cm and per cent of total length) of males and females of roundnose grenadier from the Hatton bank in 3 cm total length groupings.

aA	Total length grouping, cm	Sex	Number of specimens	M ± m	S ± s	V ± v	Number of degrees of freedom	T	Significance of differencies (+; −)
	87–89	males	29	I7,68±0,2I	I,II±0,I4	6,27±0,84	43	2,39	+
		females	I6	I8,52±0,29	I,I5±0,20	6,I9±I,I3			
	90–92	males	20	I8,29±0,38	I,7I±0,27	9,35±I,53	36	2,34	+
		females	I8	I9,47±0,3I	I,34±0,22	6,87±I,I8			
	78–89	males	29	20,I0±0,23	I,25±0,I6	6,20±0,83	43	2,57	+
		females	I6	2I,I2±0,33	I,32±0,23	6,24±I,I4			
	90–92	males	20	20,I5±0,43	I,9I±0,30	9,50±I,55	36	2,3I	+
		females	I8	2I,43±0,34	I,42±0,24	6,65±I,I4			

Note: For symbols see Table 5.

Table 7. Statistical characteristics of total and pre-anal lengths of roundnose grenadier in different weight groupings :Div. 2G (sample No.2).

Sex	Description	Weight range and statistical characteristics (total length/pre-anal length)						
Males	Weight groupings,g	101-200	201-300	301-400	401-500	501-600	601-700	701-800
	Number of fish	21	44	43	41	34	12	12
	M ± m	44,5±0,9	51,6±0,5	57,2±0,4	62,2±0,4	67,7±0,4	72,0±0,8	75,2±0,9
		9,22±0,20	10,50±0,14	11,56±0,12	12,47±0,12	13,34±0,13	14,57±0,37	14,58±0,26
	S ± s	4,37±0,67	3,23±0,34	2,58±0,28	2,75±0,30	2,53±0,31	2,83±0,58	2,98±0,61
		0,92±0,14	0,94±0,10	0,76±0,08	0,79±0,09	0,75±0,09	1,29±0,27	0,89±0,18
	V	9,82 / 9,96	6,26 / 8,92	4,50 / 6,62	4,43 / 6,35	3,73 / 5,60	3,93 / 8,84	3,95 / 6,13
Females	Weight groupings,g	201-300	301-400	401-500	501-600	601-700	701-800	801-900
	Number of fish	31	35	24	22	25	14	11
	M ± m	51,6±0,6	56,0±0,3	62,0±0,6	65,4±0,6	70,1±0,5	74,6±0,8	78,0±1,1
		10,94±0,17	11,58±0,11	12,88±0,20	13,29±0,23	14,33±0,23	14,78±0,24	15,63±0,37
	S ± s	3,24±0,41	2,06±0,25	2,85±0,41	2,82±0,42	2,67±0,38	3,09±0,58	3,52±0,75
		0,93±0,12	0,63±0,08	0,96±0,14	1,09±0,16	1,17±0,16	0,91±0,17	1,21±0,26
	V	6,28 / 8,54	3,67 / 5,48	4,60 / 7,48	4,32 / 8,17	3,81 / 8,16	4,14 / 6,18	4,51 / 7,78

Note: For symbols see Table 5.

Table 8. Statistical characteristics of total and pre-anal lengths of roundnose grenadier from different weight groupings, Hatton bank (sample No. 3).

Sex	Description	Weight range and statistical characteristics (total length/pre-anal length)						
Males	Weight groupings, g	701–800	801–900	901–1000	1001–1100	1101–1200	1201–1300	1301–1400
	Number of fish	22	36	34	40	39	19	13
	M ± m	74,3±0,6 / 15,05±0,20	78,0±0,4 / 16,44±0,20	81,6±0,6 / 16,53±0,18	84,7±0,5 / 17,06±0,14	86,5±0,6 / 17,46±0,15	89,1±1,0 / 18,35±0,25	91,5±0,6 / 19,26±0,48
	S ± s	2,82±0,42 / 0,92±0,14	2,37±0,28 / 1,23±0,14	3,60±0,44 / 1,04±0,13	3,06±0,34 / 0,92±0,10	3,47±0,39 / 0,96±0,11	4,22±0,68 / 1,11±0,18	2,10±0,41 / 1,74±0,34
	V	3,79 / 6,11	3,04 / 7,47	4,41 / 6,29	3,61 / 5,39	4,01 / 5,49	4,73 / 6,05	2,29 / 9,03
Females	Weight groupings, g	1101–1200	1201–1300	1301–1400	1401–1500	1501–1600	1601–1700	1701–1800
	Number of fish	10	8	14	25	20	5	10
	M ± m	83,4±0,9 / 17,42±0,25	85,1±0,8 / 18,66±0,34	86,6±0,9 / 18,40±0,32	90,2±0,7 / 19,02±0,27	93,1±0,6 / 19,97±0,27	96,6±1,3 / 20,62±0,72	95,5±0,6 / 19,50±0,43
	S ± s	2,97±0,66 / 0,78±0,17	2,20±0,55 / 0,95±0,24	3,46±0,65 / 1,20±0,23	3,57±0,50 / 1,36±0,19	2,90±0,46 / 1,20±0,19	3,01±0,95 / 1,60±0,51	2,01±0,45 / 1,37±0,31
	V	3,56 / 4,47	2,59 / 5,10	3,99 / 6,55	3,96 / 7,17	3,12 / 6,00	3,11 / 7,77	2,11 / 7,02

Note: For symbols see Table 5.

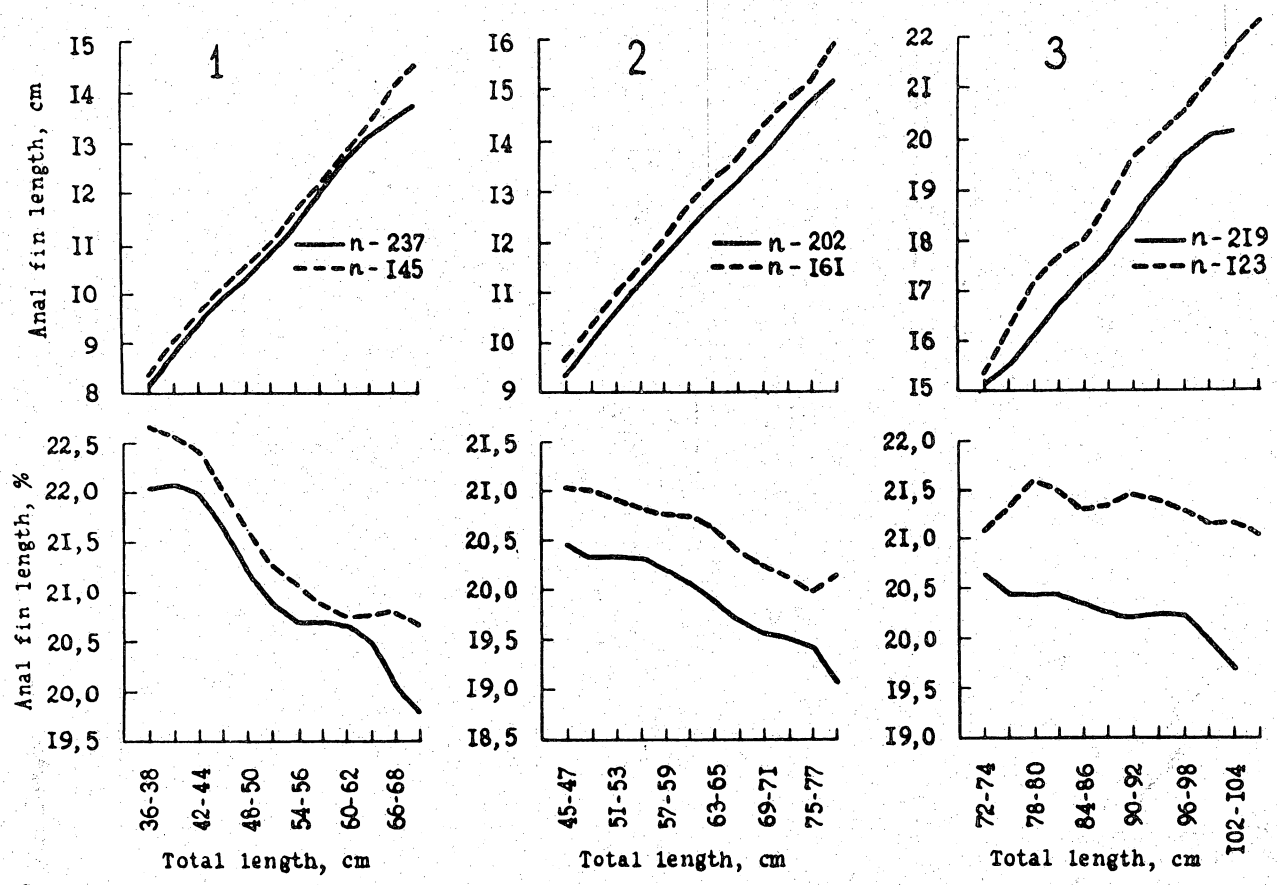

Fig. 1 Pre-anal length in cm and per cent of total length of males (solid line) and females (broken line) of roundnose grenadier with different length: 1 - Div.3K, 2 - Div.2G, 3 - Hatton bank.

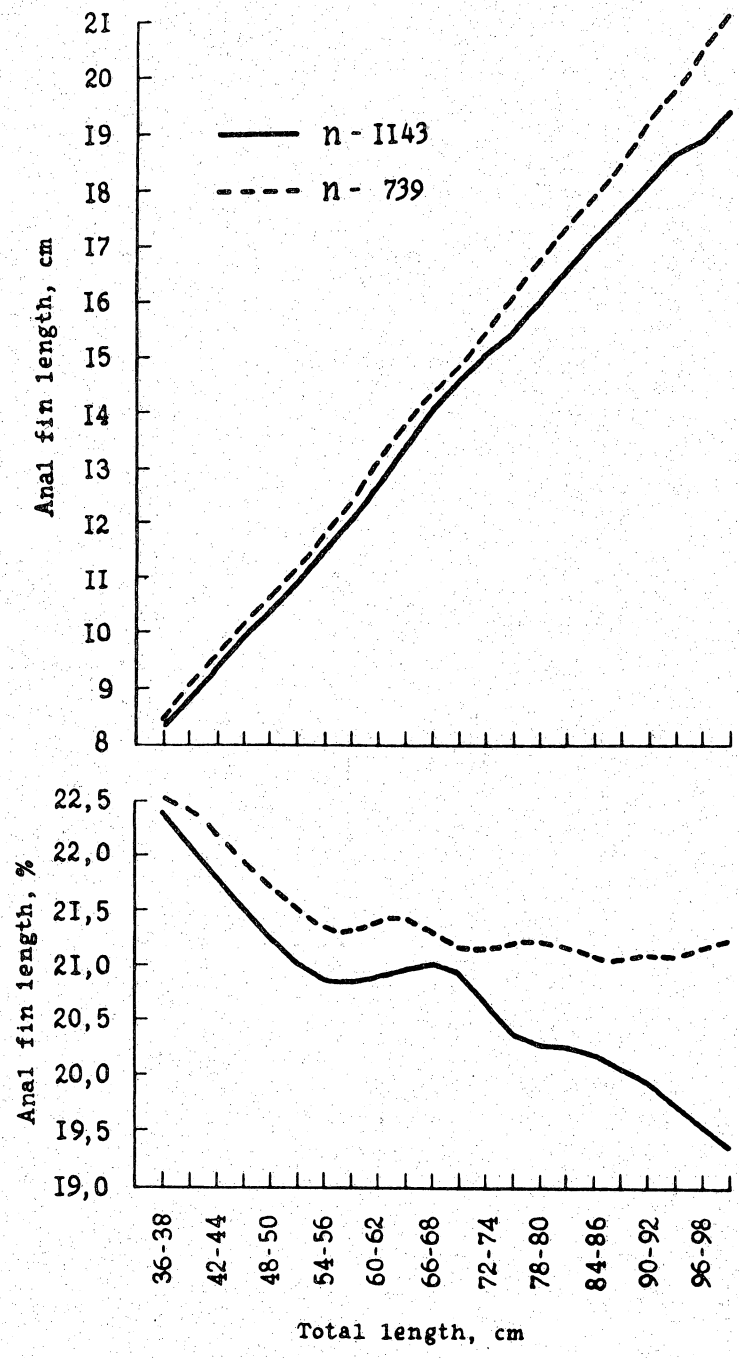

Fig. 2 Pre-anal length in cm and per cent of total length of males (solid line) and females (broken line) of roundnose grenadier of different length in catches taken in the North Atlantic.