

# On Correlation Between Total Length and Preanal Length of Roundnose Grenadier in the North Atlantic

P. I. Savvatimsky

Polar Research Institute of Marine Fisheries and Oceanography (PINRO)  
6 Knipovich Street, Murmansk 183763, USSR

## Abstract

Although preanal length has been recommended as a replacement for total length in measuring roundnose grenadier (*Coryphaenoides rupestris*), the analyses in this paper indicate that preanal lengths of females are greater than those for males of the same total length, the differences increasing unevenly with fish size. The absence of a simple linear relationship between preanal length and total length complicates the accurate conversion of preanal lengths to total lengths. Also, the coefficients of variation of preanal lengths are substantially greater than those of total lengths, although preanal length is only about 20% of total length, implying that total length is a more precise measurement for biological studies.

## Introduction

Problems related to length measurements of roundnose grenadier have arisen when determining length-weight relationships and age compositions of catches for use in analytical assessments of the stocks. Many of the fish have broken or regenerated tails, which make it difficult to obtain consistently reliable total length measurements of random samples of the catches. In such cases, researchers look for some partial length measurement (e.g. snout to end of caudal peduncle, snout to anterior part of one of the fins, etc.) as a substitute for total length.

Jensen (MS 1976) recognized the problem of tail breakage and suggested that roundnose grenadier should be measured from the tip of the snout to the beginning of the anal fin (hereinafter termed "preanal length") to the nearest 0.5 cm, and he presented a formula for converting this partial length to total length. Atkinson (MS 1979) pointed out that preliminary studies by Canadian scientists indicated that there might be differences in preanal lengths of males and females of the same total length and that the formula of Jensen (MS 1976) should be used with caution. An overview of information in these papers and the results of additional studies by Canadian scientists were presented by Atkinson (1981), indicating that there were no pronounced differences in preanal lengths of male and female roundnose grenadier of the same total length. At its meeting in June 1980, the Scientific Council of NAFO recommended that length measurements of grenadiers should be reported as preanal length in 0.5 cm intervals (NAFO, 1980).

A subsequent study of limited material by Savvatimsky (MS 1981) indicated that preanal lengths might be different for male and female roundnose grenadier of the same total length. The aim of this paper is to present the results of analyzing the variation in preanal

length with increasing fish size, based on roundnose grenadier samples from three regions of the North Atlantic.

## Materials and Methods

Three sets of measurements of total length and preanal length of male and female roundnose grenadier were obtained from bottom-trawl catches in two regions of the Northwest Atlantic and one region of the Northeast Atlantic (Table 1). Only fish with complete tails were selected for measurement. Total length was measured to the nearest 1 cm, and preanal length (tip of snout to first ray of anal fin along median axis of body) was recorded to nearest 0.1 cm. Total body weight was measured to the nearest 1 g. The curves in Fig. 1 and 2 were smoothed by using the formula  $(a+2b+c)/4 = b'$ , where a, b and c are consecutive preanal-length means.

To facilitate analysis, the data were grouped by 3-cm total-length classes (e.g. 30-32, 33-35, etc.). For comparison of the variations in total length and preanal length, the data were grouped by 100-g weight classes (e.g. 301-400, 401-500, etc.). Standard parametric statistical procedures were employed, which involved the calculation of means, standard deviations (SD), standard errors (SE) and coefficients of variation (CV), and

TABLE 1. General information on roundnose grenadier samples from the North Atlantic. (M = male; F = female.)

	Sample 1	Sample 2	Sample 3
Date	14 Jan 1984	04 Dec 1983	09 Oct 1983
Area	Div. 3K	Div. 2G	Hatton Bank
Position	50°36'N 50°42'W	58°14'N 59°37'W	57°02'N 19°56'W
Depth (m)	640-650	1,000-1,010	840-920
No. of fish	250 M, 150 F	220 M, 180 F	275 M, 125 F

TABLE 2. Mean preanal length (A cm) and percent preanal length of total length (A%) for male and female roundnose grenadier from three areas of the North Atlantic.

Total length (cm)	Northeast Newfoundland (Div. 3K)						Northern Labrador (Div. 2G)						Hatton Bank (NE Atlantic)						
	Male			Female			Male			Female			Male			Female			
	No.	A cm	A%	No.	A cm	A%	No.	A cm	A%	No.	A cm	A%	No.	A cm	A%	No.	A cm	A%	
27-29	2	6.6	23.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30-32	1	7.1	22.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33-35	2	7.2	21.3	2	7.3	21.6	4	7.1	21.0	1	6.5	19.1	1	8.7	25.6	—	—	—	—
36-38	6	8.3	22.6	6	8.5	23.0	2	7.8	21.1	—	—	—	2	8.6	23.4	—	—	—	—
39-41	14	8.7	21.8	9	9.1	22.8	1	8.9	22.2	3	8.9	22.2	—	—	—	—	—	—	—
42-44	15	9.6	22.3	13	9.5	22.1	8	8.6	19.9	2	8.8	20.6	2	9.7	22.7	—	—	—	—
45-47	18	10.0	21.7	16	10.3	22.3	12	9.6	20.9	6	9.8	21.4	1	10.0	21.7	—	—	—	—
48-50	36	10.3	21.1	20	10.5	21.5	16	9.8	20.0	7	10.1	20.7	2	11.5	23.5	—	—	—	—
51-53	25	10.8	20.8	13	11.0	21.1	17	10.7	20.5	16	11.0	21.1	1	12.6	24.2	—	—	—	—
54-56	40	11.4	20.7	16	11.6	21.0	25	11.3	20.5	24	11.5	21.0	3	11.6	21.1	—	—	—	—
57-59	44	12.0	20.7	24	12.2	21.1	29	11.7	20.1	21	11.8	20.4	8	12.5	21.6	—	—	—	—
60-62	14	12.7	20.8	11	12.5	20.4	19	12.3	18.4	12	12.9	21.1	4	13.2	21.6	—	—	—	—
63-65	8	13.3	20.8	5	13.2	20.7	22	12.8	19.9	16	13.3	20.7	11	13.5	21.0	—	—	—	—
66-68	12	13.4	20.0	8	14.2	21.2	26	13.2	19.7	20	13.5	20.1	6	14.3	21.3	—	—	—	—
69-71	5	13.7	19.6	4	14.5	20.7	11	13.6	19.4	11	14.2	20.2	15	14.7	21.0	—	—	—	—
72-74	4	14.9	20.5	1	14.8	20.3	12	14.4	19.7	17	15.0	20.6	20	15.1	20.7	2	14.7	20.1	—
75-77	4	14.2	18.7	2	15.4	20.3	9	14.7	19.3	7	14.7	19.3	21	15.4	20.3	6	16.5	21.7	—
78-80	—	—	—	—	—	—	4	15.6	19.7	4	15.9	20.2	40	16.1	20.4	5	17.1	21.7	—
81-83	—	—	—	—	—	—	3	14.8	18.0	7	16.9	20.6	29	16.9	20.6	13	17.8	21.7	—
84-86	—	—	—	—	—	—	—	—	—	1	18.0	21.2	44	17.3	20.4	11	17.8	21.0	—
87-89	—	—	—	—	—	—	—	—	—	2	19.0	21.6	29	17.8	20.2	16	18.5	21.1	—
90-92	—	—	—	—	—	—	—	—	—	1	18.9	20.5	20	18.3	20.1	18	20.0	22.0	—
93-95	—	—	—	—	—	—	—	—	—	1	21.5	22.9	8	19.3	20.5	24	20.0	21.2	—
96-98	—	—	—	—	—	—	—	—	—	1	20.2	20.8	5	19.6	20.2	14	20.4	21.1	—
99-101	—	—	—	—	—	—	—	—	—	—	—	—	1	20.3	20.3	8	21.4	21.4	—
102-104	—	—	—	—	—	—	—	—	—	—	—	—	—	20.0	19.4	3	21.2	20.5	—
105-107	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	23.5	22.2	—
108-110	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	21.8	20.0	—

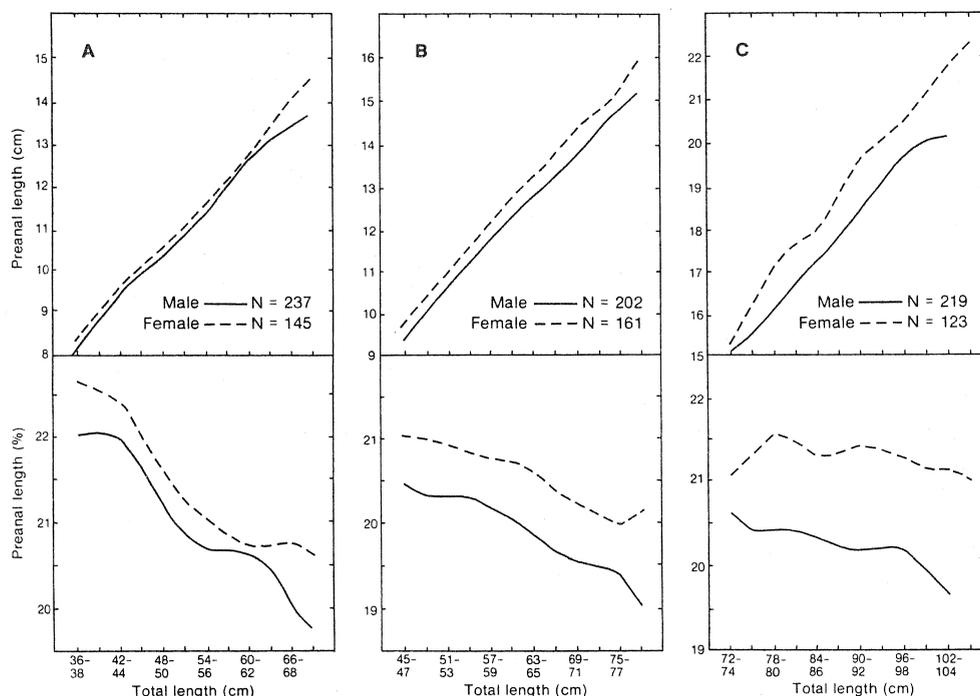


Fig. 1. Trends in absolute and relative (percent of total length) preanal length with increasing total length of male and female roundnose grenadier from (A) northeastern Newfoundland, (B) northern Labrador, (C) Hatton Bank.

the application of t-tests whereby differences between means were considered significant when  $P < 0.05$  for the appropriate degrees of freedom (df).

## Results and Discussion

The mean preanal lengths of roundnose grenadier from each area, for most of the total-length classes were greater for females than for males (Table 2). The differences were less apparent in the sample from Div. 3K, which contained mostly small fish, than in the samples of larger fish from the other areas (Fig. 1). For the larger fish, the differences tended to increase with fish size. This trend is particularly well illustrated in Fig. 2, which is based on the combination of data presented in this paper and data for two other samples from the North Atlantic (Div. 2G in November 1979 and southwest of Faroe Islands in November 1980) (Savvatimsky, MS 1981). The ratios of preanal length to total length (expressed as percentages) consistently declined for both sexes in small fish up to about 55 cm TL. For the larger fish (>70 cm TL), the percentages were relatively constant at about 22% for females but continued to decline from about 21 to 19.5% for males. Evidently, different non-linear relationships exist between preanal length and total length of males and females.

In order to determine if the differences in preanal length of female and male roundnose grenadier are statistically significant, the standard t-test was applied to the mean proportions (preanal length as percent of total length) for females and males from each area over a common total length range (Table 3). The results indicated that the difference between females and males was statistically significant ( $P < 0.05$ ) for the Labrador (Div. 2G) and Hatton Bank samples but not for the sample of smaller fish taken off northeastern Newfoundland (Div. 3K). These calculations also indicated increasing differences between preanal length of females and males with increasing fish size.

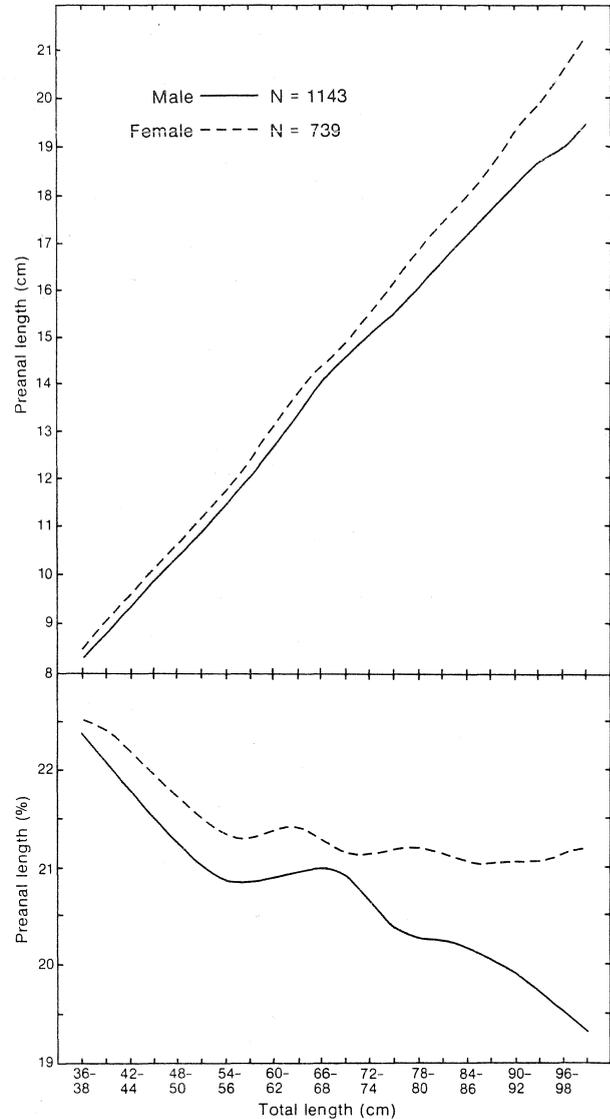


Fig. 2. Trends in absolute and relative (percent of total length) preanal length with increasing total length of male and female roundnose grenadier from the North Atlantic (including two samples reported by Savvatimsky, MS 1981).

TABLE 3. Differences in preanal lengths (as percent of total length) of male and female roundnose grenadier from three areas of the North Atlantic. (SE = standard error, SD = standard deviation, CV = coefficient of variation, df = degrees of freedom, and t = Student's t.)

Area	No. of length groups	Length range (cm)	Sex	No. of fish	Percent preanal length of total length				t-test results	
					Mean	SE	SD	CV	df	t
Div. 3K	12	36-71	Male	237	21.02	0.22	0.77	3.66	22	1.44
			Female	145	21.47	0.21	0.74	3.43		
Div. 2G	12	45-80	Male	202	19.93	0.12	0.40	2.03	22	3.99 <sup>a</sup>
			Female	161	20.56	0.10	0.36	1.76		
Hatton Bank	11	72-104	Male	219	20.26	0.08	0.28	1.37	20	10.17 <sup>a</sup>
			Female	120	21.32	0.06	0.20	0.95		

<sup>a</sup> Highly significant ( $P < 0.01$ )

TABLE 4. Differences in absolute and relative (as percent of total length) values of preanal lengths of male and female roundnose grenadier for two 3-cm total length classes from Hatton Bank. (SE = standard error, SD = standard deviation, CV = coefficient of variation, df = degrees of freedom, and t = Student's t.)

Preanal length parameter	Total length (cm)	Sex	No. of fish	Absolute and relative values of preanal length				t-test results	
				Mean	SE	SD	CV	df	t
Absolute values	87-89	M	29	17.68	0.21	1.11	6.27	43	2.39 <sup>a</sup>
		F	16	18.52	0.29	1.15	6.19		
	90-92	M	20	18.29	0.38	1.71	9.35	36	2.34 <sup>a</sup>
		F	18	19.47	0.31	1.34	6.87		
Relative values	87-89	M	29	20.10	0.23	1.25	6.20	43	2.57 <sup>a</sup>
		F	16	21.12	0.33	1.32	6.24		
	90-92	M	20	20.15	0.43	1.91	9.50	36	2.31 <sup>a</sup>
		F	18	21.43	0.34	1.42	6.65		

<sup>a</sup> Significant (P<0.05)

TABLE 5. Statistical characteristics of total length and preanal length by sex and weight group for samples of roundnose grenadier from two regions of the North Atlantic.

Sex	Weight range (g)	No. of fish	Total length (cm)				Preanal length (cm)			
			Mean	SE	SD	CV	Mean	SE	SD	CV
<b>Div. 2G (Northwest Atlantic)</b>										
Male	101-200	21	44.5	0.9	4.37	9.82	9.22	0.20	0.92	9.96
	201-300	44	51.6	0.5	3.23	6.26	10.50	0.14	0.94	8.92
	301-400	43	57.2	0.4	2.58	4.50	11.56	0.12	0.76	6.62
	401-500	41	62.2	0.4	2.75	4.43	12.47	0.12	0.79	6.35
	501-600	34	67.7	0.4	2.53	3.73	13.34	0.13	0.75	5.60
	601-700	12	72.0	0.8	2.83	3.93	14.57	0.37	1.29	8.84
	701-800	12	75.2	0.9	2.98	3.95	14.58	0.26	0.89	6.13
Female	201-300	31	51.6	0.6	3.24	6.28	10.94	0.17	0.93	8.54
	301-400	35	56.0	0.3	2.06	3.67	11.58	0.11	0.63	5.48
	401-500	24	62.0	0.6	2.85	4.60	12.88	0.20	0.96	7.48
	501-600	22	65.4	0.6	2.82	4.32	13.29	0.23	1.09	8.17
	601-700	25	70.1	0.5	2.67	3.81	14.33	0.23	1.17	8.16
	701-800	14	74.6	0.8	3.09	4.14	14.78	0.24	0.91	6.18
	801-900	11	78.0	1.1	3.52	4.51	15.63	0.37	1.21	7.78
<b>Hatton Bank (Northeast Atlantic)</b>										
Male	701-800	22	74.3	0.6	2.82	3.79	15.05	0.20	0.92	6.11
	801-900	36	78.0	0.4	2.37	3.04	16.44	0.20	1.23	7.47
	901-1000	34	81.6	0.6	3.60	4.41	16.53	0.18	1.04	6.29
	1001-1100	40	84.7	0.5	3.06	3.61	17.06	0.14	0.92	5.39
	1101-1200	39	86.5	0.6	3.47	4.01	17.46	0.15	0.96	5.49
	1201-1300	19	89.1	1.0	4.22	4.73	18.35	0.25	1.11	6.05
	1301-1400	13	91.5	0.6	2.10	2.29	19.26	0.48	1.74	9.03
Female	1101-1200	10	83.4	0.9	2.97	3.56	17.42	0.25	0.78	4.47
	1201-1300	8	85.1	0.8	2.20	2.59	18.66	0.34	0.95	5.10
	1301-1400	14	86.6	0.9	3.46	3.99	18.40	0.32	1.20	6.55
	1401-1500	25	90.2	0.7	3.57	3.96	19.02	0.27	1.36	7.17
	1501-1600	20	93.1	0.6	2.90	3.12	19.97	0.27	1.20	6.00
	1601-1700	5	96.6	1.3	3.01	3.11	20.62	0.72	1.60	7.77
	1701-1800	10	95.5	0.6	2.01	2.11	19.50	0.43	1.37	7.02

Comparison of mean lengths of female and male roundnose grenadier in whole samples may be biased, because the individual length classes usually contained variable numbers of fish. More realistic indication of the differences between females and males may be obtained by comparing mean preanal lengths for narrow ranges of total length (Table 4). From comparisons of both absolute and relative values of preanal

length of large females and males in the same total length classes of the Hatton Bank sample, the differences were significant (P<0.05) in all cases.

To examine the variability in total length and preanal length, the data were grouped by 100-g weight classes for the samples from northern Labrador (Div. 2G) and Hatton Bank (Table 5). Although the mean

preanal lengths were only about 20% of the mean total lengths, the coefficients of variation for the preanal lengths of both males and females were in nearly all cases much larger than those for total lengths.

Variations in preanal lengths of males and females of the same total length are rather large, being 2–3 cm in small fish and 5 cm or more in larger individuals. For example, male roundnose grenadier from Hatton Bank with total lengths of 87–89 cm had preanal lengths of 15.0–19.8 cm, and those with total lengths of 90–92 cm had preanal lengths of 15.9–24.0 cm. It is also evident that total length measurements are more accurate than preanal lengths, because preanal length is much smaller than total length.

Because of the difficulty of ensuring that total length measurements are random samples of the catches due to broken and regenerated tails, preanal length has been recommended for measuring grenadiers (NAFO, 1980). However, the variation associated

with preanal length measurements may be greater than the potential bias associated with total length measurements of only those fish with complete tails. Also, the conversion of preanal lengths to total lengths is complicated by the fact that different relationships (possibly non-linear) are evident for males and females.

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