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BIOMETRIC CHARACTERS AND GROWTH OF GREENLAND HALIBUT *REINHARDTIUS HIPPOGLOSSOIDES* (WALBAUM, 1792) FROM THE BARENTS SEA

CECHY BIOMETRYCZNE ORAZ WZROST HALIBUTA NIEBIESKIEGO *REINHARDTIUS HIPPOGLOSSOIDES* (WALBAUM, 1792) Z MORZA BARENTSA

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The paper describes meristic and metric characters of the Berents Sea population of *Reinhardtius hippoglossoides*. Additionally, the length and age distributions, as well as the rate of length growth and length-weight relationship were estimated.

INTRODUCTION

The present paper is a continuation of a study on morphometry and growth of the Greenland halibut from North Atlantic.

The former paper (Krzykawski, 1991) described the Labrador population. The present work was aimed at comparing results obtained in the Barents Sea with those derived off Labrador. It is, moreover, important that both studies broaden the knowledge on variability in biometric characters of the species as a whole.

MATERIALS AND METHODS

The materials studied, consisting of 127 individuals of Greenland halibut (64 males and 63 females) caught in the Barents Sea (72°34' N; 15°00' E) were collected on 6 May 1977.

The biometric analysis involved 22 measurements and determination of 7 meristic characters of each fish. Measurements of all the metric characters were taken with a ruler or callipers to 0.1 cm. Fish weight was determined to 1 g.

The detailed description of methods and techniques of data analysis is given in Krzykawski (1991).

RESULTS

Biometric characters

Table 1 summarizes the biometric characters of the Greenland halibut population studied, per cent indices being shown.

As seen from the table, a single character only, namely the distance between anal and ventral fins (V–A), shows a significant variability (coefficient of variation exceeding 10%).

A comparison of the mean values of the indices for metric characters summarized in Table 2, demonstrates relatively small (less than 2%) differences between males and females. Females showed a slightly longer head, larger postorbital length, longer upper and lower jaws, and larger preventral and preanal distance. These characters are significantly different between females and males (Table 2). Additionally, the sexes differ significantly from each other in the minimum body height and length of pectoral fin, the mean value of the characters being higher in males. Significant differences between the sexes were also found when comparing metric characters converted to per cent indices with respect to the lateral head length. In this case, significant differences were found between lengths of both the upper and lower jaws and, between the eye diameter (Table 2), the eye diameter being proportionally larger in males.

As in the population of Labrador (Krzykawski, 1991) relationships between metric characters expressed as per cent indices (relative values) and length of the body and head were determined in the population studied in this work. This analysis is summarized in Tables 3 and 4. Data concerning the entire population show only five (out of twenty one) characters to be uncorrelated with the body length, while only two (out of six) characters correlated with the head length. Most characters studied in females were significantly correlated with the body length (lack of significance was found with respect of 7 characters only). Males showed the fewest characters correlated with the head and/or body length. The following six characters correlated significantly with the body length: preorbital length, horizontal eye diameter, head height, minimum body height, predorsal length, and middle ray length in the caudal fin. Significant correlations with the lateral head length were shown for the following three characters: preorbital length, horizontal eye diameter, and head length.

As seen from the above, it is the three characters only, namely the eye diameter, minimum body height, and length of middle rays in the caudal fin, that correlate significantly with body length in the three data sets analyzed: on the other hand, a significant correlation with the lateral head length was revealed for the horizontal eye diameter only.

Table 5 summarizes metric characters of the population from the area of study. As seen from the table, the range of soft rays in the dorsal fin was 82–107, females showing a slightly wider range. Most fishes had 95, 96 and 97 rays; in males individuals

Table 1

Metric characters of Greenland halibut from the Barents Sea as % of longitudo corporis and as % longitudo capitis lateralis

Character	Latin name	% longitudo corporis				
		Range	$\bar{x}$	S	m	V
x_1	longitudo totalis	112.1–117.4	114.9	1.04	0.09	0.91
x_2	longitudo caudalis	110.5–115.4	112.7	0.98	0.09	0.87
x_7	longitudo capitis lateralis	21.2– 27.1	23.8	1.02	0.09	4.27
x_4	longitudo praeorbitale	4.2– 5.9	5.0	0.34	0.03	6.91
x_5	diameter oculi	3.0– 4.8	4.0	0.31	0.03	7.78
x_6	longitudo postorbitale	11.8– 16.3	13.8	0.80	0.07	5.77
x_8	altitudo capitis	11.7– 17.9	14.2	1.16	0.10	8.15
x_9	longitudo ossis maxillare	10.0– 12.7	11.3	0.63	0.06	5.53
x_{10}	longitudo ossis dentale	12.4– 16.1	14.0	0.68	0.06	4.84
x_{11}	altitudo corporis maxima	27.8– 38.2	33.0	1.87	0.17	5.68
x_{12}	altitudo corporis minima	6.6– 9.1	7.8	0.52	0.05	6.66
x_{13}	longitudo praedorsale	8.6– 11.1	9.9	0.56	0.05	5.66
x_{14}	longitudo praeventrale	20.5– 29.6	26.0	1.58	0.14	6.05
x_{15}	longitudo praeanale	31.1– 46.0	37.6	3.14	0.28	8.36
x_{16}	longitudo pedunculi caudae	8.5– 14.5	11.0	0.97	0.09	8.86
x_{17}	altitudo pinnae D	7.5– 14.6	9.1	0.87	0.08	9.54
x_{18}	altitudo pinnae A	7.9– 12.0	10.0	0.86	0.08	8.64
x_{19}	longitudo pinnae P	8.5– 13.0	11.1	0.80	0.07	7.16
x_{20}	longitudo pinnae V	5.3– 8.3	6.8	0.67	0.06	9.86
x_{21}	distantia V–A	8.3– 23.1	13.3	2.45	0.22	18.40
x_{22}	longitudo mediale radiorum pinnae C	10.7–14.8	12.7	0.72	0.06	5.68
		% longitudo capitis lateralis				
x_4	longitudo praeorbitale	18.0– 25.3	21.0	1.33	0.12	6.33
x_5	diameter oculi	11.7– 20.2	16.8	1.44	0.13	8.56
x_6	longitudo postorbitale	52.0– 63.2	58.1	2.51	0.22	4.32
x_8	altitudo capitis	48.3– 74.4	59.9	4.67	0.42	7.80
x_9	longitudo ossis maxillare	43.6– 51.4	47.7	2.12	0.19	4.44
x_{10}	longitudo ossis dentale	54.5– 63.6	59.1	2.30	0.20	3.89

$\bar{x}$ – arithmetic mean
S – standard deviation
m – standard error
V – coefficient of variation

Table 2

Analysis significance of differences (Student's t test) in meristic characters between the sexes of Greenland halibut from the Barents Sea ($t_{0.05} = 1.96$)

Character	Males			Females			t calc.
	n	$\bar{x}$	S	n	$\bar{x}$	S	
Metric characters – % longitudo corporis							
x_1	64	114.9	1.04	63	114.9	1.04	0.37
x_2	64	112.7	0.91	63	112.8	1.04	0.46
x_7	64	23.6	0.93	62	24.0	1.05	2.47*
x_4	64	5.0	0.34	63	5.0	0.35	0.16
x_5	64	4.0	0.30	63	3.9	0.31	1.64
x_6	64	13.6	0.67	63	14.0	0.87	2.60*
x_8	64	14.3	1.02	63	14.2	1.28	0.24
x_9	64	11.1	0.53	63	11.6	0.64	4.20*
x_{10}	64	13.8	0.62	63	14.3	0.66	3.94*
x_{11}	64	33.0	1.79	63	33.0	1.96	0.06
x_{12}	64	7.9	0.53	63	7.6	0.47	2.88*
x_{13}	64	9.9	0.59	63	9.9	0.53	0.10
x_{14}	64	25.6	1.50	63	26.5	1.53	3.21*
x_{15}	64	36.7	2.63	63	38.4	3.39	3.07*
x_{16}	64	11.1	0.98	63	10.9	0.95	1.45
x_{17}	64	9.2	1.05	63	9.0	0.60	1.57
x_{18}	64	10.0	0.88	63	9.9	0.84	0.52
x_{19}	64	11.3	0.84	63	11.0	0.72	2.07*
x_{20}	64	6.8	0.71	63	6.7	0.62	0.92
x_{21}	64	12.9	2.16	63	13.7	2.64	1.90
x_{22}	64	12.7	0.69	63	12.7	0.75	0.39
Metric characters – % longitudo capitis lateralis							
x_4	64	21.2	1.35	62	20.8	1.28	1.61
x_5	64	17.1	1.33	62	16.5	1.47	2.42*
x_6	64	57.8	1.62	62	58.4	3.14	1.41
x_8	64	60.6	4.60	62	59.1	4.62	1.80
x_9	64	47.2	1.46	62	48.2	2.53	2.79*
x_{10}	64	58.6	1.62	62	59.5	2.76	2.22*
Meristic characters							
D	63	96.86	4.40	60	96.88	4.68	0.02
A	64	72.39	3.64	63	71.90	3.44	0.77
C	55	19.09	0.35	52	19.13	0.40	0.55
V	64	6.00	0.00	63	6.00	0.00	0.00
P	64	13.86	0.43	63	13.86	0.39	0.00
sp. br.	64	15.19	1.13	63	14.81	1.17	1.85
vt.	63	62.71	0.72	58	62.66	0.81	0.36

* – Difference statistically significant
Symbols are explained in Table 1

Table 3

Correlation coefficients and regression equations for relationships between metric characters and body length (l.c.) of Greenland halibut from the Barents Sea

Character	Males (n = 64)		Females (n = 63)		Males and Females (n = 127)	
	Correlation coefficient $r_{0.05}$=0.468 *	Regression equation	Correlation coefficient $r_{0.05}$=0.381*	Regression equation	Correlation coefficient $r_{0.05}$=0.349*	Regression equation
x_1	−0.379	y = 116.988 − 0.047x	−0.210	y = 115.496 − 0.014x	−0.342	y = 115.904 − 0.021x
x_2	−0.298	y = 114.239 − 0.037x	−0.629	y = 114.764 − 0.044x	−0.642	y = 114.474 − 0.038x
x_4	−0.598	y = 6.276 − 0.030x	0.439	y = 4.478 + 0.013x	0.183	y = 4.874 + 0.005x
x_5	−0.634	y = 5.244 − 0.030x	−0.578	y = 4.731 − 0.017x	−0.649	y = 4.815 − 0.019x
x_6	−0.088	y = 13.891 − 0.005x	0.662	y = 11.982 + 0.047x	0.600	y = 12.452 + 0.034x
x_7	−0.103	y = 24.012 − 0.009x	0.362	y = 22.969 + 0.030x	0.490	y = 22.434 + 0.036x
x_8	−0.685	y = 18.168 − 0.090x	0.462	y = 12.367 + 0.045x	0.288	y = 13.475 + 0.021x
x_9	−0.336	y = 12.042 − 0.021x	0.478	y = 10.567 + 0.025x	0.511	y = 10.311 + 0.027x
x_{10}	−0.166	y = 14.224 − 0.008x	0.598	y = 12.908 + 0.033x	0.600	y = 12.755 + 0.033x
x_{11}	−0.302	y = 35.456 − 0.057x	0.600	y = 28.041 + 0.105x	0.608	y = 29.122 + 0.088x
x_{12}	−0.483	y = 9.118 − 0.029x	−0.612	y = 8.795 − 0.025x	−0.671	y = 8.948 − 0.026x
x_{13}	−0.749	y = 12.260 − 0.056x	−0.111	x = 10.190 − 0.004x	0.750	y = 8.756 + 0.026x
x_{14}	−0.366	y = 28.061 − 0.058x	0.394	y = 24.488 + 0.050x	0.518	y = 23.688 + 0.058x
x_{15}	0.047	y = 36.004 + 0.018x	0.710	y = 29.544 + 0.207x	0.728	y = 28.887 + 0.207x
x_{16}	−0.407	y = 13.553 − 0.054x	−0.379	y = 12.140 − 0.027x	−0.548	y = 13.008 − 0.043x
x_{17}	0.133	y = 8.562 + 0.016x	−0.277	y = 9.649 − 0.013x	−0.113	y = 9.319 − 0.006x
x_{18}	−0.437	y = 11.941 − 0.047x	−0.327	y = 10.712 − 0.019x	−0.384	y = 10.782 − 0.021x
x_{19}	0.077	y = 11.040 + 0.008x	0.454	y = 9.902 + 0.025x	0.374	y = 10.419 + 0.017x
x_{20}	0.433	y = 5.015 + 0.043x	0.048	y = 6.704 + 0.002x	0.192	y = 6.404 + 0.008x
x_{21}	0.262	y = 10.300 + 0.065x	0.716	y = 6.934 + 0.154x	0.756	y = 6.655 + 0.156x
x_{22}	−0.604	y = 15.573 − 0.067x	−0.635	y = 14.400 − 0.038x	−0.684	y = 14.367 − 0.038x

* Limit of correlation significance. Symbols are explained in Table 1.

Table 4

Correlation coefficients and regression equations for relationships between metric characters and head length (x_7) of Greenland halibut from the Barents Sea

Character	Males (n = 64)		Females (n = 62)		Males and Females (n = 126)	
	Correlation coefficient $r_{0.05}$=0.468 *	Regression equation	Correlation coefficient $r_{0.05}$= 0.381*	Regression equation	Correlation coefficient $r_{0.05}$=0.349*	Regression equation
x_4	−0.574	y = 26.557 − 0.536x	0.171	y = 20.070 + 0.070x	−0.151	y = 21.773 − 0.057x
x_5	−0.594	y = 21.517 − 0.471x	−0.694	y = 20.320 − 0.370x	−0.764	y = 20.845 − 0.401x
x_6	−0.064	y = 58.452 − 0.062x	0.383	y = 55.850 + 0.216x	0.347	y = 56.122 + 0.187x
x_8	−0.661	y = 76.395 − 1.558x	0.338	y = 53.668 + 0.472x	0.076	y = 59.012 + 0.080x
x_9	−0.346	y = 49.924 − 0.267x	0.363	y = 46.298 + 0.167x	0.335	y = 46.201 + 0.154x
x_{10}	−0.087	y = 59.265 − 0.048x	0.417	y = 56.520 + 0.233x	0.476	y = 56.923 + 0.203x

* Limit of correlation significance

Symbols are explained in Table 1

Table 5

Meristic characters of Greenland halibut from the Barents Sea

Character	Males						Females						Males and Females					
	n	Range	$\bar{x}$	S	m	V	n	Range	$\bar{x}$	S	m	V	n	Range	$\bar{x}$	S	m	V
D	63	86-105	96.86	4.40	0.55	4.54	60	82-107	96.88	4.68	0.60	4.83	123	82-107	96.87	4.52	0.41	4.67
A	64	65- 80	72.39	3.64	0.46	5.03	63	64- 79	71.90	3.44	0.43	4.79	127	64- 80	72.15	3.55	0.32	4.93
C	55	19- 21	19.09	0.35	0.05	1.82	52	19- 21	19.13	0.40	0.06	2.08	107	19- 21	19.11	0.37	0.04	1.94
V	64	6	6.00	0.00	0.00	0.00	63	6	6.00	0.00	0.00	0.00	127	6	6.00	0.00	0.00	0.00
P	64	13- 15	13.86	0.43	0.06	3.09	63	13- 15	13.86	0.39	0.05	2.83	127	13- 15	13.86	0.41	0.04	2.97
sp.br.	64	13- 19	15.19	1.13	0.14	7.44	63	13- 18	14.81	1.17	0.15	7.88	127	13- 19	15.00	1.16	0.10	7.76
vt.	63	61- 64	62.71	0.72	0.09	1.16	58	61- 64	62.66	0.81	0.11	1.29	121	51- 64	62.69	0.76	0.07	1.21

D — numerus radiorum pinnae dorsalis
A — numerus radiorum pinnae analis
C — numerus radiorum pinnae caudalis
V — numerus radiorum pinnae ventralis
P — numerus radiorum pinnae pectoralis
sp.br. — numerus spinarum ad arcum branchiorum
vt. — numerus vertebrarum

Statistical symbols are explained in Table 1

Table 6

Analysis of variability in meristic characters by age groups of Greenland halibut from the Berents Sea

Age	n		D	A	C	V	P	sp.br	vt.
IV	5	$\bar{x}$	96.00	71.00	19.00	6.00	13.80	14.80	62.40
		S	5.96	4.24	0.00	0.00	0.45	0.84	0.55
		m	2.66	1.90	0.00	0.00	0.20	0.37	0.24
		V	6.21	5.98	0.00	0.00	3.24	5.65	0.88
V	32	$\bar{x}$	94.71	70.34	19.10	6.00	13.91	15.19	62.48
		S	4.55	3.08	0.31	0.00	0.30	1.15	0.68
		m	0.82	0.54	0.06	0.00	0.05	0.20	0.12
		V	4.80	4.37	1.62	0.00	2.13	7.56	1.08
VI	36	$\bar{x}$	97.14	72.67	19.13	6.00	13.75	14.72	62.58
		S	3.98	3.85	0.43	0.00	0.50	1.06	0.73
		m	0.66	0.64	0.08	0.00	0.08	0.18	0.12
		V	4.10	5.30	2.23	0.00	3.64	7.19	1.17
VII	23	$\bar{x}$	97.64	72.87	19.05	6.00	14.00	15.48	62.83
		S	3.75	3.39	0.22	0.00	0.30	1.34	0.78
		m	0.80	0.71	0.05	0.00	0.06	0.28	0.16
		V	3.84	4.65	1.17	0.00	2.15	8.68	1.24
VIII	9	$\bar{x}$	97.87	72.89	19.00	6.00	13.78	15.11	62.75
		S	3.64	2.85	0.00	0.00	0.44	1.05	1.04
		m	1.29	0.95	0.00	0.00	0.15	0.35	0.37
		V	3.72	3.91	0.00	0.00	3.20	6.98	1.65
IX	7	$\bar{x}$	96.00	72.43	19.40	6.00	14.14	14.43	63.50
		S	6.81	3.91	0.55	0.00	0.38	0.79	0.55
		m	2.78	1.48	0.24	0.00	0.14	0.30	0.22
		V	7.10	5.40	2.82	0.00	2.67	5.45	0.86
X	4	$\bar{x}$	98.00	73.50	19.00	6.00	14.00	14.25	62.75
		S	4.24	0.58	0.00	0.00	0.00	0.96	0.96
		m	2.12	0.29	0.00	0.00	0.00	0.48	0.48
		V	4.33	0.79	0.00	0.00	0.00	6.72	1.53
XI	7	$\bar{x}$	100.43	74.14	19.00	6.00	13.71	14.86	63.00
		S	4.83	3.53	0.00	0.00	0.49	1.57	0.82
		m	1.82	1.33	0.00	0.00	0.18	0.59	0.41
		V	4.80	4.76	0.00	0.00	3.56	10.59	1.30
XII	2	$\bar{x}$	103.50	76.00	19.00	6.00	13.50	15.00	63.00
		S	3.54	0.00	0.00	0.00	0.71	0.00	0.00
		m	2.50	0.00	0.00	0.00	0.50	0.00	0.00
		V	3.42	0.00	0.00	0.00	5.24	0.00	0.00
XIII	2	$\bar{x}$	96.50	68.50	20.00	6.00	13.50	15.50	63.00
		S	3.54	2.12	1.41	0.00	0.71	2.12	1.41
		m	2.50	1.50	1.00	0.00	0.50	1.50	1.00
		V	3.66	3.10	7.07	0.00	5.24	13.69	2.24
		$F_{calc.}$	2.09*	2.17*	2.04*	0.00	1.60	1.22	1.46
		$F_{0.05}$	1.96	1.96	1.97	1.96	1.96	1.96	1.97

* Difference statistically significant.

Symbols are explained in Table 1 and 5.

with 97 rays predominated, while those with 96 prevailed in females. The overall mean was 96.87 rays; the means for each sex were basically identical.

The number of rays found in the anal fin ranged within 64–80, most individuals in each sex showing 73 rays. The overall mean of number of rays in this fin was 72.15, the mean in males exceeding that in females.

The range of variation in the caudal fin ray count was narrow (19–21), individuals with 19 rays markedly predominating in the sample. Hence the mean value for the whole sample was 19.11, the mean value in females being slightly higher than in males.

The soft ray count in the ventral fin was constant and amounted to 6 rays.

The number of soft rays in the pectoral fin covered the range from 13 to 15 only; however, individuals with 14 rays were most frequent. The arithmetic mean for this character was identical in the entire sample and in each sex (13.86).

The total number of gill rakers on the first gill arch ranged within 13–19, the range in females being 13–18. Most individuals showed 14,15 and 16 rakers. The mean count for the whole sample examined was 15.00, males showing a somewhat higher value.

The vertebral count covered the range of 61–64; most frequent were individuals with 63 and 62 vertebrae. The mean value of the character was 62.69 throughout the entire sample, while in males the mean was slightly higher.

The coefficients of variation of meristic features discussed above, presented in Table 5, are below the assumed level of significance ($V < 10\%$), the gill raker count being relatively most variable (the variations lacking statistical significance).

The analysis of meristic characters (Table 2) showed no statistically significant differences between sexes.

Snedecor's F test was used to test for significance of differences between generations of all fish studied. The test is summarized in Table 6. As can be seen, significant differences between generations appeared three times and concerned number of rays in the dorsal, anal and caudal fins.

Growth rate

Fig. 1 shows results of analysis of the length and age distributions of the Greenland halibut from the area of study for the entire sample and for each sex separately.

As can be seen from the graph, the length of fish measured ranged from 35.5 to 77.5 cm, the 47.1–48.0 cm length classs being the most numerous one. The mean length of individuals studied amounted to 50 cm.

The age ranged from 4 to 13 years, age groups 5–7 being most numerous. The age group 6 contained most fishes, the mean age in the whole sample amounting to 6.76. The number of females and males in the sample was almost identical. Females from the length classes 40.1–41.0 cm and 47.1–48.0 were most numerous. The mean length of females (51.9 cm) was by almost 4 cm larger than that of males which did not exceed 60 cm. The female age ranged within 4 to 13 years, while males ranged from 4 to 10

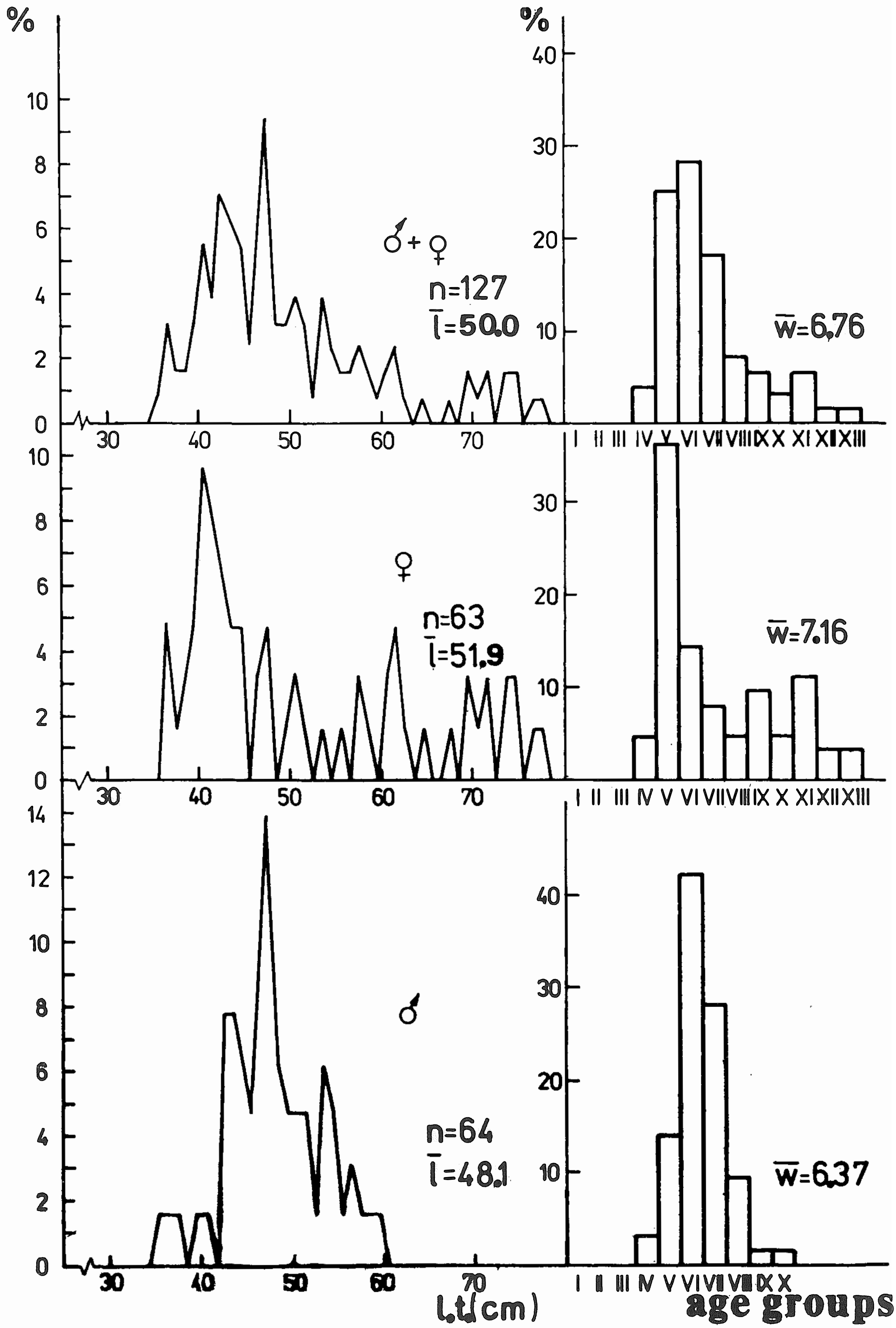

Fig. 1. Length distribution and age structure of Greenland halibut from the Barents Sea

Table 7

Growth equation parameters of Greenland halibut from the Barents Sea

Equation:				
v. Bertalanffy	Gompertz	Ford-Walford	Binomial	Power function
$L_\infty = 141.3$ $K = 0.056$ $t_0 = -0.536$	$a = 92.4$ $b = 0.081$ $c = 0.825$	$k = 0.919$ $l_1 = 9.1$	$a = 4.597$ $b = 7.340$ $c = -0.149$	$a = 11.403$ $b = 0.740$

General form of growth model:

v. Bertalanffy: $l_t = L_\infty \left[1 - e^{-K(t-t_0)} \right]$

Gompertz: $l_t = ab^{c^t}$

Ford-Walford: $l_t = l_1 + k\,(l_{t-1})$

Binomial: $l_t = a + bt + ct^2$

Power function: $l_t = at^b$

years of age only. The female mean age was by nearly 1 year longer than that of males.

To determine growth rate with 5 mathematic models, the mean lengths in different age groups, obtained by back calculations, were used. Back calculations were performed with the Rosa Lee formula, 3.51 cm being assumed as the length at which scales appear (Krzykawski, 1976a). Table 7 shows all values of parameters of the v. Bertalanffy, Gompertz and Ford-Walford equations, as well as binomial and power function. All models proved adequate in describing the Greenland halibut growth, values obtained from the v. Bertalanffy equations showing the smallest deviations from the empirical data.

The length (L) – weight (W) relationship for the area of study can be expressed with the following equation:

$$W = 0.0025\, L^{3.3213}$$

The modified v. Bertalanffy equation displaying weight growth is as follows:

$$W_t = 34610 \left[1 - e^{-0.056(t + 0.536)} \right]^{3.3213}$$

DISCUSSION

When discussing biometric characters, the attention should be paid to meristic ones, as they are widely held to be key systematic features at the species level and within a species. These characters should be regarded as pretty stable during fish life. Their values in different individuals are constant and they are determined during the embryonic development (Garside, 1966; Vladykov, 1934). However, values of these characters within a population in separate individuals may be altered by environmental conditions.

The mean number of dorsal fin rays in the fish examined (96.87) is larger than in fish from off Labrador (Krzykawski, 1991), the difference exceeding one ray. On the other hand, the mean is only slightly higher than that reported by Hubbs and Wilimovsky (1964) for the Greenland area (96.52). It seems then that the number of dorsal fin rays increases northwards. The all known mean values obtained in the Atlantic are higher than overall mean found in the Pacific, the latter amounting to 94.11 only as reported by the authors referred to above.

The mean value of the anal fin ray count in the sample examined (72.15) appeared to be higher, too, than that for the Labrador area (Krzykawski, 1991). The mean is almost identical with that obtained for the Greenland region. Also in this respect all means in the Atlantic fish exceed, by almost one ray, the mean of the Pacific fish.

When characterizing the dorsal and anal fins, attention should be focused on the wide range of variations in the ray counts in the sample studied, the range being basically consistent with that reported by the authors quoted above.

The mean ray count in the caudal fin in this study (19.11) was found to be higher, although slightly than that in the Labrador area. It covered a narrow range only (19–21), the fish with 19 rays clearly predominating. The value obtained for the area of study is higher by about 2 rays than that reported by Hubbs and Wilimovsky. Such a significant discrepancy may have resulted from different counting techniques (X-raying was applied in the present work).

The number of ventral fin rays was constant and amounted to 6 in the area of study. Krzykawski (1991) for Labrador region found a narrow range amounting to 5–7, individuals with 6 rays predominating markedly. This range is almost convergent with that reported by Hubbs and Wilimovsky (1964) both for the Pacific and Atlantic.

The mean pectoral fin soft ray count in the sample studied (13.86) was somewhat higher, too, than that found in the Labrador area (Krzykawski, 1991). The mean is almost identical with that given by Hubbs and Wilimovsky for the Greenland area.

Some authors maintain the gill raker count on the first gill arch increases with body length (Terlecki, 1980). No statistically significant correlation between the number of gill rakers and body length was found in the population of the Greenland halibut studied. The value of correlation coefficient for the area of study was negative and amounted to −0.091 only. Krzykawski (1991), too, did not find any statistically significant correlation between these dimensions in the population of the Greenland halibut from off Labrador. In the sample studied the number of gill rakers ranged within 13–19, with the mean value of 15.00. This value appeared to be lower than the mean calculated for the Labrador area (Krzykawski, 1991). It should be stressed that the character discussed was the only one meristic feature in the sample, that showed a lower mean value, compared with the population from off Labrador.

The vertebral count in the population examined was found to range from 61 to 64, the fish with 62 and 63 vertebrae predominating. The mean value of this character was 62.66, i.e. higher by more than one vertebra, than in fish from comparable Labrador area.

To summarize discussion on various meristic characters one should mention that the calculated values for the features analyzed were higher (except for gill raker count on the first gill arch) in the population under study from off Labrador. The results obtained are in agreement with relationships found earlier, as the study on variability of meristic characters in related species, or even within a species, a clear trend was found, the trend involving, e.g. southward decreases in the vertebral count (Schmidt, 1930).

The materials collected allowed to determine some biological properties of the population discussed. Fig. 1 shows that the mean total length of fish from the area of study amounted to 50 cm, i.e. 2.5 cm less than that reported for the area by Krzykawski (1976 b) who studied materials collected in 1970 and 1971. The two means correspond more or less closely with data given by Kovtsova and Nizovtsev (1985) who, based on their long term study in the Norwegian and Barents Sea during 1971–84, showed the 45–60 cm range as the most frequent in catches.

A comparison between mean ages of males and females (Fig. 1) shows the females to be older in the area of study. Krzykawski (1976 b) found the oldest males in the Barents Sea to be 11 years old, 15 years being the oldest age of females. In the present study, the oldest individuals were 10 (males) and 13 (females) years old. It is worth noticing that the growth length calculated using parameters of v. Bertalanffy equation, for the sample discussed, is very similar to that obtained by Krzykawski (1976 b) for fish caught in the Barents Sea in 1971.

CONCLUSIONS

1. Meristic characters of the Greenland halibut population from the Barents Sea can be expressed with the following formula: D 82–107, A. 64–80, C 19–21, V 6, P 13–15, sp. br. 13–19, vt. 61–64.

2. No statistically significant differences between meristic characters in males and females were found in the population studied.

3. The fish from the area of study showed a quite clearly sexual dimorphism. Significant differences between per cent indices were found in the following biometric characters: relative to the body length: minimum body height, length of pectoral fin (values higher in males); lateral head length, postorbital length, length of lowe and upper jaws, preventral length, preanal length (values higher in females); relative to the head length: eye diameter (higher in males) and length of upper and lower jaws (higher in females).

4. Small between generations differences in meristic characters were found to exist in the population examined. They concerned ray counts in the dorsal, anal and caudal fins.

5. The length and weight growth equations for the population studied are as follows:

$$l_t = 141.3\left[1 - e^{-0.056(t+0.536)}\right].$$

$$W_t = 34610\left[1 - e^{-0.056(t+0.536)}\right]^{3.3213}$$

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CECHY BIOMETRYCZNE ORAZ WZROST HALIBUTA NIEBIESKIEGO *REINHARDTIUS HIPPOGLOSSOIDES* (WALBAUM, 1792) Z MORZA BARENTSA

STRESZCZENIE

Celem badań było określenie zmienności cech biometrycznych halibuta niebieskiego *Reinhardtius hippoglossoides* (Walbaum, 1792) z rejonu Morza Barentsa. Zebrany materiał wykorzystano także dla ustalenia niektórych właściwości biologicznych badanej populacji. Zbadano skład długościowy i wiekowy, określono zależność pomiędzy długością a masą oraz wyliczono parametry wzrostu długości i masy ciała.

Cechy merystyczne badanej populacji halibuta niebieskiego z rejonu Morza Barentsa można ująć w formułę: D 82–107, A 64–80, C 19–21, V 6, P 13–15, sp. br. 13–19, vt. 61–64.

Dymorfizm płciowy badanej populacji halibuta niebieskiego zaznaczył się tylko w niektórych cechach wymierzalnych. Natomiast nie stwierdzono statystycznie istotnych różnic w wartościach cech merystycznych między samcami i samicami.

Badania wykazały stosunkowo niewielkie, ale statystycznie istotne różnice w wartościach cech merystycznych między pokoleniami. Różnice te dotyczą liczby promieni w płetwie grzbietowej, odbytowej i ogonowej.

Obliczone równania v. Bertalanffy'ego dotyczące wzrostu długości i masy dla badanej populacji przedstawiają się następująco:

$$l_t = 141{,}3\left[1 - e^{-0{,}056\,(t + 0{,}536)}\right]$$

$$W_t = 34610\left[1 - e^{-0{,}056\,(t + 0{,}536)}\right]^{3{,}3213}.$$

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