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Fish biology

STUDIES ON WHITING *ODONTOGADUS MERLANGUS* (L.) FROM NORTH SEA IN YEARS 1959-1967

BADANIA NAD WITLINKIEM *ODONTOGADUS MERLANGUS* (L.) Z MORZA PÓŁNOCNEGO W LATACH 1959-1967

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The work comprises characteristics of whiting catches in years 1959-1967 and the results of studies on length and age composition, and on growth rate of body length and weight of this species.

Problem of biology of whiting Odontogadus merlangus (L.) occupied many scientists, viz.: Messtorff (1959), Bowers (1954), Knudsen (1950), Hannerz (1964), Jones and Hislop (1963), Gilis (1967), Ellis and Jones (1956), Desbrosses (1948) and others. Most of their studies had, however, been directed towards estimation of catches and location of stocks.

This work was aimed to characterise the catches of whiting and to investigate such problems as: length composition, age, growth rate of length and weight, relationship between length and weight of body, sex and stages of gonads. In age investigations, attention was paid to problem how to increase the legiblety of otoliths.

According to statistics of ICES, for years discussed, the participation of whiting in total catches from North-East Atlantic amounted to 4.6 per cent. Among gadoid fishes of North Sea, whiting is, for discussed period, on the third place after haddock and cod. Catches of whiting from North Sea region had for particular years been non-uniform in relation to total mass of fish caught and had oscillated from 53.1 thousands ton in 1960 to 155.1 thousands ton in 1966; on average 91.6 thousands ton annually.

MATERIAL AND METHODS

Material

The materials for this work had been collected during the experimental voyages of survey ship m/t "Birkut", belonging to Marine Institute of Fishery, in years 1955-1967 and additionally in 1966 and 1967 during the voyage to North Sea of reconnaissance ship s/t "Wałpusza".

List of materials for biological analysis

Table 1

Date of fishing	Fishing grounds	Length of fish (l.t.) in cm		Number of measured fishes	Number of females	Number of males	Number of legible otoliths	Per cent of legible otoliths
		Range of length	Average length					
21.05.1959	8F	21-38	27.9	39	10	29	27	69.2
22.05.1959	8E	21-38	28.6	41	13	28	29	70.7
23.05.1959	10E	22-40	31.2	66	29	37	63	95.4
20.08.1959	9D	13-38	27.4	267	147	120	210	78.7
23.08.1959	9E	20-40	26.4	183	97	86	174	95.1
25.08.1959	10D	22-33	27.4	57	31	26	46	80.7
5.10.1959	9D	14-55	22.8	262	124	138	216	82.4
Totals 1959	-	13-55	26.2	915	451	464	765	83.6
7.07.1962	13E	18-41	29.5	147	60	87	123	83.7
9.07.1962	12D	20-35	25.9	110	65	45	96	96.0
13.07.1962	10F	19-31	24.2	116	50	66	100	86.2
17.08.1962	9I	16-36	22.2	100	52	48	90	90.0
19.08.1962	9F	18-39	23.7	100	48	52	89	89.0
23.09.1962	6E	18-28	21.8	115	48	67	110	95.7
24.09.1962	7E	13-28	20.9	96	47	49	89	92.7
25.09.1962	8E	12-28	21.9	100	49	51	95	95.0
26-27.09. 1962	10E	11-34	23.5	217	109	108	203	93.5
17.10.1962	6H	20-40	25.5	175	71	104	170	97.1
24.10.1962	7E	11-37	17.6	50	26	24	41	82.0
Totals 1962	-	11-41	23.9	1326	625	701	1206	91.0
21.05.1964	9E	23-41	29.4	124	24	100	104	83.9
Totals 1964	-	23-41	29.4	124	24	100	104	83.9
14.11.1965	17H	25-42	32.2	54	32	22	48	88.9
5.12.1965	15D	25-42	32.8	68	55	13	64	94.1
Totals 1965	-	25-42	32.5	122	87	35	112	91.8
19.01.1966	17H	15-47	34.9	99	72	27	81	81.8
25.01.1966	18D	22-34	26.6	100	36	64	94	94.0
5.02.1966	10C	9-30	17.4	100	50	50	100	100.0
8.06.1966	15D	21-43	27.3	101	37	64	95	94.1
Totals 1966	-	9-47	27.3	400	195	205	370	92.5
Totals 1959-1966	-	9-55	25.7	2887	1382	1505	2557	88.6

The bottom trawl of 60, 72 and 90 feet was used for fishing in North Sea fishing grounds actually exploited by fishing fleets.

Ichthyological investigations comprised the denotation of species composition of fish caught in the experimental fishing and the performance of biological analysis.

In all, during the years 1959-1967, the content of 607 trawls, of total mass 465.8 tons, had been analysed.

Detailed list of materials used for the above-mentioned analysis is presented in table 1. Age and rate of growth was read on otoliths. To verify the age readings based on otoliths, scales were taken from fish of experimental catch of 8.06.1966.

Considered in this work are also the statistical data on catches of whiting in North Sea effected by all countries associated in ICES at Copenhagen (according to Bulletin Statistique des Pêches Maritimes).

Methods

The whitings subjected to biological analysis were measured from tip of snouth to end of caudal fin (l.t.) with accuracy of 0.5 cm and weighed with accuracy of 0.5 g. Sex and stages of gonads were determined according to 8-grade Maier scale. Cross-fractures of otoliths were used in determination of age and rate of growth. For better legibility, one half of each otolith was calcinated. The calcinated and noncalcinated cross-fractures of the same otolith were examined simultaneously when determining the age and rate of growth. Calcinated and non-calcinated fractures of otoliths and the scales against calcinated fracture of the same species of whiting of various age, are compared on Fig. 1a,b,c,d and 2a,b.

The measurements were effected on longer radius of otolith fractural surface. This was due to fact, that annual rings are at that place more spaced and by the same are more clear.

It was determined that length of otolith longer radius and total length (l.t.) of whiting remain in rectilinear strict relationship. The coefficient of correlation between these values, calculated according to formulas of R o m a n o w s k i (1952), amounted $r = 0.989$, while the equation of direct regression assumed the form of:

$$y = 0.0767x + 0.08.$$

The direct, obtained according to this equation, is presented on Fig.3.

Also, the relationship between scale caudal radius and total length (l.t.) of whiting calculated for 101 fishes, may be expressed as rectilinear relationship. The coefficient of correlation between these values is $r = 0.713$ and the equation of direct regression assumes the form of:

$$y = 0.0534x + 0.01.$$

The direct obtained according to this equation is presented on Fig.4.

H a n n e r z (1964), investigating the rate of growth by scales of whiting from North Sea, calculated the relation between scale caudal radius and total length (l.t.) and presented it in form of curve. The curve is cutting the axis "x" at length of 2 cm; this confirmes that scales start forming at whiting

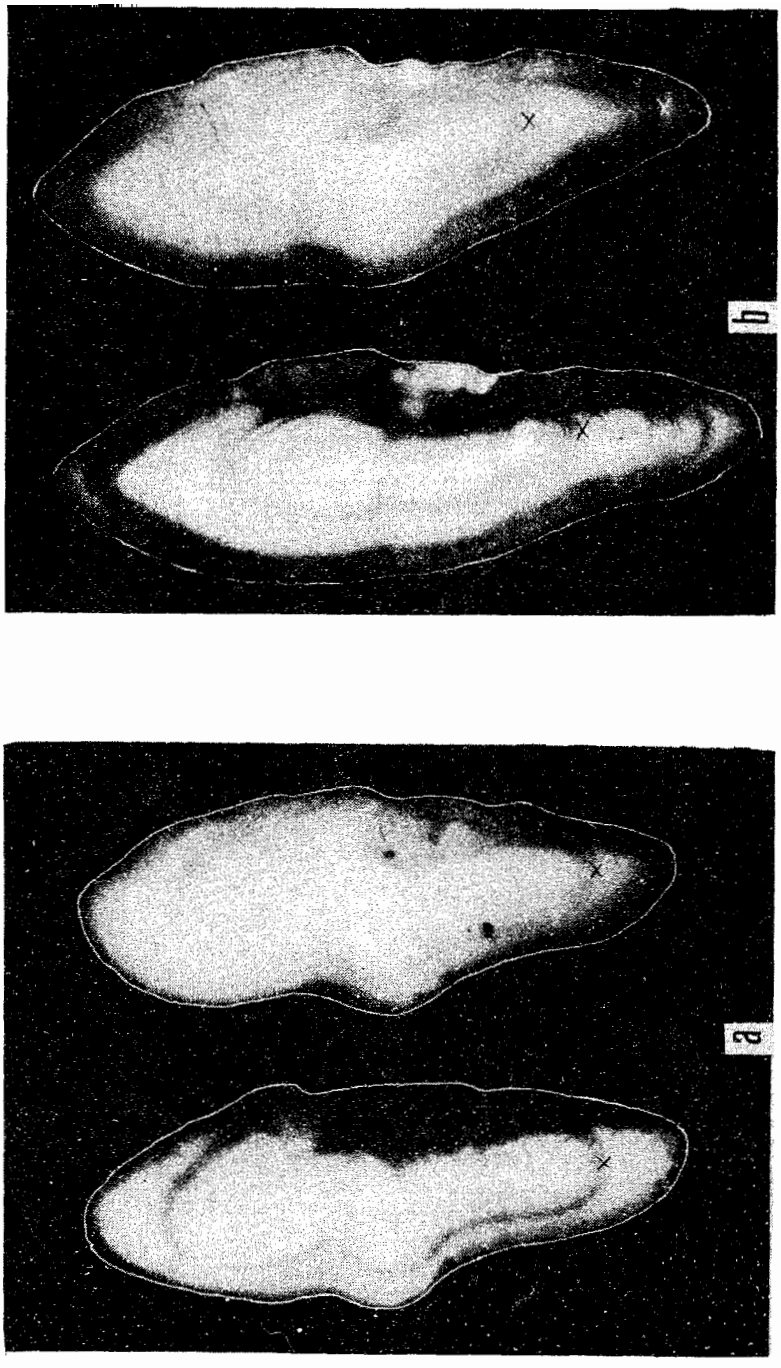

Fig.1a. Fracture of otolith of whiting at age 1+ (calcinated on left)
b. Fracture of otolith of whiting at age 2+ (calcinated on left)

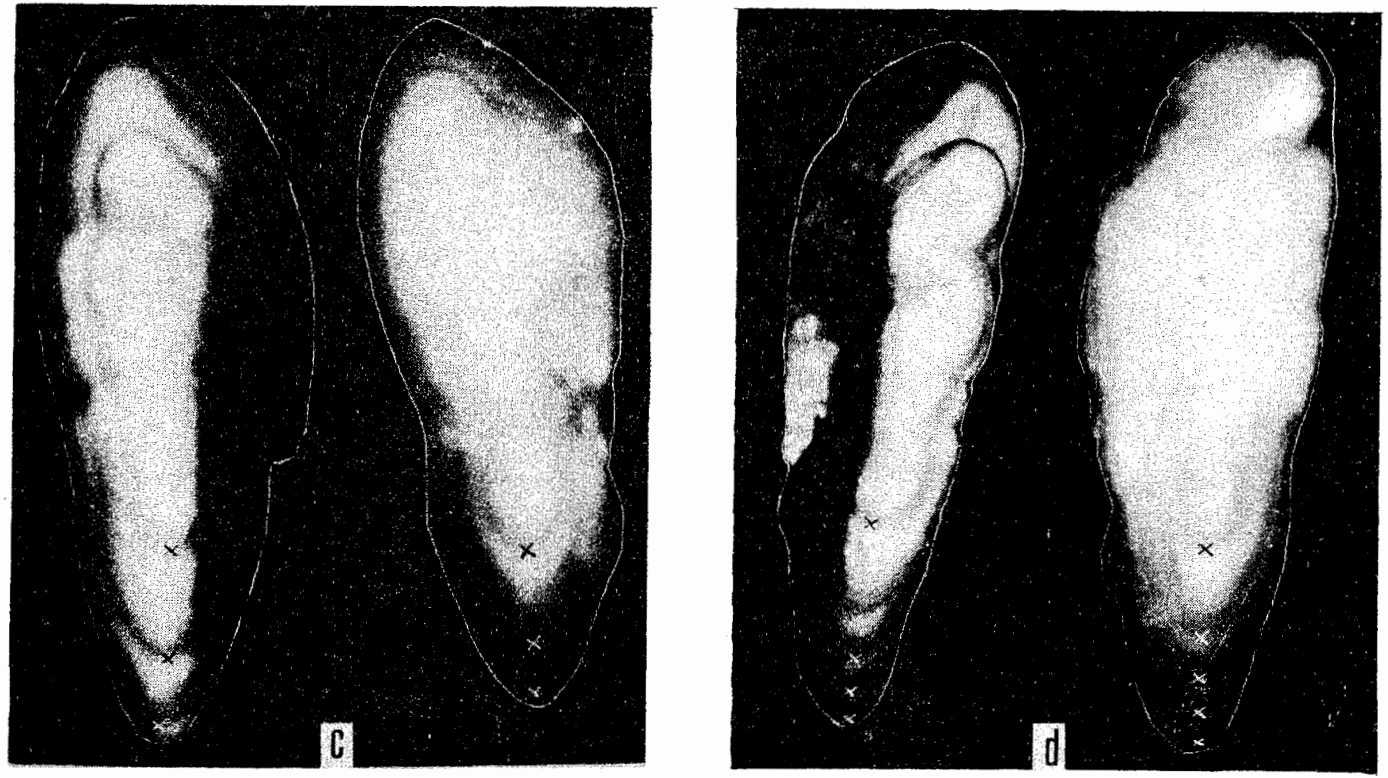

Fig.1c. Fracture of otolith of whiting at age 3+ (calcinated on left)
d. Fracture of otolith of whiting at age 5+ (calcinated on left)

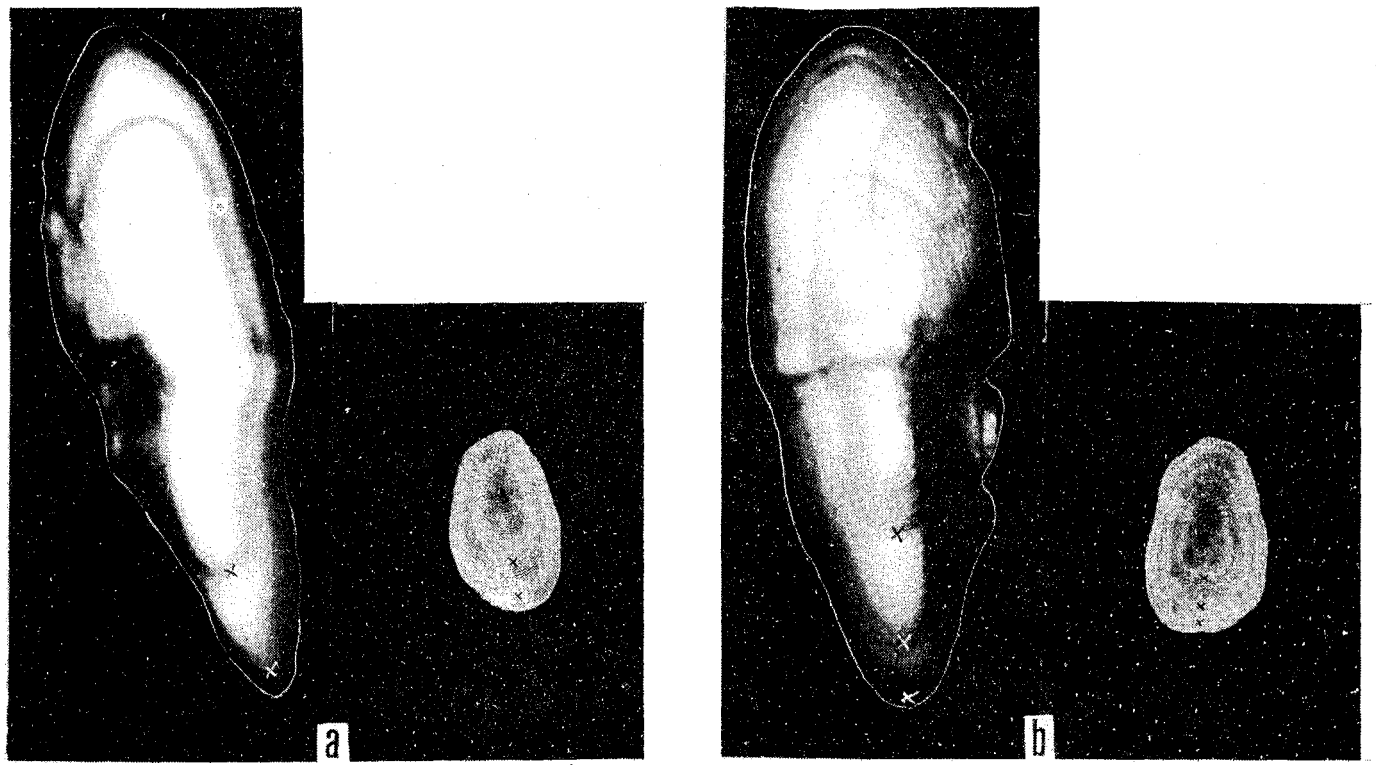

Fig. 2a. Scale and fracture of calcinated otolith of whiting at age 2+
b. Scale and fracture of calcinated otolith of whiting at age 3+

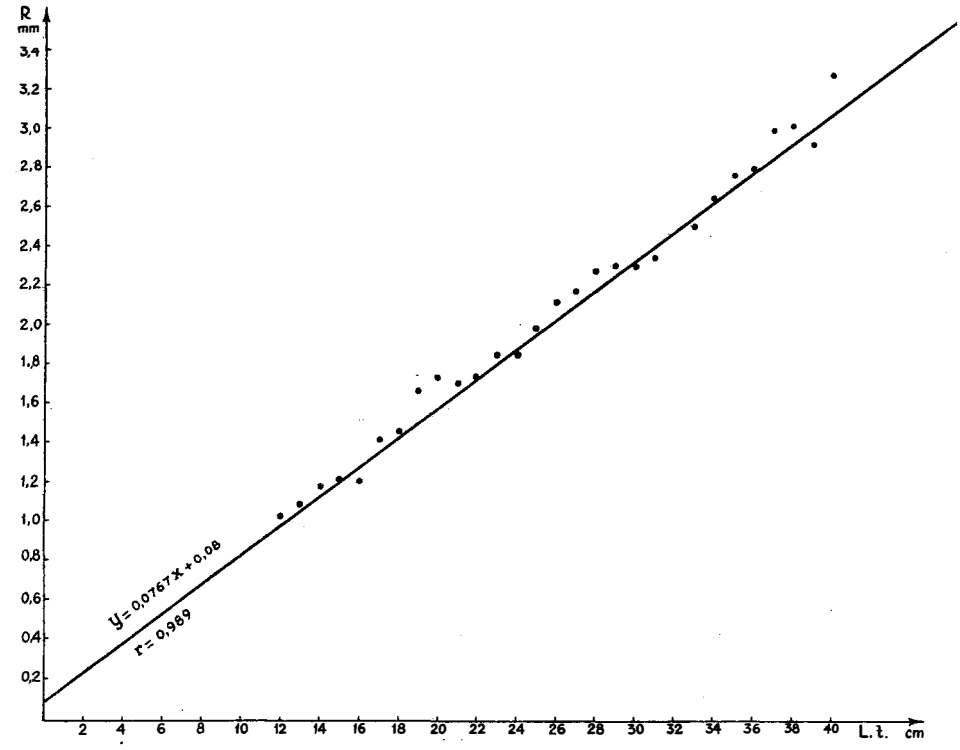

Fig.3. Relationship between longer radius of otolith fracture and total length (l.t.) of whiting

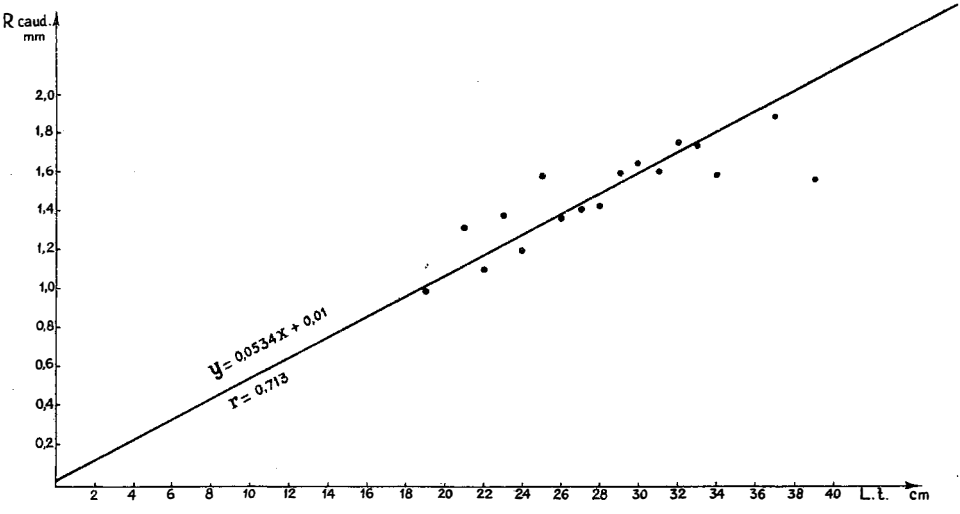

Fig.4. Relationship between caudal radius of scale and total length (l.t.) of whiting

at such length. The relationship presented by Hanner z is curvilinear upto length of about 14 cm only, and thenafter assumes the rectilinear form. As the annual whitings are of length above 14 cm, there is no need to apply any correction for the back readings effected on the basis of scale material used in this work.

According to above-mentioned investigator, no distinct differences exist between caudal radius of scale and total length (l.t.) of whiting from various regions of North Sea.

Relationship between body length and weight of whiting was determined according average weights calculated for the particular length class (by 1 cm) of 376 fishes. The relationship is expressed by the equation:

$$W = c \cdot L^n$$

where: W - weight (g)
L - length (cm)
c and n - coefficients.

The values of coefficients c and n were calculated by least square method with application of Lagler's (1959) formulas.

CHARACTERISTICS OF CATCHES

Catches of whiting according to statistical data

Table 2 presents the catches of whiting for total ICES region and North Sea for years 1959-1967.

Table 2

Catches of whiting from total ICES region and North Sea for years 1959-1967, in thousands of tons/ICES reg. = 100%)

Years	Total ICES region	North Sea particip.	Years	Total ICES region	North Sea particip.
1959	161.9 100.0	80.5 49.7	1964	167.8 100.0	91.5 54.5
1960	125.2 100.0	53.1 23.6	1965	186.6 100.0	106.7 57.2
1961	165.4 100.0	83.3 50.4	1966	227.2 100.0	155.1 68.3
1962	156.2 100.0	68.9 44.1	1967	185.3 100.0	91.2 49.2
1963	186.4 100.0	98.7 52.9	Totals 1959-1967	1562.0 100.0	829.0 53.1

Table 3

Catches of whiting by particular countries on total ICES region and North Sea for years 1959-1967 (in thous.tons and %)

Country	ICES region		North Sea	
	in thous.tons	% particip.	in thous.tons	% particip.
England	478.9	30.7	327.1	39.4
Belgium	47.0	3.0	26.2	3.2
Denmark	418.6	26.8	202.6	24.4
France	397.2	25.4	108.8	13.1
Holland	91.9	5.9	90.5	11.0
Norway	3.2	0.2	1.8	0.2
West Germany	11.7	0.7	11.2	1.3
Sweden	21.5	1.4	14.7	1.8
USSR	38.7	2.5	38.7	4.7
Other countries	53.1	3.4	7.5	0.9
Totals	1561.8	100.0	829.1	100.0

As it appears from the table, the catches varied for total ICES region and for North Sea. Smallest catches were noted for 1960, and the highest for 1966.

Table 3 presents the data relating to catches of whiting effected by particular countries for total ICES region with indication of North Sea. Highest catches were noted respectively for: England, Denmark, France and Holland, which fished the whiting nearly entirely at Nort Sea.

The catches of whiting from North Sea with indication to particular regions for years 1959-1967 are presented in table 4.

It appears from the table that, during the nine years discussed, highest catches of whiting were from region IVa, somehow smaller from region IVb, and decidedly lowest from region IVc.

Presented on Fig.5 are the indices of whiting catches for complete region included in ICES statistics and for North Sea for years 1959-1967; the catches of 1959 were assumed as 100 per cent.

As it appears from drawing, the catches for particular years from total ICES region and North Sea were chaning with general trend towards increase.

The values given in table 5 present the seasonal arrangement of catches prevailing for particular quarters of 1961-1966.

The highest yield of whiting for investigated period prevailes on III quarter and next to it - on I quarter.

The curve presenting the course of whiting catches in particular months for period 1961-1966 (Fig.6) indicates that fishing takes place in whole year, but with two peaks: winter-spring and summer seasons. During the winter--spring season, peak of catches prevailes for February (52.3 thousands ton)

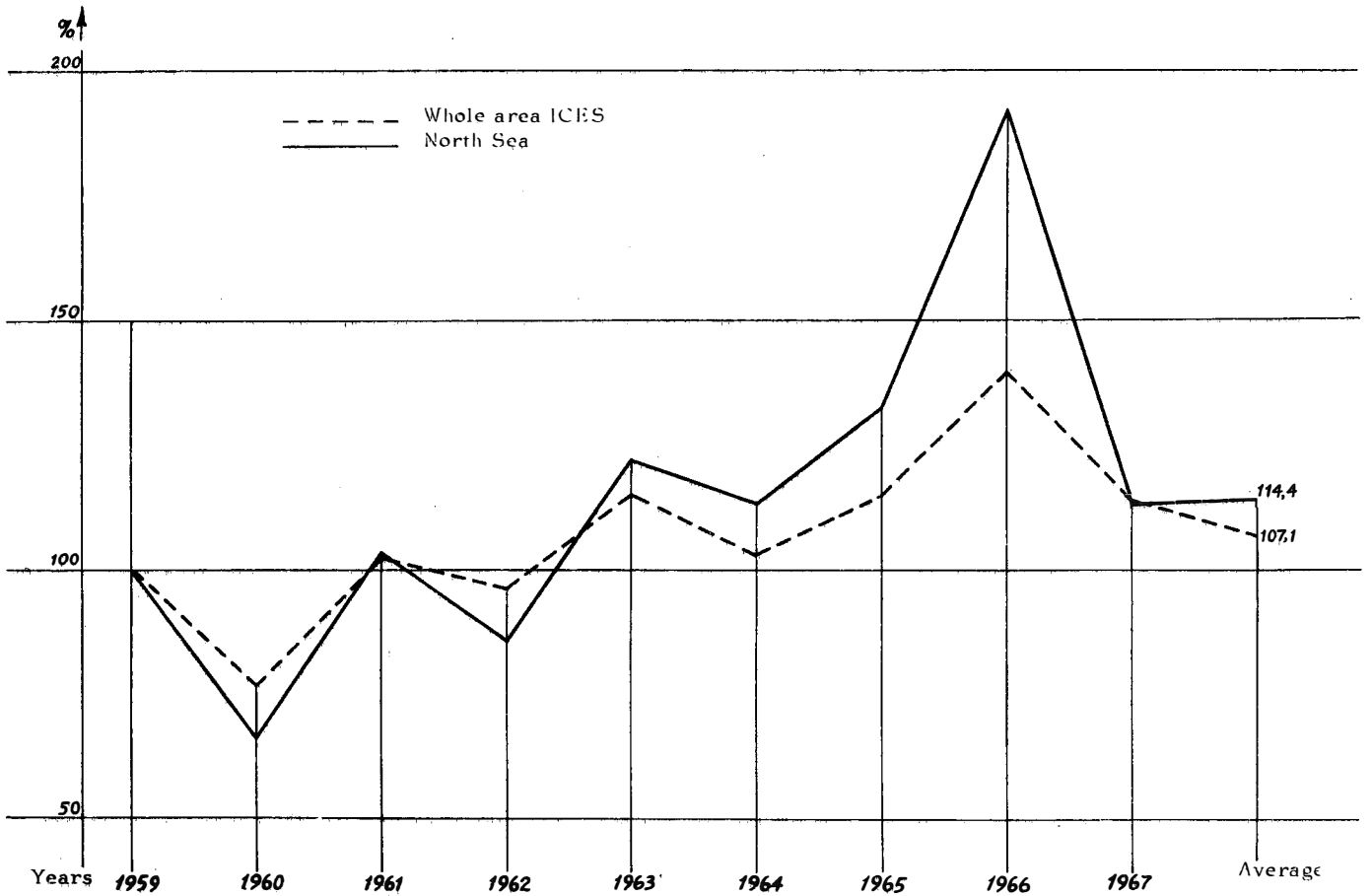

Fig. 5. Whiting catches (in %) from region of ICES statistics and from North Sea for years 1959-1967 (catches of 1959 assumed as 100%)

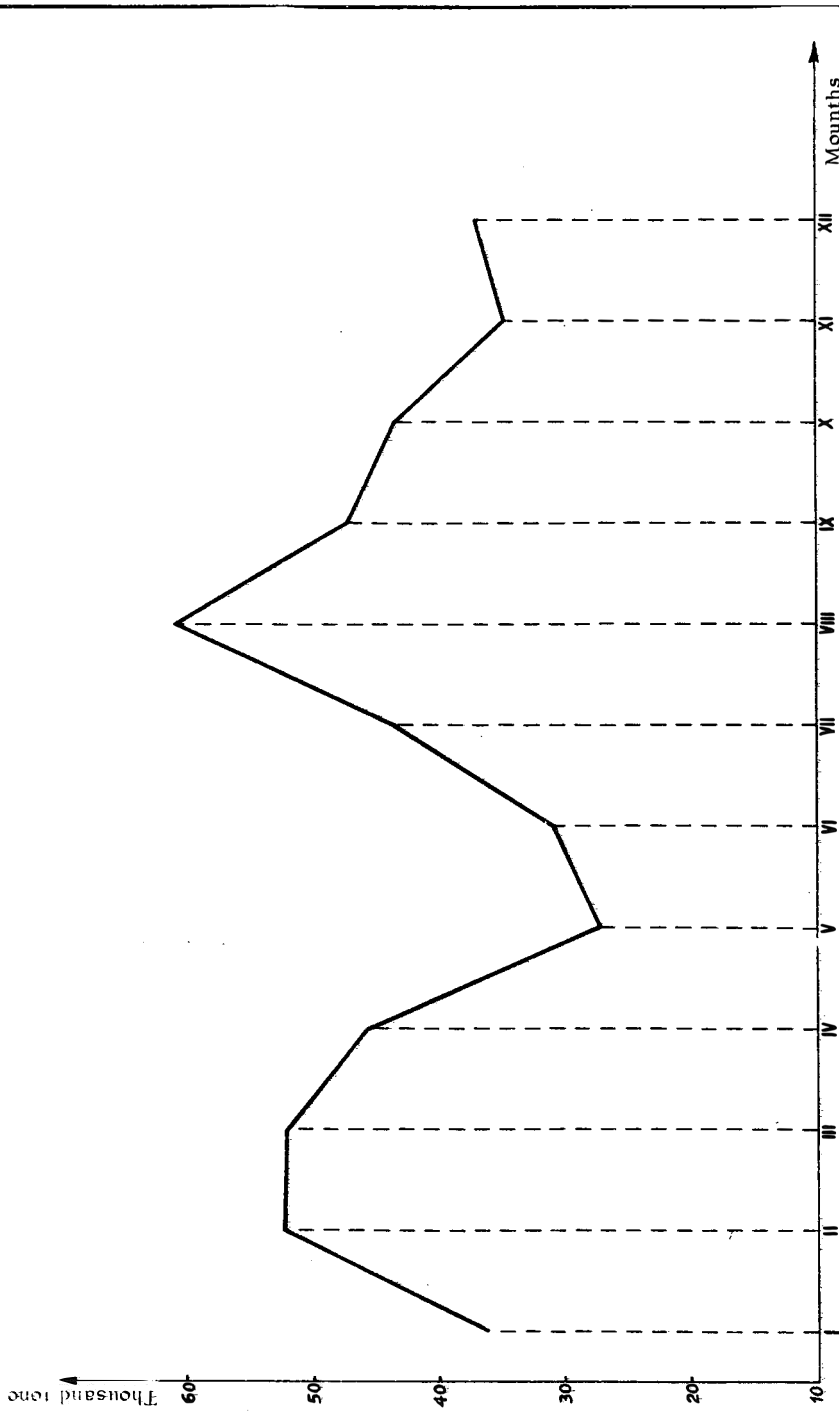

Fig.6. Total catches of whiting by seasons from North Sea for years 1961-1966 (in thous. tons)

and March (52.1 thousands tons); in all 104.4 thousands tons. The highest quantities of whiting for summer season prevailed on August - 60.7 thousands tons.

Table 4

Catches of whiting from North Sea for years 1959-1967
(data in thous. tons and %)

Years	Total yields	Participation of region		
		IVa	IVb	IVc
1959	80.5 100.0	41.7 51.8	27.5 34.1	11.3 14.1
1960	53.1 100.0	27.5 51.7	19.2 36.2	6.4 12.1
1961	83.3 100.0	43.9 52.7	33.4 40.1	5.9 7.2
1962	69.0 100.0	31.2 45.2	29.4 42.7	8.3 12.1
1963	98.6 100.0	33.4 33.8	56.2 57.0	9.0 9.2
1964	91.6 100.0	44.1 48.1	43.7 48.0	3.8 4.1
1965	106.7 100.0	59.8 56.1	42.2 39.6	4.6 4.3
1966	155.1 100.0	76.0 49.0	72.7 46.9	6.4 4.1
1967	91.2 100.0	43.2 47.4	41.4 45.4	6.6 7.2
Totals	829.1 100.0	400.8 48.3	365.7 44.1	62.3 7.6

Table 5

Catches of whiting for particular quarters
(in thous. tons and %)

Years		Quarters				Total
		I	II	III	IV	
1961-1966	thous. tons	140.4	103.7	151.6	115.2	510.9
	per cent	27.5	20.3	29.7	22.5	100.0

Whiting in experimental fishing at North Sea

During the investigated years 1959-1967, 28 voyages had been made to various fishing grounds of North Sea; the content of 607 effective trawls of total mass of fish 465.8 tons had been analysed.

Data relating to per cent participation of whiting in total mass of fish caught is presented in table 6. It appears from it, that the participation of whiting in experimental fishing oscillated between 3 and 12.6 per cent, with average for investigated period - 8.7 per cent of total yield. According to data, participation of whiting in total yield is not great, but by arrangment of species, its participation among gadoid fishes is of basic importance. The respective data is presented in Table 7.

Table 6

Per cent participation of whiting in experimental fishing at North Sea

Years	Fish totals in tons	Participation of whiting	
		in tons	in %
1959-1961	168.4	5.0	3.0
1962-1964	54.6	5.0	9.2
1965-1967	242.8	30.7	12.6
Totals	465.8	40.7	8.7

Table 7

Per cent participation of whiting in total yield of gadoid fish obtained in experimental fishing at North Sea

Years	Total gadoid fish in tons	Participation of whiting in %
1959-1961	7.4	67.9
1962-1964	11.1	45.1
1965-1967	83.7	36.6
Totals	102.2	39.9

On the basis of collected materials is prepared the table 8; it presents the calculated per cent participation of particular species in total yield of gadoid fishes obtained during the experimental fishing on various grounds of North Sea during 1959-1967.

From analysis of data presented in table 8, it is evident that, highest per cent participation in total yield of gadoid fishes for years 1959-1967 prevailes for whiting and haddock, and thenafter for cod and coal-fish. Participation of the remaining species in total yield of gadoid fish amounts jointly to 3.8 per cent.

Table 8

Species composition of gadoid fish in experimental fishing (average in %)

Species	Average for years			
	1959-1961	1962-1964	1965-1967	1959-1967
Whiting Odontogadus merlangus (L.)	67.9	45.1	36.6	39.9
Haddock Melanogrammus aeglefinus (L.)	13.8	30.2	38.3	35.6
Cod Gadus morrhua L.	16.5	22.7	12.0	13.5
Coalfish Pollachius virens (L.)	0.8	0.5	8.7	7.2
Pollack Pollachius pollachius (L.)	-	-	3.0	2.4
Ling Molva molva (L.)	0.6	1.2	0.9	1.0
Hake Merluccius merluccius (L.)	0.4	0.3	0.2	0.2
Tusk Brosmius brosme (Asc.)	-	-	0.3	0.2
Totals	100.0	100.0	100.0	100.0

Analysed also, is the quantitative participation of specimen in particular length-classes of whiting from experimental fishing on North Sea during 1959-1967. For collective measurement, was taken the fish from various fishing grounds exploited by fishing fleet. The results of such measurements are graphically presented on Fig. 7. The size of whiting was considered seperately for region IVa and IVb of North Sea.

From curves presented on drawing 7 appears that in region IVa most numberous whiting was of 21-32 cm in length, what in examined material presented 87.9 per cent. Highest participation prevailed for specimen in length classes 24-26 cm (34.0 per cent) and 27-29 cm (27.0 per cent). The average length of fish caught calculated by measurements of 6088 pcs, amounted to 27.3 cm. Encountered in catches were fishes of 14 cm to 49 cm.

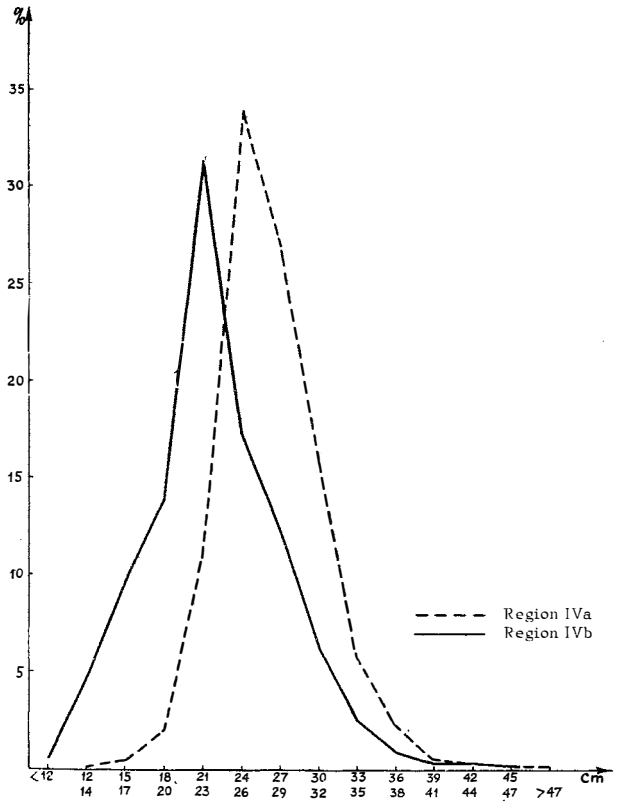

Fig.7. Length composition of whiting (in %) from North Sea in IVa and IVb regions for years 1959-1967

Basically, catches of whiting for region IVb formed the whitings of 18-29 cm in length (74.7 per cent). Most numberously presented was whiting of length 21-23 cm (31.3 per cent) and 24-26 cm (17.3 per cent). Average length of measured fish amounted to 22.9 cm, and it was calculated on measurements of 16745 specimen. Generally, length of fish in catches oscillated between 9 cm to 55 cm.

Presented on drawing 8, is the per cent participation of whiting in particular length-classes for total yield of North Sea. It is apparent from data shown on Fig.8 that, main part of yield form the whitings of 21-32 cm in length (76.2 per cent); highest participation prevails for fish of length--classes 24-26 cm (20.8 per cent) and 27-29 cm (20.6 per cent). Average weight of whiting amounted to 116.9 g.

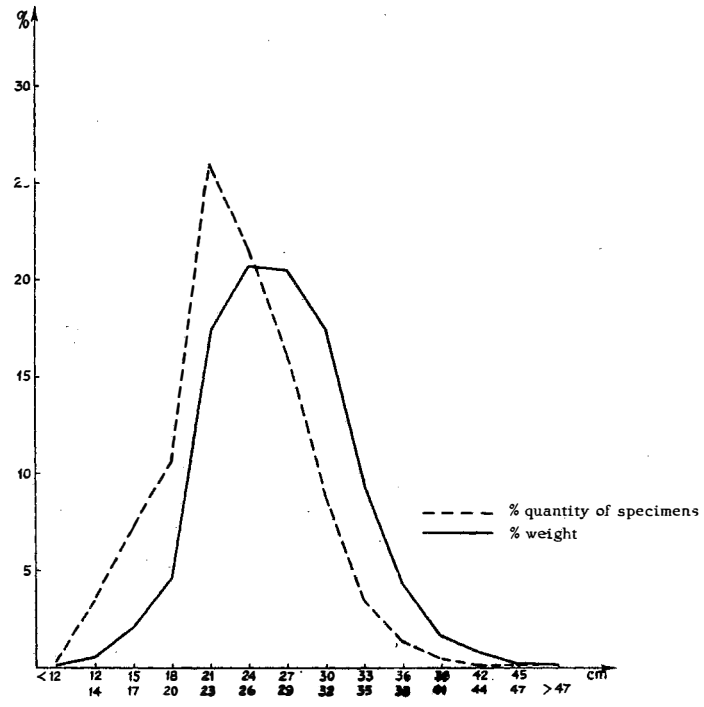

Fig. 8. Quantity and weight of particular length classes of whiting appearing in experimental fishing in years 1959-1967, expressed in % (100% = total quantity and total weight of whitings caught)

BIOLOGICAL CHARACTERISTICS

Length composition

The length composition of whiting subjected to biological analysis was processed on measurements of 2887 fishes caught during 1959-1966.

Presented on Fig. 9 are the curves of whiting quantities for particular years and a totalling curve of all measured fishes taken for biological analysis.

It is apparent from drawing that the quantitative curves for particular years are of multi-peak form, with exception of 1962 when one peak is formed of dominating length-classes 22-24 cm. For the remaining years, most numberously presented length-classes oscillated from 22 cm in 1959 to 34 cm in 1966. On summarising diagram, which comprises all material collected for biological analysis, range of measured fish oscillates within 9 to 55 cm. Dominating are the length-classes from 22 to 27 cm; on the displacement curve are noted 4 peaks at length 15, 23, 26 and 29 cm which may correspond to

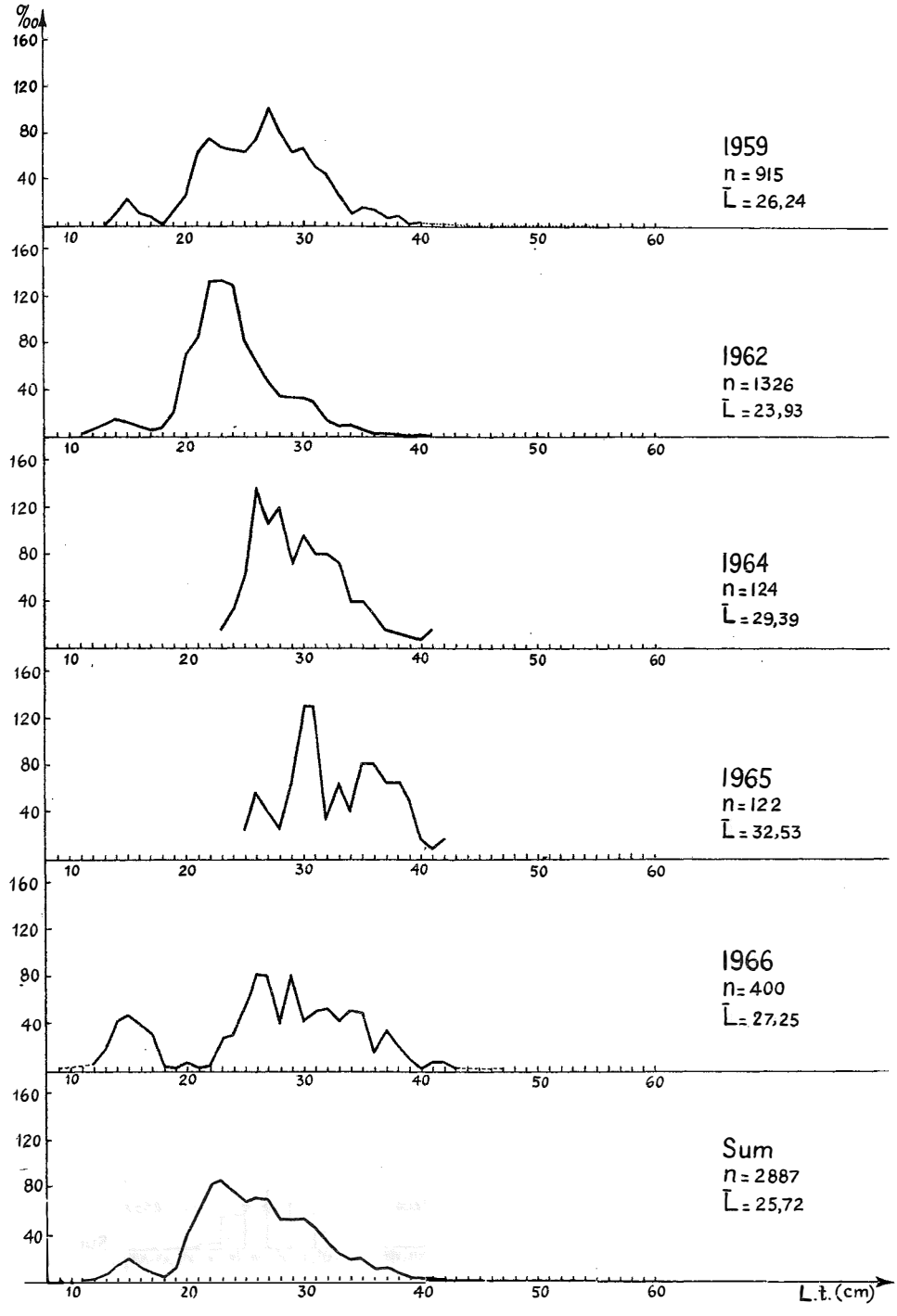

Fig. 9. Length composition of whiting catches for various years

first four age-groups. Average length of all specimen investigated amounted to 25.7 cm.

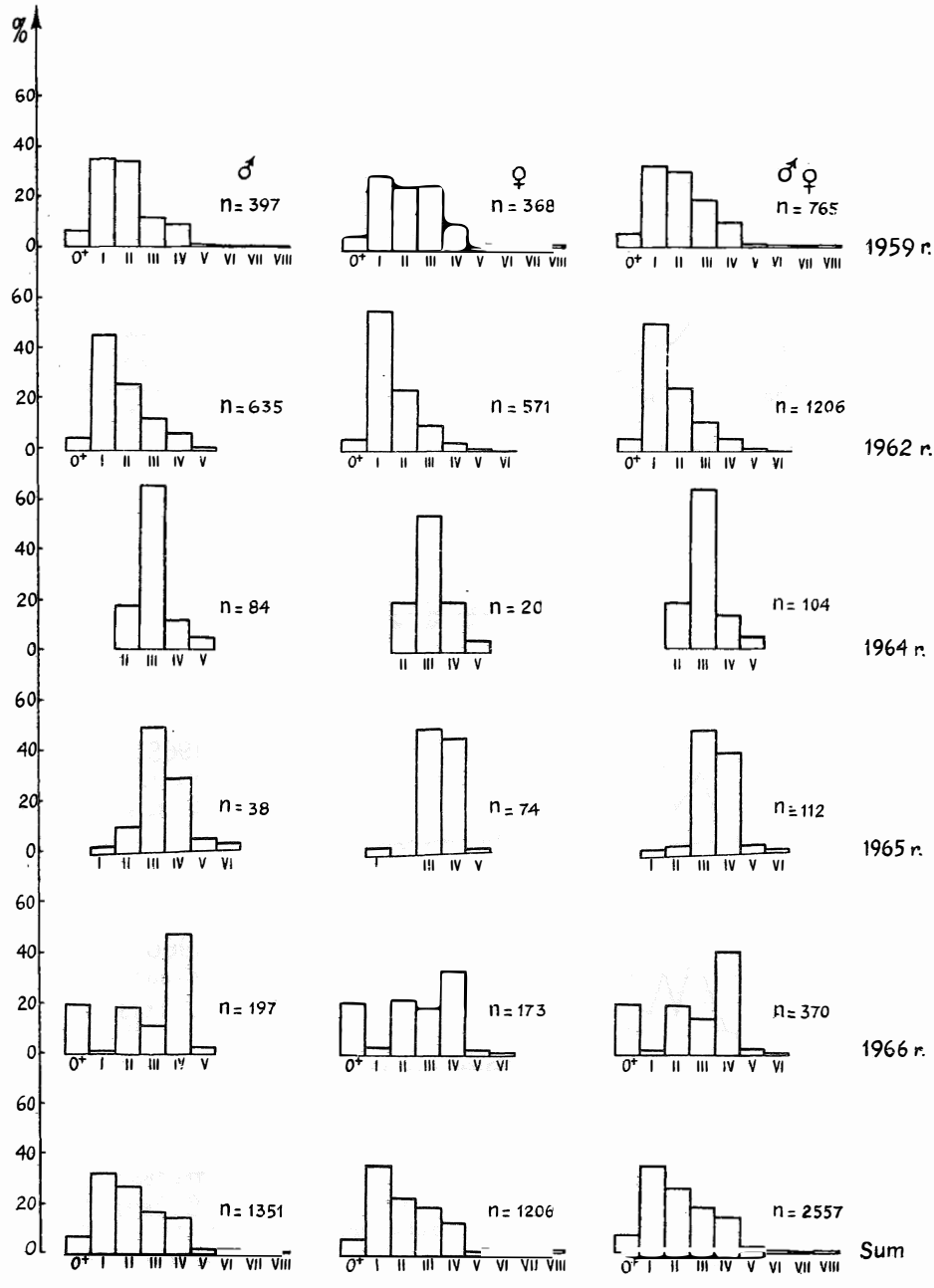

Fig. 10. Age composition of whiting catches for various years

Age composition

Analysing the Fig.10, which presents the age composition of whiting for particular years, it may be ascertained that during 1959 dominated the whiting of one and two years, in 1962 most numberously presented was the first age-group and in 1964 - the third age-group. In 1965 dominated the whitings of three and four years and in 1966 - the fourannual. It must be pointed out, that age of whiting for years 1964 and 1965 was denoted for relatively small material.

From total listing of drawing 10 appears that, age of whiting in material investigated oscillated within 0+ to VIII; dominated the specimen in age from I to IV with most numberously presented, first age-group.

Messtorff (1959), who investigated the whiting from North Sea, determines the age limit for this species for nine/ten years. According to Bowers (1954), the age limit for this fish amounts to eight years. Knudsen (1950) and Saemundsson (1925) estimated the whiting age limit for six years in males and nine years in females. The oldest specimen in this work, males and females, had eight years.

Rate of length growth

The rate of whiting growth in this work was calculated by method of back readings. The rate of weight growth was calculated according to the empiric data and the weight calculated on basis of determined relationship between length and weight.

Listed on table 9 are the lengths and ages of all material investigated and the average length for both sexes of particular age groups calculated by method of direct measurements.

When comparing the average length obtained in particular years by whiting females and males it is noted that beginning from the first year of life, the growth rate of females is higher; the difference is increasing with years from nearly 1 cm in first year to 4.5 cm in fifth year of life. Owing to limited material, average length calculated for age-groups of fish 6, 7 and 8 years, may be casual. According to Messtorff (1959), the differences in length-group between both sexes are distinct already towards the end of first year of life and are increasing with age to obtain 4 to 5 cm in seventh year of life in favour of females.

On Fig.11 is presented the rate of growth for whiting females and males calculated by back reading methods. The results obtained are similiar to results obtained by direct measurements of length (table 9).

Beginning from first year of life, the females dominate over males with better rate of growth; difference of growth for both sexes is increasing and obtains the value of about 4 cm in the fourth year of life and is maintained in further years.

The rate of length growth of whiting calculated by back reading method for fish caught in particular years, is presented on Fig.12.

As it appears from drawing, the differences in rate of growth for particular years were relatively negligeable and amounted maximally to about 2 cm.

Table 9

List of whiting length and age with consideration of sex

Age	0+			I			II			III			IV			V			VI			VII			VIII			Totals		
Length (l.t.) in cm \ Sex	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀
9	-	1	1																									-	1	1
10	-	-	-																									-	-	-
11	3	2	5																									3	2	5
12	7	3	10																									7	3	10
13	10	11	21																									10	11	21
14	20	24	44	3	-	3																						23	24	47
15	29	22	51	2	-	2																						31	22	53
16	17	15	32	1	1	2																						18	16	34
17	9	7	16	2	4	6																						11	11	22
18	2	2	4	6	4	10																						8	6	14
19	-	1	1	24	14	38																						24	15	39
20	1	-	1	65	50	115	1	1	2																			67	51	118
21				87	68	155	7	5	12																			94	73	167
22				97	96	193	23	20	43																			120	116	236
23				84	85	169	44	25	69	-	2	2																128	112	240
24				50	59	109	59	32	91	1	-	1																110	91	201
25				12	39	51	66	41	107	11	2	13	1	-	1													90	82	172
26				2	13	15	68	42	110	36	5	41	6	-	6	1	-	1										113	60	173
27				-	4	4	60	40	100	40	18	58	10	2	12	-	-	-										110	64	174
28							18	25	43	40	28	68	13	2	15	-	-	-										71	55	126
29							9	21	30	34	27	61	30	7	37	1	-	1										74	55	129
30							3	16	19	31	34	65	31	9	40	2	-	2	1	-	1							68	59	127
31							-	4	4	23	33	56	40	8	48	4	-	4	-	-	-							67	45	112
32							1	-	1	5	24	29	24	18	42	5	-	5	-	-	-							35	42	77
33							-	2	2	5	19	24	18	15	33	-	-	-	-	-	-							23	36	59
34										1	12	13	12	15	27	6	2	8	-	-	-							19	29	48
35										-	11	11	10	21	31	2	2	4	-	-	-				1	1	2	13	35	48
36										-	7	7	2	14	16	-	2	2	-	-	-				-	1	1	2	24	26
37										-	6	6	1	11	12	3	5	8	-	-	-				1	-	1	5	22	27
38										-	5	5	-	11	11	1	1	2	-	1	1	1	-	1				2	18	20
39													-	11	11	-	-	-	-	-	-	-	-	-				-	11	11
40													-	3	3	-	1	1	1	2	3	1	-	1				2	6	8
41													-	4	4	-	2	2	-	-	-	-	-	-				-	6	6
42													-	3	3	-	1	1	-	1	1	-	1	1				-	6	6
Totals	98	88	186	435	437	872	359	274	633	227	233	460	198	154	352	25	16	41	2	4	6	2	1	3	2	2	4	1348	1209	2557
Average length (l.t.) in cm	14.7	14.6	14.7	21.7	22.3	22.0	25.1	25.8	25.5	28.3	30.8	29.6	30.7	34.5	32.4	32.9	37.3	34.6	35.0	40.0	38.3	39.0	42.0	40.0	36.0	35.0	35.8	-	-	-

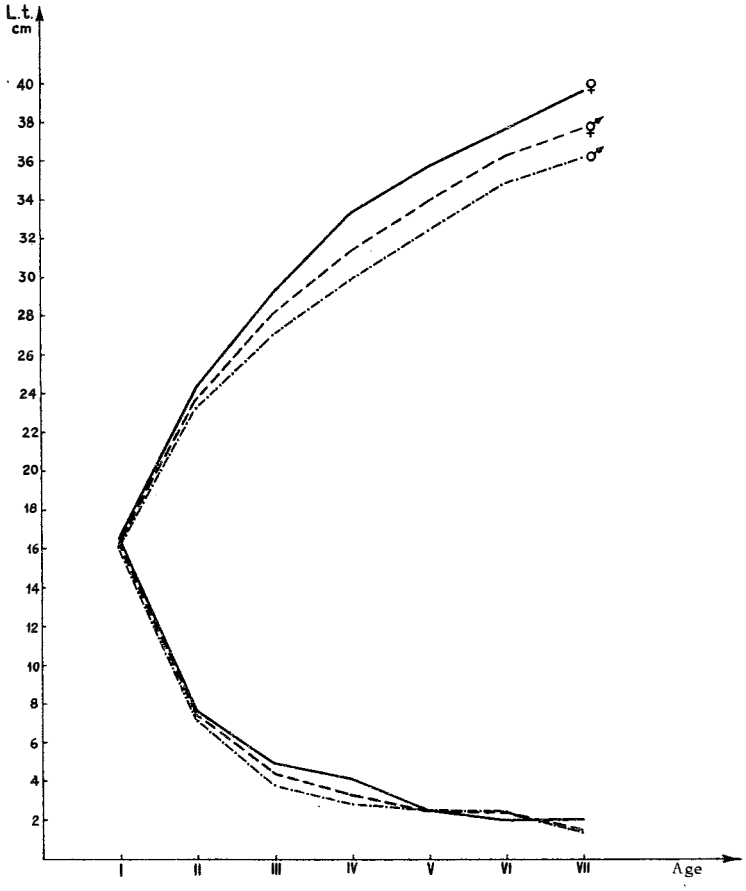

Fig.11. Body length rate of growth of whiting females and males

Presented on Fig.13 is a comparison in rate of length growth calculated according to back readings from cross-fractures of calcinated otoliths and scales for the specimen caught on 8.06.1966. From curves of drawing 13 appears that, the results obtained are similiar in application of both elements and this conforms the correctness of applied method.

Presented in table 10 are the results of investigations carried-out by various authors on growth rate of whiting from North Sea.

It appears that, data of this work which characterise the whiting from North Sea are approximative to results of Sahrhage (1963) and Lamolet (1965). Higher differences in comparison to investigation results of Messtorff (1959), Jones and Hislop (1963) and Gotkowska (1968), may support the hypothesis of Hislop (1966) on existance of seperate populations of whiting in North Sea. According to Hannerz (1964), spawning of whiting from North Sea is very extended in time and this may cause distinct differences in length for the same age-groups. Similiarily may be explained some considerable differences in length obtained for particular age-groups by various authors.

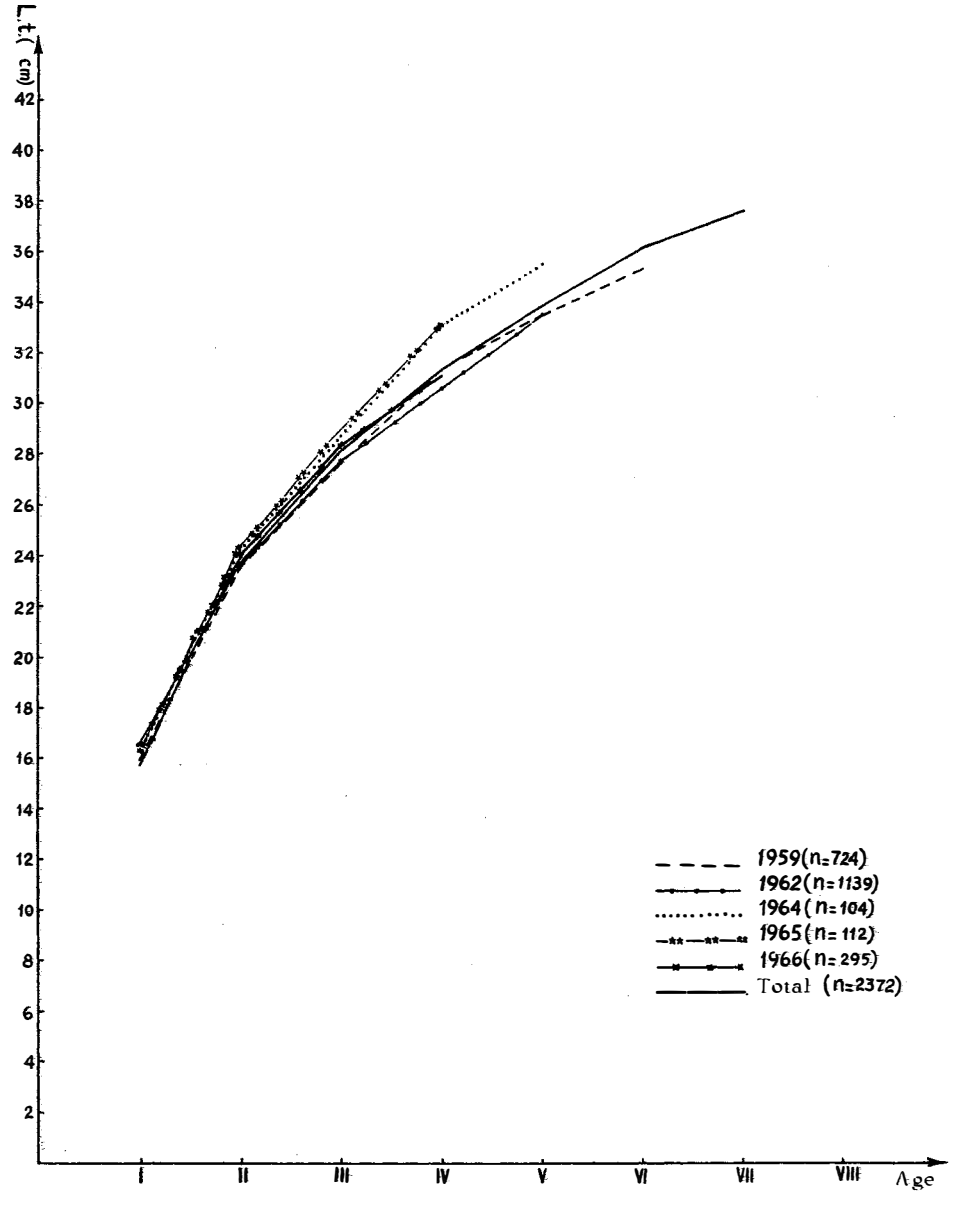

Fig. 12. Body length rate of growth of whiting fished in particular years

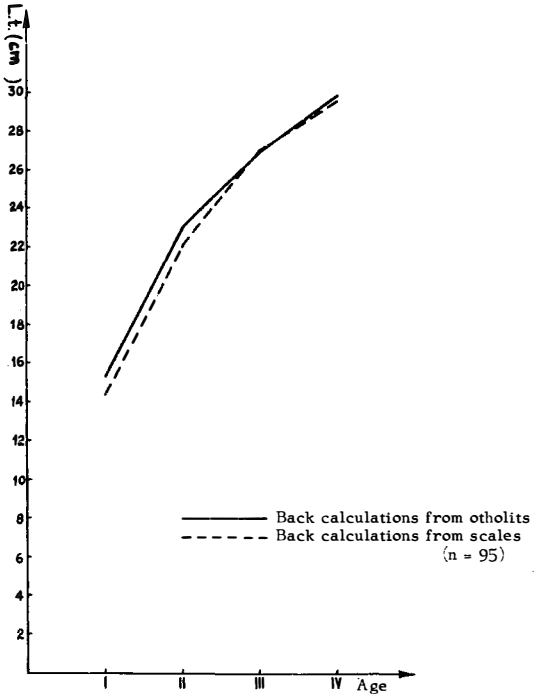

Fig. 13. Comparison of body length rate of growth calculated from otoliths and scales

Table 10

Rate of length growth of whiting from North Sea according to various authors

Author and year	Age groups							
	I	II	III	IV	V	VI	VII	VIII
Messtorf (1959)	16.3	20.3	25.1	26.6	27.4	28.9	-	-
Jones Hislop (1963)	22.4	27.4	34.0	35.0	36.0	-	-	-
Sahrhage (1963)	15.1	24.4	30.1	31.5	34.3	-	-	-
Lamolet (1965)	22.1	24.7	27.7	29.5	-	-	-	-
Gotkowska (1968)	15.1	23.2	25.8	27.8	29.4	31.2	33.0	37.1
Author's own data	16.3	23.7	28.1	31.4	33.9	36.2	37.7	-

Relationship between the length and body weight and growth of body weight

Presented on Fig. 14 in form of curve is the relationship between the length and weight of whiting body, determined according to average body weights calculated for particular class-length (by 1 cm).

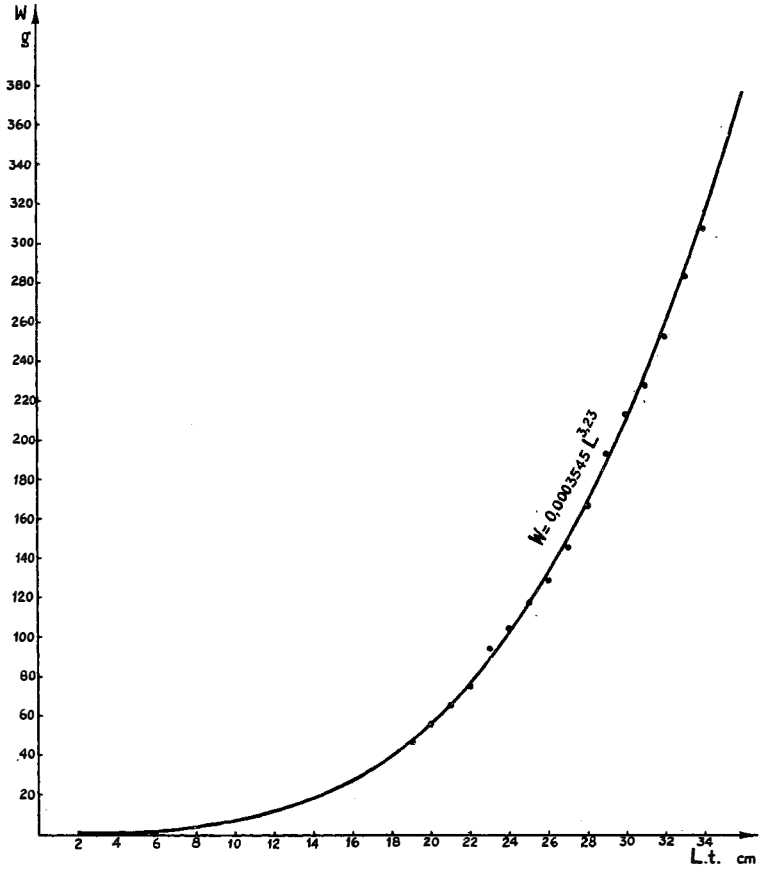

Fig. 14. Rate of weight growth calculated according to direct measurements

The equation for this relationship may be expressed as:

$$W = 0.0003545 \cdot L^{3.23}$$

where: weight (W) given in g
length (L) given in cm.

The rate of weight growth calculated according to empiric data for females and males is presented on Fig. 15.

It appears from this drawing that beginning from the first year of life, the females dominate by better rate of weight growth, and this increases with age.

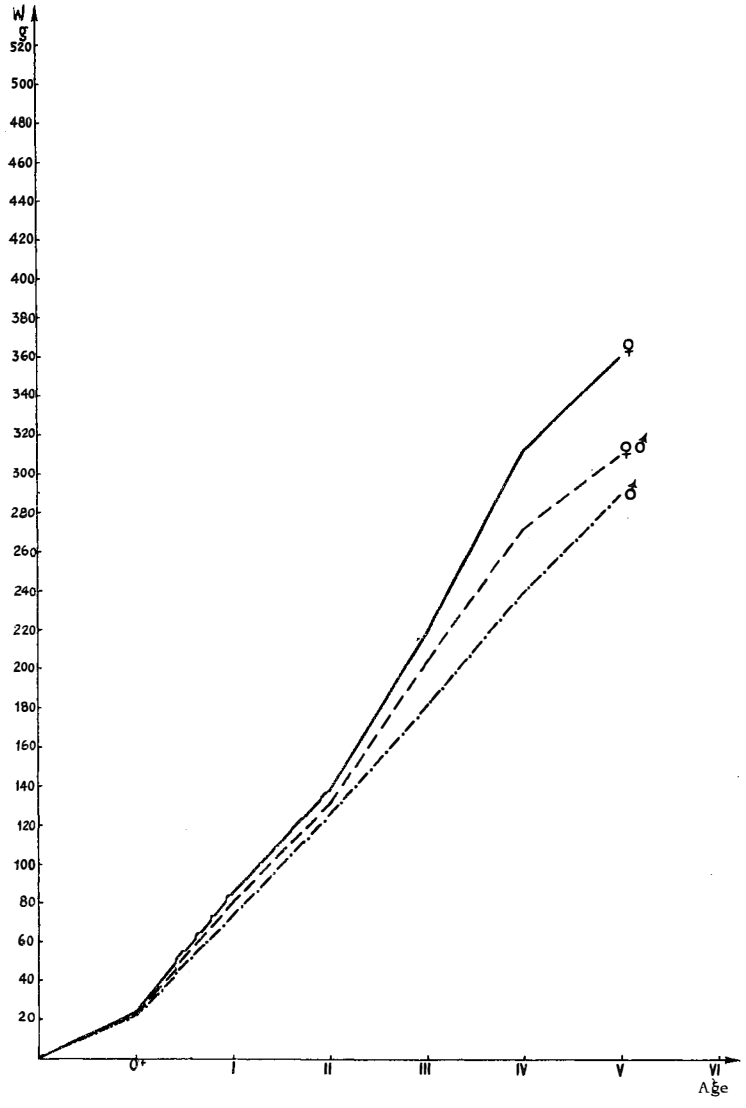

Fig. 15. Comparison of growth rate of length and weight of whiting

On Fig. 16 presented summarily: the rate of length growth for those fishes at which the length was calculated by back readings for particular years of life; the rate of weight growth calculated according to length obtained in particular age-groups by formula which expresses the relationship between length and body weight of whiting.

It appears from drawing, that the rate of length growth is fastest in first year of life and then the annual increases gradually are decreasing. The rate of weight growth is slowest in the first year of life. Later on, upto the sixth year of life, the rate of weight growth is more speedy and even. Certain de--accelleration of rate in weight growth occures in the seventh year of life.

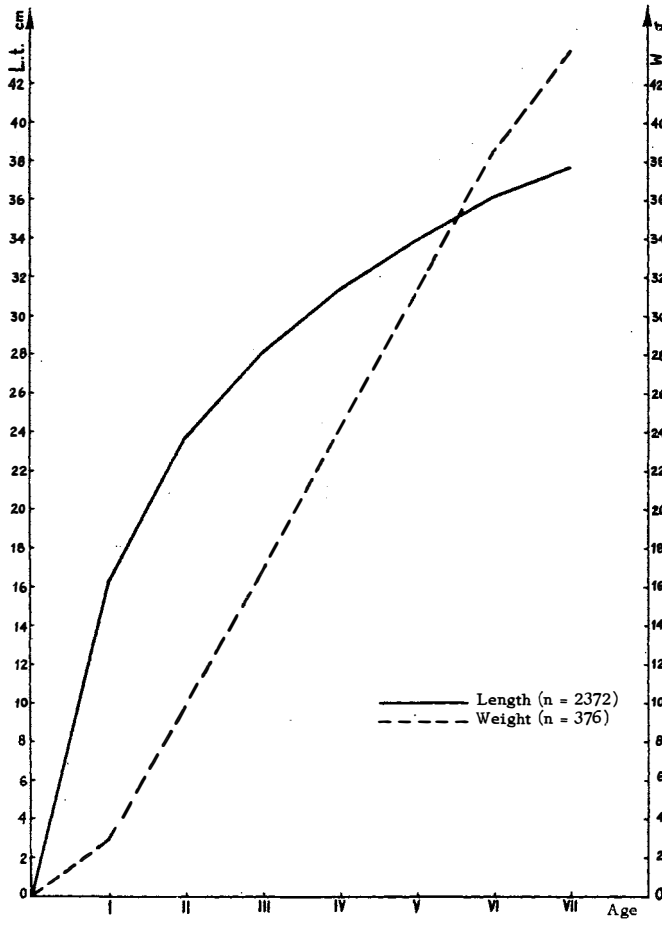

Fig. 16. Relationship between length (l.t.) and weight of whiting body from North Sea

Sex and stages of gonads

Observations on gonad maturity of whiting were effected at 2887 fishes (1505 males and 1382 females), according to 8-grade Maier scale.

On Fig. 17 is presented the stage of gonads development at whiting males and females fished during various months (no results for March and April, and particular samples originate from various years).

It appears from presented drawing that, in catches were dominating the non-matured fishes (I-II stage of gonads). Fish of VII and VIII stage of gonads maturity presented, in the material discussed, some negligeable per-cent. Most of fish of such stages was noted for May and encountered in some minor quantities, from June to August. Very few specimen of VI stage of gonad maturity were observed for May and September; this proves considerable time extension of whiting spawning in North Sea. Owing to shortage of fish in ana-

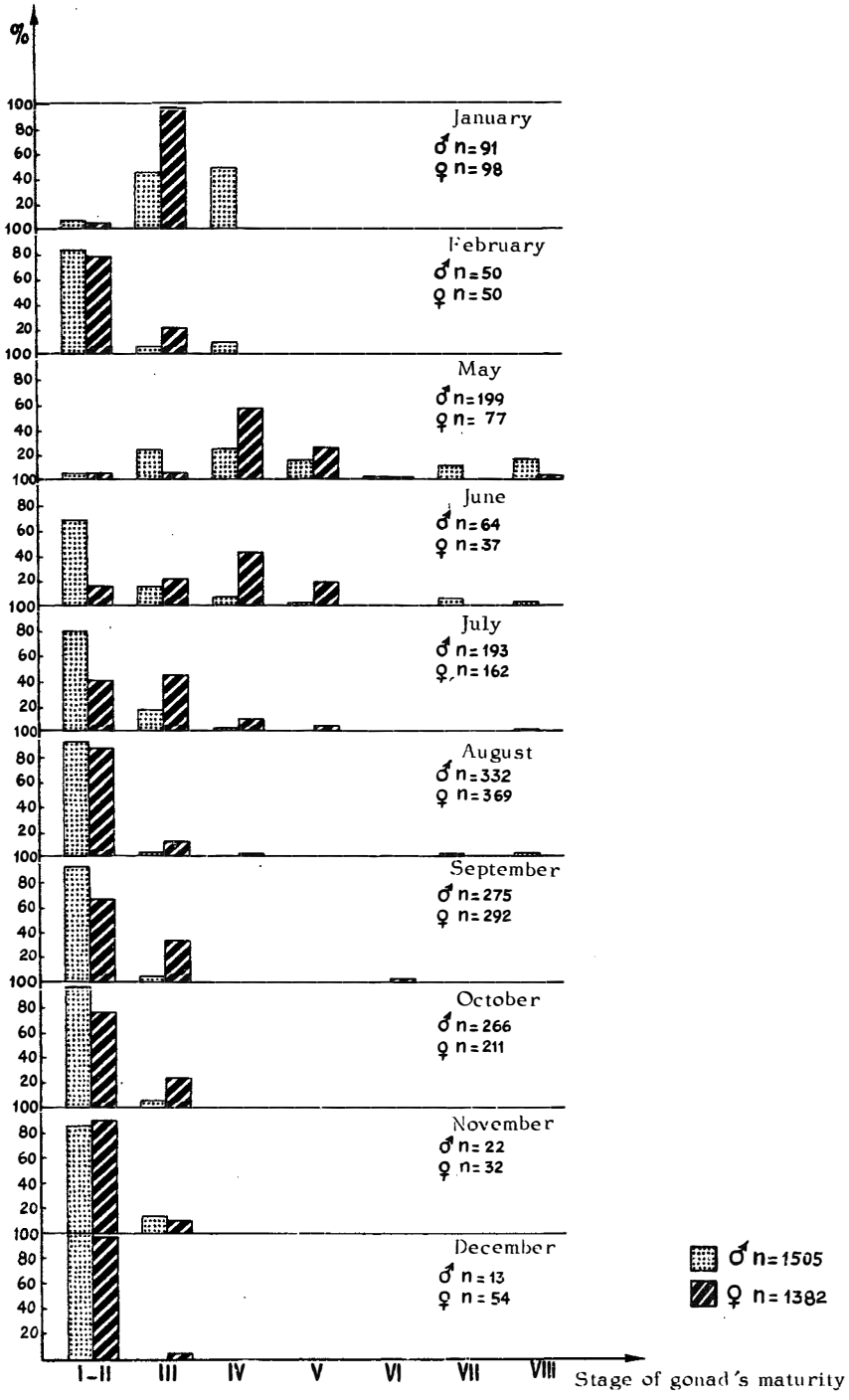

Fig. 17. Stages of gonads for particular months according to Maier scale

lysed material for months March-April, no plain picture of spawning course of whiting in North Sea, can be presented. Also Hannerz (1964) points out to extensive spawning period of whiting, which for exemple at Kattegat lasts from beginning of March to middle of August.

CONCLUSIONS

1. Calcination of otoliths cross-fractures considerable increases their clearness and ligeblety.
2. Relationship between whiting total length (l.t.) and longer radius of otolith section is nearly directly proportional.
3. Relationship between scale caudal radius and total length (l.t.) of whiting may be assumed as directly proportional.
4. In material analysed were appearing the whitings of length from 9 cm to 55 cm and of age from 0+ to VIII years. In region IVa, the average length amounted to 27.3 cm and in region IVb - 22.9 cm. Fishes belonging to first age-group were dominating.
5. The rate of whiting length growth is fastest in first year of life; decrease of rate is noted in later years.
6. Females are characteristic for faster rate of growth than males.
7. Rate of weight growth is slowest in first year of life. It increases in next years and is nearly even upto sixth year of life; certain de-accelleration in rate of weight growth is observed in sevenths year.
8. Spawning period of whiting is very extended in time. Matured and riped fishes were noted from May to September.

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BADANIA NAD WITLINKIEM ODONTOGADUS MERLANGUS (L.) Z MORZA PÓŁNOCNEGO W LATACH 1959-1967

Streszczenie

Celem niniejszej pracy było scharakteryzowanie połowów witlinka Odontogadus merlangus (L.) na obszarze ICES oraz zbadanie takich zagadnień jak: skład długościowy, wiek, tempo wzrostu długości i ciężaru, zależność pomiędzy długością i ciężarem ciała oraz płeć i stadium dojrzałości gonad. Przy badaniu wieku zwrócono uwagę na problem zwiększenia czytelności otolitów.

Ogółem w okresie badań w latach 1959-1967 przeanalizowano zawartość 607 zaciągów o łącznej masie połowu 465,791 ton. W ciągu całego okresu zmierzono 22 745 sztuk witlinka, z czego do analiz biologicznych pobrano 2887 ryb. Wiek i tempo wzrostu określano na podstawie otolitów z 2557 ryb metodą odczytów wstecznych Dahl-Lea.

Na podstawie niniejszej pracy można wyciągnąć następujące wnioski:

1. Prażenie przełomów poprzecznych otolitów zwiększa znacznie ich czytelność (rys. 1a,b,c,d i 2a,b).

2. Zależność pomiędzy długością całkowitą (l.t.) witlinka a dłuższym promieniem przełomu otolitu jest prawie wprost proporcjonalna (rys.3).

3. Zależność pomiędzy promieniem kaudalnym łuski a długością całkowitą (l.t.) witlinka można przyjąć za wprost proporcjonalną (rys.4).

4. W analizowanym materiale występowały witlinki o długości od 9 cm do 55 cm i w wieku od 0+ do VIII lat. W rejonie IVa średnia długość wynosiła 23,3 cm a w rejonie IVb - 22,9 cm. Przeważały ryby należące do pierwszej grupy wieku (tabela 1, rys. 7 i 10).

5. Tempo wzrostu długości witlinka jest najszybsze w pierwszym roku życia. W późniejszych latach zaobserwowano spadek tego tempa (rys. 11).

6. Samice charakteryzują się szybszym tempem wzrostu niż samce (tabela 9, rys. 11).

7. Tempo wzrostu ciężaru jest najwolniejsze w pierwszym roku życia. W następnych latach jest szybsze i prawie równomierne aż do szóstego roku, a w siódmym obserwuje się pewne zahamowanie we wzroście ciężaru ciała (rys. 15).

8. Okres tarła witlinka jest bardzo rozciągnięty w czasie. Ryby dojrzałe i cieknace obserwowano od maja do września (rys. 17).

ИЗУЧЕНИЕ МЕРЛАНГА ODONTOGADUS MERLANGUS (L.) ИЗ СЕВЕРНОГО МОРЯ В 1959 - 1967 Г.Г.

Р е з ю м е

Целью настоящей работы является характеристика уловов мерланга на территории ИЦЕС, а также исследование таких проблем, как размерный состав, возраст, темп роста и веса, зависимость между длиной и весом тела, пол и стадии созревания гонад. При изучении возраста было обращено внимание на проблему увеличения чёткости отолитов.

В общей сложности за период исследований в 1959 - 1967 г.г. проанализировали содержание 607 замётов общей массой улова 465,791 т. В течение всего периода измерили 22745 штук мерлангов, из которых для биологического анализа взяли 2887 рыб. Возраст и темп роста определяли на основе отолитов из 2557 рыб по методу отсчётов назад Даль-Лея.

На основе проведенных исследований можно сделать следующие выводы:

1. Прокаливание поперечных переломов отолитов значительно увеличивает их чёткость (рис. 1a,b,c,d и 2a,b).
2. Зависимость между общей длиной (l.t.) мерланга и самым длинным лучом перелома отолита является почти прямо пропорциональной (рис. 3).
3. Зависимость между каудальным лучом чешум и общей длиной (l.t.) мерланга можно принять за прямо пропорциональную (рис, 4).
4. В анализируемом материале встречались мерланги длиной от 9 до 55 см и в возрасте от 0+ до VIII лет. В районе IVa средняя длина составляла 23,3 см, а в районе IVб - 22,9 см. Преобладали рыбы, принадлежащие к первой возрастной группе (табл. 1, рис. 7 и 10).
5. Темп роста длины мерланга является наивысшим на первом году жизни. В более поздние годы наблюдалось снижение этого темпа (рис. 11).
6. Самки характеризуются более высоким темпом роста, чем самцы (табл. 9, рис. 11).

7. Темп роста веса является самым низким на первом году жизни, в последующие годы он является более высоким и почти равномерным, вплоть до шестого года, а на седьмом году наблюдается некоторое заторможение в росте веса тела (рис. 15).
8. Период нереста мерланга является более продолжительным. Зрелая и текучая рыба встречалась с мая по сентябрь (рис. 17).

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