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Fish biology

SOME DATA ON THE BIOLOGY OF COMMON BREAM, *ABRAMIS BRAMA* (L., 1758), FROM THE MIĘDZYODRZE WATERS

NIEKTÓRE DANE Z BIOLOGII LESZCZA, *ABRAMIS BRAMA* (L., 1758) Z WÓD MIĘDZYODRZA

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Growth rate (based on fry length measurements and back calculations), condition, relative gonad size, and length at first maturity were determined in the common bream population inhabiting Międzyodrze, a deltaic area situated in the vicinity of Szczecin.

INTRODUCTION

Along with the roach, the common bream is the most important fish species in freshwater areas of Poland. Biology of bream inhabiting Polish waters is relatively well known. The ample list of relevant publications includes papers by Filuk (1957, 1963) on different aspects of biology and fisheries of the bream stock in the Vistula Lagoon. Karpińska-Waluś (1961) described growth of bream in 20 Masurian lakes, her studies on fish length-scale radius relationship being of a particular importance for methodology of growth rate back calculations. Wojno (1964 a, b) investigated in detail the seasonality in bream growth. Zawisza (1970) studied biology and migrations of bream in several coastal Pomeranian lakes. Brylińska (1971) wrote a comprehensive monograph on fecundity and reproduction of bream in different water bodies. In addition, worthy of attention is a series of papers by Marciak (1974 a, b, c) which concisely focus, from both biological and fisheries-related perspectives, on different questions related to bream growth in Polish waters.

Bream has always played an important role in fisheries of the downstream section of the River Odra and its estuary (Neubaur 1926; Zimdars 1941; Pęczalska 1963 b; Pęczalska and Kraczkiewicz 1972; Kompowski and Pieńkowski 1992). The species is very common in the Międzyodrze waters as well. Międzyodrze is a deltaic area in the lower part of the Odra, situated upstream of Szczecin and consisting of two major river branches: the Regalica and the Western Odra, interconnected by a complex system of minor branches and canals. Most of the Międzyodrze area is a bream habitat, hence it is understandable that the species dominates in catches, accounting for—on the average—more than 40% of the total annual commercial catch from the area (Kompowski 1999).

In the downstream part of the Odra and its estuary, most of the relevant information pertains to the bream stocks inhabiting the Szczecin Lagoon, Pomeranian Bay, and Lake Dąbie. Neubaur (1926), Żukowski (1962), Pęczalska (1963 a, b), Pęczalska and Kraczkiewicz (1972), Kompowski (1982, 1988) as well as Załachowski and Więski (1998) dealt with various questions of bream biology and fisheries in those areas. So far, the Międzyodrze bream has been studied by Kompowski (1982) only. As those studies had been carried out in a rather distant period in time, it seemed justified to repeat them and broaden their scope. Such an effort was deemed necessary in view of the fact that the noticeable environmental improvement taking place during the last decade (Trzebiatowski 1999) could influence the biology of the population in question.

The present work was aimed at studying some selected aspects of the Międzyodrze bream biology.

MATERIAL AND METHODS

The materials, processed in this study, were collected within 1992–1997 primarily from commercial catches effected by fishermen of the Fishermen Cooperative "Regalica" in Gryfino who used deep-water fyke nets with 4-m-high wings and 15-mm codend mesh size. Random samples from those catches yielded a total of 353 individuals, supplemented with 211 individuals, mostly juveniles, caught during experimental fishing with a 100×100 cm/10 mm mesh size scoop net, a 15 m between-wing distance/5 mm codend mesh size small trawl, and a set of 20 and 22 mm mesh size trammel nets (Kompowski and Neja 1999) (Table 1).

The individuals caught were measured (total length, *TL* and standard length, *SL*) to 1 mm and weighed (w_1) to 1 g. Following dissection of the body cavity, the fish were sexed and their Maier scale maturity stage was determined from the state of gonads, weighed to 0.1 g. The gutted fish were reweighed (w_2). Fish age was determined from annual ring counts on scales, collected from the left side of the body below the lateral line, near the tip of the pectoral fin, and examined under a microfiche reader. Growth rate was estimated by back calculations. Toward this end, the caudal scale radius (*V*, mm), enlarged 17.5 times with the microfiche reader vs. standard length (*SL*, cm) relationship was determined at first (Fig. 1). The relationship was described with the following three different mathematical models, each producing a relatively good fit to the empirical data ($n = 279$):

1. a linear equation: $SL = 0.2804 \cdot V + 0.6654$; $r^2 = 0.9749$;
2. a binomial: $SL = -0.0001 \cdot V^2 + 0.2975 \cdot V + 0.2101$; $r^2 = 0.9751$;
3. an exponential equation: $SL = 0.3981 \cdot V^{0.9264}$; $r^2 = 0.980$.

Table 1

List of material collected and analyses performed

Date and locality of catch	Fishing gear	Length range (*SL*, cm)	Type of analysis: Length measurement	Weighing	Ageing and scale measurement	Sex and gonad maturity determination	Gonad weighing
Commercial catches							
05 Nov 1992, Widuchowa	fyke net	28.5–39.5	11	11	10	11	9
10 Dec 1992, Widuchowa	„	35.2–36.3	3	3	3	3	3
26 Apr 1993, Namyślin	„	29.7–43.8	17	17	9	17	17
27 Sep 1993, Odra Zachodnia	„	30.7–35.8	11	11	2	11	11
28 Oct 1993, Międzyodrze*	„	11.0–18.4	12	12	12	—	—
10 Mar 1994, Widuchowa	„	25.0–37.8	11	11	9	11	11
26 Apr 1994, Międzyodrze*	„	31.0–43.4	24	24	14	24	24
25 Oct 1994, Międzyodrze*	„	22.3–31.7	37	37	33	37	37
27 Mar 1995, Siekierki	„	8.8–25.3	23	23	5	23	7
17 Aug 1995, Berliński Canal	„	30.5–37.2	3	3	—	3	3
28 Mar 1996, Ciepły Canal	„	14.0–24.9	11	11	1	11	11
12 Apr 1995, Tama Pomorzańska	„	20.9	1	1	—	1	—
18 Apr 1996, Gryfiński Canal	„	27.5–34.7	8	8	1	8	8
24 Apr 1996, Ciepły Canal	„	7.1–24.9	72	72	59	72	20
30 Apr 1996, Stara Regalica	„	8.2–23.8	18	18	18	18	5
30 Apr 1996, Gryfiński Canal	„	20.4–35.5	91	91	45	91	79
TOTAL		7.1–43.8	353	353	221	341	245
Experimental catches							
10 May 1993, Długi Canal	scoop net	5.5–6.5	7	7	6	—	—
14 Jun 1993, Gryfiński Canal	„	6.7	1	1	1	—	—
21 Jun 1994, Mała Regalica	trammel net	12.0–22.1	2	2	2	—	—
13 Jul 1994, Podkowa Canal	„	20.3	1	1	1	—	—
31 May 1995, Bobrowy Canal	„	26.1–39.8	3	3	3	—	—
12 Jul 1995, Długi Canal	„	12.0–18.3	2	2	2	—	—
13 Sep 1995, Gryfiński Canal	„	23.1	1	1	1	—	—
09 Oct 1995, Długi Canal	„	17.0–21.3	2	2	2	—	—
16 May 1996, Podkowa Canal	„	11.7–40.5	3	3	3	—	—
23 Jul 1996, Stara Regalica	small trawl	2.4–3.1	2	—	2	—	—
06 Aug 1996, Stara Regalica	„	2.9	2	—	2	—	—
27 Aug 1996, Długi Canal	trammel net	20.9	1	1	1	—	—
29 Aug 1996, Stara Regalica	„	30.3	1	1	1	—	—
29 Aug 1996, Stara Regalica	small trawl	3.4	1	—	1	—	—
27 Sep 1996, Długi Canal	trammel net	10.7	1	1	1	—	—
13 May 1997, Długi Canal	small trawl	4.9–6.0	7	—	7	—	—
23 May 1997, Długi Canal	„	3.9–5.9	14	—	14	—	—
03 Jul 1997, Stara Regalica	„	1.9–2.7	18**	—	1	—	—
03 Jul 1997, Długi Canal	„	1.9–3.4	135**	—	—	—	—
02 Sep 1997, Długi Canal	„	3.8	1	—	1	—	—
02 Sep 1997, Stara Regalica	„	4.4–4.7	6	—	6	—	—
TOTAL		1.0–40.5	211	25	58	—	—
GRAND TOTAL		1.0–43.8	564	378	279	341	245

* No detailed data about catch locality

** 153 individuals, making up a random sample picked out from a total of 707, were measured

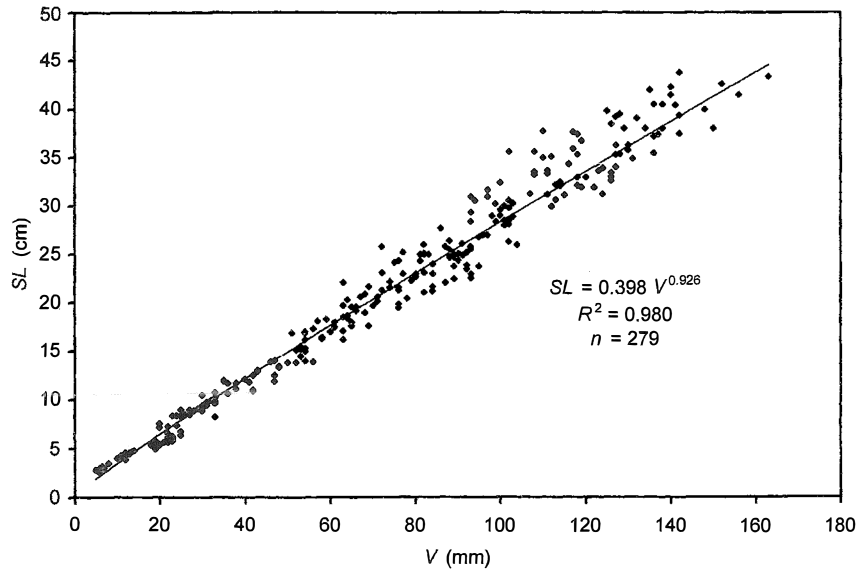

Fig. 1. Relationship between 17.5× magnified scale radius (V) and body length (SL) of bream from the Międzyodrze

The best fit was obtained with the third equation, as evidenced by its highest coefficient of determination (r^2). For this reason, the exponential curve plot (Fig. 1) was used for the subsequent back calculations. The length of fish in different years of life was reconstructed from the scale caudal radius in consecutive growth zones (V_n), measured in a manner identical to that used for the total scale radius, corresponding to the length of a given individual. The radius was then divided by the actual scale radius of the individual examined. The ratio obtained was subsequently used as a correction factor, to be multiplied by the radius of a given growth zone. The length corresponding to the corrected radius was read from the plot.

The gonado-somatic indices (the Fulton index, GSI_1 or the Clark index, GSI_2) were calculated from the formula:

$$GSI_n = \frac{G \cdot 100}{w_n},$$

where: G, gonad weight (g); w_1 or w_2: total weight (w_1) or gutted weight (w_2).

When determining the length at first maturity, the fish with gonads showing at least Maier scale stage II were assumed to be mature.

RESULTS

SL vs. *TL* relationship

Although the standard length (*SL* = *l.c.*) has been used in most bream studies, some authors reported the total length (*TL* = *l.t.*). To render the two dimensions comparable, the relationship between them was studied. The relationship can be described with a linear equation $TL = 1.2125 \cdot SL + 1.3274$ which shows a very good fit to the empirical data, as evidenced by its coefficient of determination, $r^2 = 0.997$. However, the exponential equation $TL = 1.424 \cdot SL^{0.9645}$ produced a still better fit ($r^2 = 0.999$). It can be therefore concluded that the relationship between the standard and the total length is slightly curvilinear.

Fry length

Table 2 summarises data on numbers of juvenile bream (age group 0) in different length (*SL*) groups in the experimental catches. On 10 May 1993, a total of 6 juvenile individuals measuring 55–65 mm were caught with the scoop net. Their scales lacked an annual ring. Similar were scales of the 21 individuals measuring 39–60 mm, caught with a small trawl in May (13 and 23) 1997, except for a single individual measuring 57 mm the scales of which showed a clearly visible annual ring on the edge. All those individuals were of more or less the same age of 1 year, hence their length provides information on the size attained by the bream in the population under study during their first year of life.

Table 2

Length frequency distributions of juvenile bream from the Międzyodrze waters

SL (cm)	Sampling period				
	May 1993	May 1997	Jul 1997	Aug 1996	Sep 1997
2.0	—	—	84	—	—
2.5	—	—	68	—	—
3.0	—	—	—	2	—
3.5	—	—	1	1	—
4.0	—	2	—	—	1
4.5	—	2	—	—	6
5.0	—	2	—	—	—
5.5	2	12	—	—	—
6.0	2	3	—	—	—
6.5	2	—	—	—	—
Total	6	21	153	3	7

A large sample of 153 measured individuals picked out at random from 707 juvenile bream caught with a small trawl on 3 July 1997 was found to consist of fish measuring 19–27 mm (modal value of 22 mm). The sample contained also an exceptionally large individual measuring 34 mm. Most of the delicate scales of those small bream fell off on capture. The retained scales of a 27 mm long individual showed 4–6 sclerites, their caudal radius length being about 0.3 mm. Thus during the 1–1.5 month of life since hatch (May), the individuals examined had grown to attain an average length of 22 mm.

A small sample, consisting of 10 individuals caught with the small trawl in August 1996 and in early September 1997 allowed to assume that the juveniles of the population studied were able to grow to 29–47 mm in the second half of summer. Their scales showed 13–33 sclerites, the caudal radius ranging within 0.34–0.80 mm.

Linear growth

Table 3 shows mean lengths attained by the Międzyodrze bream in different years of life, reconstructed from back-read scales. Noteworthy is a considerable length range recorded in individuals of identical age. Specifically, the length range reconstructed for the first year of life was 3.9–9.5 cm, the coefficient of variation accounting for 18.6% of the mean (6.17 cm). In the second year of life, the fish grew to 6.8–15.9 cm, the mean length and coefficient of variation being 10.38 cm and 15.7%, respectively. In the subsequent years, the length range became even wider: the difference between the upper and lower value of the range was 5.6 cm in the first year and increased to 9.0, 12.6, 16.1, and 18.6 cm in the second, third, fourth, and fifth year, respectively. On the other hand, the coefficient of variation decreased with age, thus evidencing a relative reduction of variability.

Mean annual length increments were found to monotonically decrease with age (Table 3), thus making the von Bertalanffy growth curve to fit well the empirical data. When estimating L_∞, the very high correlation coefficient ($r = 0.999$) was obtained, the correlation coefficient of the estimated K and t_0 being $r = -0.999$.

The following parameters were arrived at:

$$L_\infty = 59.3 \text{ cm}; K = 0.0999; t_0 = -0.037 \text{ yr}.$$

To estimate those parameters, mean lengths in age groups I–XI were used. Lengths in older groups were disregarded, as the sample size was too small.

Weight-length relationship and weight growth

The weight-length relationship for the Międzyodrze bream was described with the following exponential equation:

$$w = 0.0126 \cdot SL^{3.1638}; r^2 = 0.997.$$

By substituting the mean lengths attained in different years of life (from Table 3) into the equation, the corresponding mean weights were obtained (Table 3). By substituting $L_\infty = 59.3$ cm, the weight of $w_\infty = 5097.3$ g was calculated.

Condition

The Fulton (K_1) and Clark (K_2) condition coefficients were calculated separately for each individual examined. The results were grouped by sex and the spring and autumn values were compared (Table 4). The summer and winter values were disregarded due to the small sample size. The condition coefficient vs. fish length relationship is presented in Figs. 2a–f.

In spring, the females showed the K_1 range to vary from 1.672 to 2.748, the mean value being 2.190. Fig. 2a depicts a rather considerable increase of K_1 with fish length. The wide range of values in different classes resulted most likely from the fact that the different bream females caught in spring were either full, spawning, or spent, hence different maturity stages of their gonads: from Maier scale stage VI to VIII. This is confirmed by a much narrower range of the Clark coefficient (K_2, see Fig. 2b). The K_2 range in spring was 1.556–2.163 (mean: 1.869) (Table 4). As shown by Fig. 2b, the coefficient grew slowly within the *SL* range of 13–25 and equally slowly decreased thereafter.

In autumn, the female K_1 values varied within 1.873–2.595 (mean: 2.127), the autumn values being thus somewhat lower than the spring ones. The mean female K_2 in autumn was 1.894, i.e., only slightly higher than in spring and with a narrower range of variations (Table 4).

In males, K_1 ranged in spring within 1.930–3.046, the mean value (2.287) being higher than that in the females. The widest scatter of K_1 values and the highest extreme values were recorded in those males measuring 26–34 cm (Fig. 2c). The same length classes produced also the highest values of K_2 and their highest variability (Fig. 2d). As shown by Table 4, K_2 varied in males within 1.882–2.077, the values being thus higher than those recorded in the females.

In autumn, the male K_1 and K_2 were clearly lower than in spring, K_1 and K_2 being, on the average, lower than the respective values in females in that season (Table 4; Figs. 2c–d).

The immature individuals showed a gradual, albeit well-visible increase in both coefficients with length, condition of the immature members of the population in spring being only slightly worse than in autumn (Table 4; Figs. 2e–f). In addition, values of K_1 and K_2 recorded in the immature bream were, on the average, somewhat lower than the corresponding values found in adults.

Table 3

Growth rate of bream, *Abramis brama* (L., 1758) from the Międzyodrze area; a, mean length (*SL*, cm) in age groups; b, length range; c, standard deviation; *v*, coefficient of variation; Δ*L*, annual length increment; w_1, mean total weight (g) in age groups; *n*, number

Age (yr.)	*n*		L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}	L_{11}
1	21	a	7.28										
		b	5.1–8.9										
		c	1.12										
2	33	a	6.09	10.19									
		b	4.0–6.2	8.0–13.4									
		c	1.10	1.46									
3	17	a	6.44	11.09	15.34								
		b	4.4–8.6	8.3–14.6	11.7–19.7								
		c	1.14	1.72	2.16								
4	23	a	6.20	10.01	14.22	17.89							
		b	4.6–8.7	7.4–14.7	10.6–17.8	13.5–22.7							
		c	1.12	1.65	1.84	2.03							
5	52	a	5.66	9.94	14.91	18.97	22.21						
		b	3.9–8.5	7.0–15.8	10.6–21.9	14.5–24.4	16.2–29.9						
		c	1.06	1.61	2.23	2.41	2.71						
6	26	a	6.02	10.30	15.19	19.70	23.52	26.48					
		b	4.2–7.8	7.4–12.5	10.1–22.7	14.4–30.0	17.8–34.8	21.6–35.7					
		c	0.89	1.48	2.77	3.77	4.07	3.90					
7	24	a	6.23	11.08	16.18	20.44	24.34	28.14	30.81				
		b	4.6–8.5	7.5–14.3	13.9–18.8	16.5–25.0	20.3–30.1	22.9–34.2	24.2–36.8				
		c	1.07	1.55	1.43	2.53	2.75	2.79	3.17				
8	14	a	6.14	10.81	15.36	20.43	24.21	27.96	31.35	34.09			
		b	4.4–9.5	7.8–15.2	11.8–21.1	15.7–28.6	19.4–30.0	23.5–33.3	27.7–36.3	30.0–39.5			
		c	1.30	1.90	2.43	3.68	3.23	3.05	2.51	2.86			

Table 3 (cont.)

Age (yr.)	n		L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}	L_{11}
9	15	a	5.79	10.42	14.75	19.18	23.59	26.94	30.61	33.47	35.46		
		b	4.8–7.4	6.8–12.2	12.4–19.6	16.2–23.9	19.3–27.7	21.4–31.5	25.5–37.5	28.4–39.2	30.7–40.5		
		c	0.78	1.52	2.12	2.31	2.52	2.91	3.27	3.56	3.39		
10	11	a	6.31	10.64	15.10	18.71	22.82	25.99	29.45	32.41	35.45	37.40	
		b	3.9–8.4	8.7–13.5	11.3–19.6	14.7–22.9	18.0–28.6	20.2–31.0	24.2–34.2	25.9–37.5	29.1–38.8	31.3–41.5	
		c	1.28	1.63	2.71	3.02	3.09	3.39	3.27	3.73	3.19	3.21	
11	6	a	7.15	10.88	15.07	19.88	24.08	28.12	30.98	33.87	36.68	38.53	40.30
		b	5.8–8.6	8.2–14.3	12.5–20.1	15.3–23.7	19.5–27.9	24.1–31.4	27.1–33.8	29.7–37.0	32.5–40.2	34.5–41.9	37.2–43.4
		c	1.22	2.16	2.77	3.35	3.18	3.15	2.99	3.36	3.35	3.04	2.64
12	1	a	4.80	8.90	11.90	17.10	19.40	22.80	27.20	29.00	31.70	34.00	35.30
13	1	a	5.50	8.30	15.30	21.10	26.30	28.60	32.10	34.80	37.20	37.70	38.70
14	1	a	7.00	10.30	13.60	17.20	21.20	25.80	28.20	31.30	32.60	35.50	37.00
15	2*	a	7.10	11.00	15.65	19.30	21.90	25.55	27.10	30.80	33.80	35.90	38.30
		b	5.9–8.3	10.0–12.0	14.8–16.5	18.6–20.0	21.0–22.8	24.3–26.8	—	—	—	—	—
		c	1.70	1.41	1.20	0.99	1.27	1.77	—	—	—	—	—
Total	247	a	6.17	10.38	15.08	19.28	23.20	27.15	30.57	33.30	35.48	37.41	39.11
		b	3.9–9.5	6.8–15.8	10.1–22.7	13.9–30.0	16.2–34.8	20.2–35.7	24.2–37.5	25.9–39.5	29.1–40.5	31.3–41.9	35.3–43.4
		c	1.15	1.63	2.24	2.84	3.11	3.26	3.03	3.29	3.19	2.95	2.65
v			18.60	15.70	14.90	14.70	13.40	12.00	9.90	9.90	9.00	7.90	6.80
ΔL			6.17	4.21	4.70	4.20	3.92	3.95	3.42	2.73	2.18	1.93	1.70
w_1			3.99	20.67	67.58	146.06	262.24	434.13	629.26	822.88	1005.48	1188.70	1367.95
n			247	226	193	176	153	101	74	50	36	21	10

* Only the first six growth zones were measurable along caudal radius

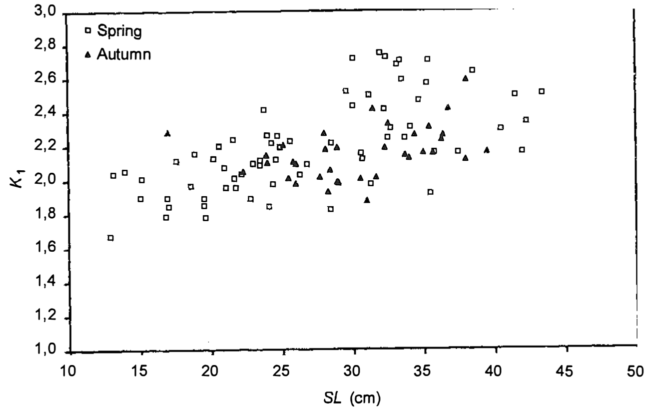

Fig. 2a. Relationship between Fulton coefficient (K_1) and body length (SL) in female bream from the Międzyodrze waters

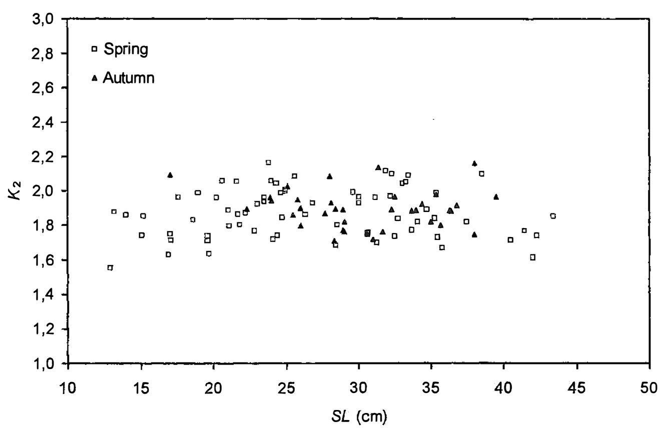

Fig. 2b. Relationship between Clark coefficient (K_2) and body length (SL) in female bream from the Międzyodrze waters

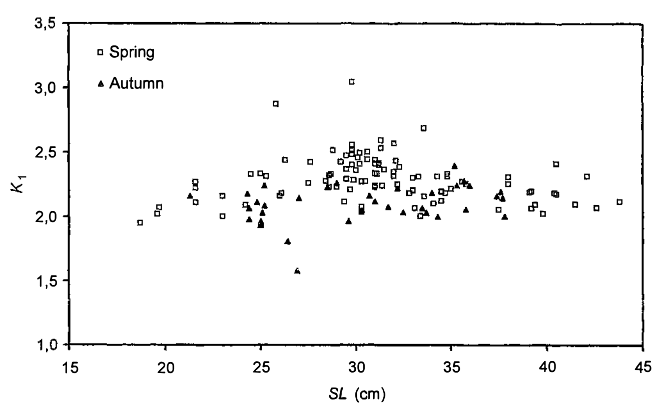

Fig. 2c. Relationship between Fulton coefficient (K_1) and body length (SL) in male bream from the Międzyodrze waters

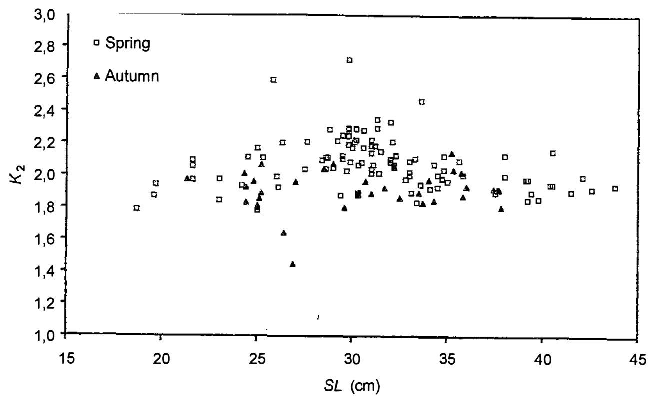

Fig. 2d. Relationship between Clark coefficient (K_2) and body length (SL) in male bream from the Międzyodrze waters

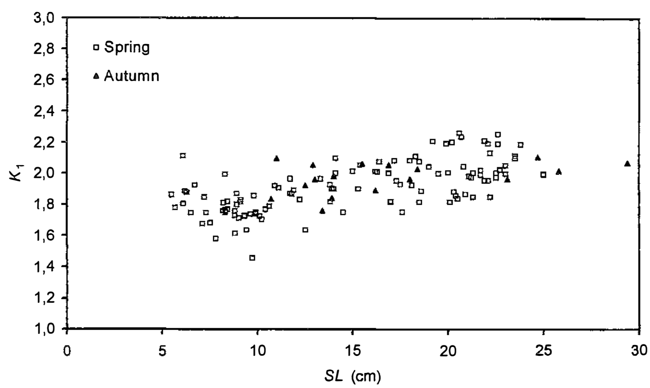

Fig. 2e. Relationship between Fulton coefficient (K_1) and body length (SL) in immature bream from the Międzyodrze waters

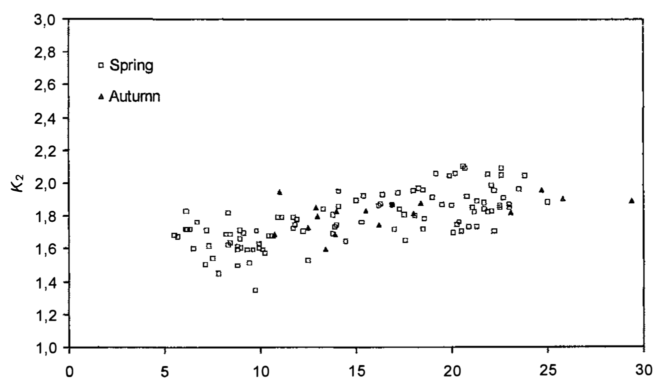

Fig. 2f. Relationship between Clark coefficient (K_2) and body length (SL) in immature bream from the Międzyodrze waters

Table 4

Condition parameters of bream from the Międzyodrze

Season	n	Fulton coefficient (K_1)				Clark coefficient (K_2)			
		min.	max.	mean	±SD	min.	max.	mean	±SD
Females									
Spring	69	1.672	2.748	2.190	0.271	1.556	2.163	1.860	0.142
Autumn	31	1.873	2.595	2.127	0.152	1.712	2.160	1.894	0.120
Males									
Spring	99	1.930	3.046	2.287	0.185	1.782	2.724	2.077	0.162
Autumn	26	1.807	2.263	2.095	0.108	1.641	2.073	1.915	0.097
Immature									
Spring	112	1.457	2.263	1.913	0.160	1.348	2.103	1.777	0.152
Autumn	17	1.762	2.105	1.978	0.099	1.596	1.960	1.814	0.098

Relative gonad size

Table 5 summarises data on the gonado-somatic indices of females and males. In spring, the ovaries accounted for 0.2–24.7% of the total body weight (mean: 7.4%) (GSI_1). On the other hand, GSI_2 varied within 0.2–33.7% (mean: 9.5%). Such an extensive variability of both indices resulted from the already mentioned fact that, in spring, the bream females examined were either full, spawning, or spent (Table 5). In summer, the resting ovaries (Maier scale stage II), made up as little as 0.6–2.1% and 0.5–2.3% of the total and gutted weight, respectively. In spring, the ovaries accounted, on the average, for a. 4% and 4.7% of the total and gutted weight, respectively. Ovaries of some females, however, were still resting in autumn, as evidenced by the low value of the lower limit of the GSI_1 range (a. 0.3%) (Table 5). The further gonad development was apparent in winter, the mean GSI_1 increasing to about 10%.

The Międzyodrze bream testes never reached a size comparable to that of the ovaries. In spring, the testes accounted for up to 3.7% (mean: 1.7%) and 4.3% (mean: 1.8%) of the total and gutted weight (Table 5). Following the summer and autumn decrease, the mean winter GSI_1 and GSI_2 values were 2.3 and 2.6, respectively (Table 5).

Length at first maturity

Fig. 3 shows changes in proportions of mature and immature fish in the population with increasing bream length. All the individuals measuring up to 12 cm were immature (Maier gonad maturity scale stage I). The smallest length of mature bream (Maier scale stage II) was 13 cm. At the length of 20 cm, 50% of the population were mature. Thus that length should be regarded as the length at first maturity. All the individuals measuring 30 cm and more were mature.

Table 5

Gonadosomatic index (GSI) of the Międzyodrze bream

Season	n	GSI_1				GSI_2			
		min.	max.	mean	±SD	min.	max.	mean	±SD
Total	109	Females							
Spring	67	0.174	23.977	7.411	7.897	0.188	33.737	9.510	10.527
Summer	6	0.455	2.130	1.055	0.621	0.491	2.286	1.142	0.667
Autumn	32	0.267	11.578	4.038	3.235	0.292	14.092	4.667	3.891
Winter	4	7.649	13.652	10.274	2.498	8.949	17.283	12.526	3.480
Total	135	Males							
Spring	99	0.117	3.682	1.658	0.693	0.129	4.271	1.830	0.778
Summer	1	0.281	0.281	0.281	—	0.297	0.297	0.297	—
Autumn	28	0.024	1.508	0.973	0.367	0.026	1.677	1.067	0.407
Winter	7	0.693	3.678	2.319	0.954	0.747	4.214	2.592	1.106

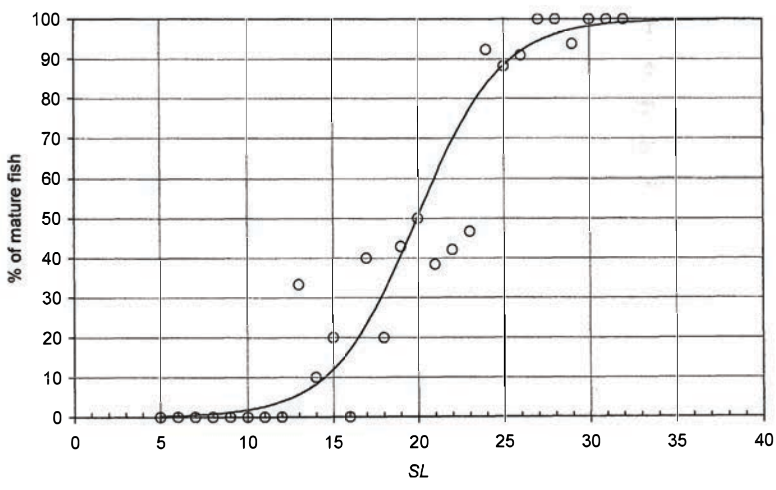

Fig. 3. Changes in the mature–immature fish ratio with increasing length of bream from the Międzyodrze waters

DISCUSSION

SL–TL relationship

In his earlier paper on bream inhabiting the Regalica and Lake Dąbie, Kompowski (1982) found the relationship to be slightly curvilinear. That finding was corroborated by the present study and is compatible with observations reported by Brylińska and Bryliński (1968).

Scale radius vs. standard length relationship and back calculation methodology

A method employed for fish growth rate assessment affects the results considerably; this particularly true in the case of back calculations (Francis 1990). Šentiakova (1969) demonstrated (using, i.a., bream as an example) that the hypothesis assuming a constant species-specific relationship between fish length and scale radius was erroneous. Moreover, a scale (or other structural element used in back calculation) may grow in asynchrony with growth of the body. Consequently, the body length-scale radius relationship changes seasonally (Reay 1972). For this reason, it is not appropriate to use, when back calculating the growth rate of a given stock, the scale radius–body length relationship determined for another stock of the species. The relationship determined for the material on hand should always be used instead. The fish length range should include all age groups of the stock, rather than only those present in commercial catches. Unfortunately, not all the published studies on bream growth rate meet those requirements, which affects the reliability of comparisons. The diversity of methods used in bream growth rate back calculation is illustrated below. Karpińska-Waluś (1961) found a curvilinear relationship between the scale caudal radius and *SL* in bream inhabiting lakes near Węgorzewo, for which reason she used the Dahl-Lea method with corrections determined with the empirical curve. In their publications, Zawisza (1970) and Chmiel et al. (1976) restricted themselves to mentioning that they had used scale back calculations, without elaborating on details. Heese and Mastyński (1990) found a linear relationship between the body length and scale radius in bream living in the Jeziorsko reservoir on the River Warta and used the Dahl-Lea method. Brylińska and Białokoz (1972) who studied bream in the Otmuchów reservoir on the Nysa Kłodzka found a lack of simple proportionality between growth of the body length and that of the scale caudal radius, for which reason they used empirical curve-based corrections developed by Karpińska-Waluś (1961). In their study on the Lake Dąbie bream growth rate, Załachowski and Więski (1998) found a linear *SL*–scale radius relationship in those fish caught in 1995 and used the Lee procedure to reconstruct mean length in age groups. On the other hand, they developed two linear regressions for their 1992 material. The first was fitted to the empirical data, while the second, auxiliary one, originated at 1.32 mm—an average body length at which, according to Heese (1992), the scales begin to appear—and run to the extreme lower empirical data points, two data points representing juveniles being used. The authors quoted assumed the general *SL*–scale radius relationship to be curvilinear for that part of their materials and used Vovk's method in their back calculations. Ševcova (1983), too, observed a curvilinear *SL*–scale radius relationship in bream inhabiting limnologically differing lakes in the Daugava and Niemen catchments and fitted an exponential equation $l = a \cdot v^{b}$ to her empirical data. Our study, too, demonstrated a slight curvilinearity of the relationship, the exponential curve fitting the data relatively well. It is worth reminding that the relationship in question was studied here for a very wide *SL* range (3.1–43.8 cm), hence we did not have to resort to hypothesising on the shape of the curve in length classes absent from the materials on hand.

Growth rate calculations from mean lengths in age groups, based on direct measurements, are frequently biased due to gear selectivity. The mean length of younger age groups is usually over-estimated as the fast-growing individuals are usually selected by the gear.

With a due consideration to all the reservations discussed above, the Międzyodrze bream growth rate can be now compared with data on length growth rate in other water bodies.

Variability in bream growth rate in the Odra estuary and comparison with growth rates recorded in other water bodies

As shown in Table 6, the Międzyodrze bream is characterised by a high growth rate, higher than the average for the Polish bream as calculated by Marciak (1974a). Still higher growth rates were in Poland demonstrated for the bream inhabiting the Szczecin and Vistula Lagoons and lakes Dąbie and Jamno. Elsewhere, a higher growth rate was recorded in eutrophic Lake Miastro in Belarus (Ševcova 1983). The data in Table 6 indicate also that the Międzyodrze bream growth rate increased during the period of study, compared to earlier years (1974–1977). A similar trend could be observed in other parts of the downstream section of the Odra and in its estuary, i.e., in Lake Dąbie and in the Szczecin Lagoon. It may be presumed that the increased growth rate was related to improved state of the environment in the lower Odra and its estuary (Trzebiatowski 1999). However, it should be borne in mind that at least some components of the above comparison may be biased due to different methods of growth rate estimation used by various authors, and due to different periods of study, sometimes very far apart from one another in time.

Table 6

A comparison of the growth rate of bream *Abramis brama* (L., 1758) in various water bodies (*SL*, cm)

Water body, period of catches, method used	Length et age (L_n)															Source
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}	L_{11}	L_{12}	L_{13}	L_{14}	L_{15}	
Szczecin Lagoon, 1951–54, back-calculations	—	14.2	18.3	22.0	25.7	28.0	31.0	33.8	36.3	39.0	41.2	43.0	44.7	—	—	Chełkowski unpublished
Szczecin Lagoon, 1956–58, direct measurements	—	—	16.6	19.7	22.4	26.4	29.9	33.0	36.2	37.1	40.2	43.1	44.0	44.3	46.6	Pęczalska and Kraczkiewicz 1972**
Szczecin Lagoon, 1968–71, direct measurements	—	11.9	14.6	16.9	21.4	25.2	27.9	30.5	34.5	36.5	38.7	42.0	43.4	44.9	46.7	Pęczalska and Kraczkiewicz 1972**
Szczecin Lagoon, 1985–86, back-calculations	5.7	11.3	16.8	21.9	26.4	30.1	33.0	35.1	36.9	40.2	41.6	43.6	44.5	—	—	Kompowski 1988
Lake Dąbie, 1974–1977, back-calculations	5.7	10.4	15.2	19.7	23.8	26.7	30.0	32.7	34.7	36.6	38.5	39.8	42.4	43.1	46.6	Kompowski 1982
Lake Dąbie, 1985–1986, back-calculations	5.5	10.7	15.9	21.4	25.9	29.1	31.6	33.7	35.3	36.4	37.2	—	—	—	—	Kompowski 1982
Lake Dąbie, 1992, back-calculations	7.9	13.9	20.4	26.1	29.8	31.9	33.9	34.8	35.0	37.1	38.2	40.1	—	—	—	Załachowski and Węski 1998
Lake Dąbie, 1995, back-calculations	6.4	11.8	16.9	21.4	25.4	29.1	32.4	35.0	37.6	39.9	41.2	42.6	42.5*	43.1*	45.6*	Załachowski and Węski 1998
Regalica, 1974–1977, back-calculations	5.4	9.3	13.5	17.6	21.6	24.5	27.3	29.6	32.0	33.9	35.2	37.3	39.4	40.3	40.7	Kompowski 1982
Lower Odra and Między-odrze, 1992–1997, back-calculations	6,2	10.4	15.1	19.3	23.2	27.2	30.6	33.3	35.5	37.4	39.1	38.9*	41.5*	42.6*	43.8*	Neja and Kompowski this paper
Vistula Lagoon, 1960, direct measurements	—	—	19.0	23.3	27.8	31.1	34.3	36.6	38.8	41.5	42.6	43.8	45.7	46.6	47.9	Filuk 1963**

Table 6 (cont.)

Water body, period of catches, method used	Length et age (L_n)															Source
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}	L_{11}	L_{12}	L_{13}	L_{14}	L_{15}	
Lake Gardno, 1962, back-calculations	5.7	9.0	13.2	15.6	19.0	22.4	24.9	27.8	31.0	34.2	36.0	38.0	—	—	—	Zawisza 1970
Lake Łeba, 1963, back-calculations	6.3	10.5	14.1	17.5	21.2	24.2	28.2	31.8	35.5	38.2	—	—	—	—	—	Zawisza 1970
Lake Jamno, 1966, back-calculations	6.2	11.2	15.7	19.5	23.2	26.3	30.8	35.0	37.9	39.8	42.1	43.6	45.2	46.8	48.3	Zawisza 1970
Vistula River near Toruń	5.3	9.5	14.1	18.8	23.3	27.2	30.9	33.8	36.5	39.1	42.2	—	—	—	—	Brylińska 1969
Otmuchów Reservoir, 1968–1969, back-calculations	5.0	9.5	12.5	15.6	18.5	21.2	23.7	25.4	27.5	29.5	31.5	33.6	35.6	38.5	—	Brylińska and Białokoz 1972
Lake Wierzchołek, 1972, back-calculations	3.5	7.1	11.2	14.9	17.4	19.5	—	—	—	—	—	—	—	—	—	Chmiel et al. 1976
Lake Dobskie, 1972, back-calculations	4.3	8.1	12.2	16.7	20.5	23.2	26.6	30.1	32.5	—	—	—	—	—	—	Chmiel et al. 1976
Jeziorsko Reservoir, 1988	6.8	12.4	19.8	26.0	30.2	33.9	34.6	40.1	41.9	44.2	45.6	—	—	—	—	Heese and Mastyński 1990
Average bream growth rate in Polish waters	4.9	8.9	12.7	16.7	20.6	24.5	28.0	31.0	33.5	34.8	36.9	38.6	39.0	—	—	Marciak 1974a
Lake Miastro, 1976–1980, back-calculations	5.8	11.7	16.9	21.3	24.7	27.8	30.3	32.7	34.7	36.8	39.2	41.6	43.7	—	—	Ševcova 1983
Lake Batorino, 1976–1980, back-calculations	5.0	10.5	15.4	20.1	24.9	29.0	32.8	35.6	38.2	—	—	—	—	—	—	Ševcova 1983
Lake Obstierno, 1976–1980, back-calculations	4.6	9.7	14.6	18.6	22.3	25.6	29.0	32.4	35.4	37.6	39.4	—	—	—	—	Ševcova 1983
Lake Lukomlsloye, 1976–1980, back-calculations	7.4	14.3	21.0	27.0	30.5	33.0	35.2	37.2	39.2	41.2	43.3	45.3	—	—	—	Ševcova 1983
Rybinsk Reservoir	—	12.8	15.4	19.5	22.7	24.8	27.4	29.7	32.0	34.0	35.6	37.1	38.4	—	—	Volodin 1992

* Mean based on few specimens; ** Originally *TL*, here recalculated to *SL*

Fry growth

Wilkońska (1988) summarised literature data on lengths attained by bream fry in September. The lower limit of the range slightly exceeded 3 cm (the Vistula, lakes of the Suwalskie and Masurian Lake Districts), the upper limit exceeding 6 cm (Lake Ślesińskie, Kuibyshev Dam Reservoir). The only set of data on bream fry growth in the Odra estuary can be found in Neubaur (1926). As shown by his observations, in October of their first year of life, the bream of different part of the Szczecin Lagoon and adjacent waters grew to 3.0–8.0 cm. It should be remembered that Neubaur's data on total length were converted to SL. It is evident that the range of variation in fry length, reported by Neubaur, is comparable with that of L_1, back-calculated in this study. On the other hand, it is clear that both the lower and upper limits of the latter is higher than the corresponding data reported by Neubaur. It should be, however, borne in mind that his data were collected almost 80 years ago from a different, albeit close to ours, area, and concerned October, while our back calculations were made for fry growth during the first annual ring formation, i.e., May–June. Wojno (1964b) demonstrated that juvenile bream grow both in autumn and in spring prior to the formation of the first annual ring. The back-calculated range of variation in L_1 is wider than the range of lengths of the fry we caught. This becomes understandable when one considers the fact that the fry was caught mainly from two sites in Stara Regalica during two summer seasons only, while the materials for back calculations were collected over a long-term period from the entire Międzyodrze area.

Condition

Condition coefficient may vary widely in bream. According to Brylińska (1971), the Fulton coefficient (K_1) of mature bream females from different Polish populations ranged within 1.33–3.51 (the corresponding range in the Międzyodrze bream females was much narrower). The range was wider in younger females and the values were, on the average, higher than in older ones. Brylińska observed a similar age-dependent pattern with respect to the Clark coefficient (K_2) as well.

Wojno (1964a) studied fat and protein contents in bream muscles and viscera throughout a year. He recorded the lowest fat content in March, before spawning, the highest content being typical of August, towards the end of the period of intensive feeding. Against that backdrop, it is interesting to note the presence of large amounts of perivisceral fat in the Międzyodrze bream. Large deposits of that fat were found also in the spawners, and even in the freshly spent individuals. This observation may be an evidence of ample food resources available to the Międzyodrze bream.

Marciak (1974a) reported mean values of the Fulton coefficient (K_1) for bream inhabiting Polish lakes. The values increased with fish length, which is compatible with our observations as mature males and females caught from Międzyodrze showed higher K_1

values than did immature (hence smaller) ones, K_1 increasing with length in the latter as well.

Relative gonad size

Changes in GSI_2 throughout the year were described by Wojno (1964a) in the Lake Wdzydze bream. Mean values are reported only. The maximum and minimum mean GSI_2 values in females were 24.1 and 1.45, respectively. The mean GSI_2 in those females having gonads at the same Maier scale maturity scale increased with age. The minimum and maximum GSI_2 in males was 0.6 and 3.38, respectively, the mean GSI_2 increasing with age, similarly to the situation in females. Pęczalska (1963) reported similar findings with respect to the Szczecin Lagoon bream: the relative gonad weight increased with fish size. The maximum GSI_1 was in some cases exceeding 25%, i.e., it was close to the maximum values found in this work.

Length at first maturity

Various authors adopt different criteria for the first maturity in fish and the criteria are often not defined clearly enough. This renders a comparative analysis difficult. With respect to bream, Brylińska (1971) prepared the most comprehensive summary of length (*SL*) at which 50% of the individuals were mature. The length in question was, on the average, 17.5–30.9 cm in males and 26.0–33.5 cm in females. The author did not, unfortunately, provide her definition of a sexually mature fish.

Length at first maturity in the Odra estuary was earlier studied by Neubaur (1926). He discussed quite extensively, but not precisely enough, his observations on the length of the bream which "spawned for the first time" in the Szczecin Lagoon. Conversion of his data from *TL* to *SL* produced the lower and upper length range limits equal to 23.2 and 30.7 cm, respectively. A similar criterion of first maturity ("the first spawning") was adopted by Pęczalska (1963a), although she was not precise in her definition, either. According to her data, 50% of males reached maturity at TL = 35.5 cm (equivalent to SL = 27.7 cm) and at the age of 7 years, while 50% females matured having attained TL = 39 cm (SL = 30.5 cm) at the age of 8 years. Volodin (1992) reported bream inhabiting the Rybinsk reservoir on the Volga to be sexually mature when older than 7 years, when 9.3% of the individuals were mature, at the average length of 27.4 cm. At the age of 9 years, almost half (48.1%) of all the individuals were mature, at the average length of 32.0 cm. All the bream (100%) were mature as late as in their 13th year of life, having attained a mean length of 38.4 cm. Unfortunately, the author referred to did not define the maturity criterion he adopted. Kompowski (1988), who used a maturity criterion similar to that adopted in this study, found 50% of bream in Lake Dąbie and the Szczecin Lagoon to be mature at 22 and 20 cm, respectively. Those lengths are comparable with the results of this study.

CONCLUSIONS

1. In the Międzyodrze bream, the scale caudal radius–standard fish length relationship is slightly curvilinear.
2. The standard length–total length relationship in the population under study is best described by the exponential equation $TL = 1.424 \cdot SL^{0.965}$.
3. The bream yearlings measured (*SL*) 3.9–6.5 cm in May of 1993 and 1997.
4. The Międzyodrze bream are characterised by a high growth rate, higher than the Polish average calculated by Marciak (1974a).
5. Growth rate of the population studied can be very accurately described with the von Bertalanffy equation having the following parameters: $L_\infty = 59.3$ cm; $K = 0.0999$; $t_0 = -0.0371$.
6. The weight–length relationship can be described with the following equation: $W = 0.0126\, SL^{3.1637}$.
7. Immature individuals in the population under study showed their condition coefficients (Fulton and Clark) to be lower than those found in the mature fish.
8. The ovaries accounted for up to 24.7 and 33.7% of the total and gutted body weight, respectively. The corresponding values for the testes were 3.7 and 4.3%.
9. Bream of the population studied was found to attain the first maturity when 20 cm long.

REFERENCES

Brylińska M., 1969: Wzrost i płodność leszcza (*Abramis brama* L.) w Wiśle koło Torunia [Growth and fecundity of bream (*Abramis brama* L.) in the river Vistula near Toruń]. Rocz. Nauk Rol. Ser. H Ryb., **91**: 331–345. (In Polish).

Brylińska M., 1971: Czynniki regulujące indywidualną płodność absolutną oraz płodność absolutną populacji leszcza (*Abramis brama* L.) [Factors regulating individual absolute fecundity and population absolute fecundity of bream (*Abramis brama* L.)]. Zesz. Nauk. WSR Olsztyn, Ser. C, Supl. 2: 3–103. (In Polish).

Brylińska M., E. Bryliński, 1968: Leszcz [Bream]. PWRiL, Warszawa. (In Polish).

Brylińska M., W. Białokoz, 1972: Wzrost i płodność leszcza (*Abramis brama* Linnaeus) w zbiorniku zaporowym w Otmuchowie [Growth and fecundity of bream (*Abramis brama* Linnaeus) in Otmuchów Dam Reservoir]. Rocz. Nauk Rol. Ser. H Ryb., **94**, 1: 41–55. (In Polish).

Chmiel M., Cz. Platt, W. Sklinsmont, 1976: Zmienność cech biometrycznych dwóch populacji leszcza *Abramis brama* L. o różnym tempie wzrostu długości ciała [Variability of biometric features of two populations of bream *Abramis brama* L. differing in the rates of body length increase and body weight gain]. Zesz. Nauk. Akad. Rol.-Tech. Olszt., Ochr. Wód Ryb. Śródl. **6**: 31–52. (In Polish).

Filuk J., 1957: Wyniki badań nad stadem leszcza Zalewu Wiślanego w latach 1951–1952 [Results of studies on bream stock in the Vistula Firth within 1951–1952]. Pr. Mor. Inst. Ryb. **9**: 221–246. (In Polish).

Filuk J., 1963: Biologiczna charakterystyka połowów leszcza (*Abramis brama* L.) Zalewu Wiślanego [Biological characteristics of bream (*Abramis brama* L.) catches of Vistula Firth]. Pr. Mor. Inst. Ryb. Ser. A, **12**: 89–116. (In Polish).

Francis R.J.C., 1990: Back-calculation of fish length: a critical review. J. Fish Biol. **36**, 6: 883–902.

Heese T., 1992: Optymalizacja metody określania tempa wzrostu ryb za pomocą odczytów wstecznych [Optimization of fish growth rate estimation using the back-calculation method]. Wyd. WSI Koszalin. (In Polish).

Heese T., J. Mastyński, 1990: Wstępna ocena wpływu nowo powstałego zbiornika zaporowego Jeziorsko na wzrost wybranych gatunków ryb [Preliminary estimate of the impact of the newly constructed Jeziorsko Dam Reservoir on the growth of selected fish species]. Rocz. Nauk. PZW **3**: 61–80. (In Polish).

Karpińska-Waluś B., 1961: Tempo wzrostu leszcza (*Abramis brama* L.) w jeziorach okolic Węgorzewa [The rate of growth of bream (*Abramis brama* L.) in lakes of Węgorzewo district]. Rocz. Nauk Rol., Ser. B **77**, 2: 455–489. (In Polish).

Kompowski A., 1982: On some aspects of biology of bream, *Abramis brama* (L. 1758), inhabiting the River Regalica and Lake Dąbie. Acta Ichthyol. Piscat., **12**, 1: 3–25.

Kompowski A., 1988: Growth rate of bream, *Abramis brama* (L. 1758), in Lake Dąbie and Szczecin Lagoon. Acta Ichthyol. Piscat., **18**, 1: 35–48.

Kompowski A., 1999: Ocena stanu zasobów i racjonalności gospodarki rybackiej prowadzonej przez Rybacką Spółdzielnię Pracy „Regalica" w Gryfinie [Resources condition assessment and fisheries management reasonableness revision in the Fishery Cooperative „Regalica" in Gryfino]. Zakład Biologicznych Zasobów Morza, Agricultural University of Szczecin. [unpubl.]. (In Polish).

Kompowski A., W. Pieńkowski, 1992: Zmiany w połowach ryb słodkowodnych w polskiej części Zalewu Szczecińskiego i Zatoki Pomorskiej w latach 1960–1985 [The changes in freshwater fish catches in the Polish part of the Szczecin Lagoon and Pomerania Bay in 1960–1985] Szczec. Rocz. Nauk. **7**, 1, Nauki Mor. 2: 7–21. (In Polish).

Kompowski A., Z. Neja, 1999: The Międzyodrze ichthyofauna as caught by various gear. Baltic Coastal Zone, **3**: 103–112

Marciak Z., 1974a: Charakterystyka wzrostu leszcza *Abramis brama* (L. 1758) w jeziorach na terenie Polski [Growth characteristics of bream (*Abramis brama* L.) from Polish lakes] Rocz. Nauk. Rol., Ser. H Ryb., **96**, 3: 75–95. (In Polish).

Marciak Z., 1974b: Typy wzrostu jako podstawa określania wymiarów gospodarczych dla populacji leszcza [Growth types as a basis for determination of economic sizes of bream populations in the lakes]. Rocz. Nauk Rol., Ser. H Ryb., **96**, 3: 97–109. (In Polish).

Marciak Z., 1974c: Wpływ czynników limnologicznych i rybackich na wzrost i połowy leszcza w jeziorach różnych typów [The effect of limnological and fishing factors upon the growth and catches of bream in the lakes of different type] Rocz. Nauk Rol., Ser. H Ryb., **96**, 3: 111–125. (In Polish).

Neubaur R., 1926: Biologisches und Wirtschaftliches vom Blei (*Abramis brama* L.) im Stettiner Haff und seinen Nebengewässern. Zeitschrift für Fischerei und deren Hilfwissenschaften. Neudamm und Berlin, **24**: 163–193.

Pęczalska A., 1963a: Z biologii rozrodu leszcza Zalewu Szczecińskiego i Zatoki Pomorskiej [The reproductive biology of bream from Szczecin Firth]. Pol. Arch. Hydrobiol., **11**, 1: 109–139. (In Polish).

Pęczalska A., 1963b: Połowy leszcza (*Abramis brama* L.) w Zalewie Szczecińskim na tle przemian w systemie i intensywności eksploatacji w latach 1886–1960 [Bream (*Abramis brama* L.) catches in the Szczecin Firth in view of the changes in the system and intensivity of exploitation in the years 1886–1960]. Pr. Mor. Inst. Ryb. Ser. A, **12**: 117–142. (In Polish).

Pęczalska A., W. Kraczkiewicz, 1972: Wyniki badań nad zasobami rybnymi i gospodarką rybacką na Zalewie Szczecińskim i Zatoce Pomorskiej [Results of studies on fish resources and fishery management in the Szczecin Lagoon and Gulf of Pomerania]. In: Ekosystemy morskie. MIR Gdynia, **4**: 133–196. (In Polish).

Reay P.J., 1972: The seasonal pattern of otolith growth and its application to back-calculation studies in *Ammodytes tobianus* L. J. Cons. int. Explor. Mer., **34**, 3: 485–504.

Šentiakova L.F., 1969: Proverka gipotezy o postojanstve vnutrividovogo sootnošenija rosta tela i češui ryb matematičeskimi kriteriami [Mathematical criteria used to test the hypothesis of the interpopulation differences of the quality of ratios between the growth of scale and body]. Vopr. Ichtiol., **9**, 3 (56): 431–449. (In Russian).

Ševcova T.M., 1983: Temp rosta lešča *Abramis brama* (L.) (Cyprinidae) v ozierach raznogo tipa [The growth rate of bream *Abramis brama* (L.) (Cyprinidae) in lakes of various type]. Vopr. Ichtiol., **23**, 5: 753–759. (In Russian).

Trzebiatowski R., 1999: Occurrence, catches and protection policies of ichthyofauna in Lower Oder Valley Landscape Park waters in relation to environmental conditions in 1982–1996, a review. Limnologie aktuell, 9 (Dohle/Bornkamm/Weigmann (Hrsg.): Das Untere Odertal): 407–416.

Volodin V.M., 1992: Nekotoryje osobennosti struktury populacij lešča *Abramis brama* Ivankovskogo i Rybinskogo vodochranilišča i faktory ich obuslovlivajuščije [Some peculiarities of the population structure of bream *Abramis brama* in the Ivankovsk and Rybinsk dam reservoirs and factors conditioning them]. Vopr. Ichtiol., **32**, 2: 149–156. (In Russian).

Wilkońska H., 1988: The effect of heated-water discharge in the Konin Lakes (Poland) on their ichthyofauna. Ekol. Pol., **36**, 1–2: 145–163.

Wojno T., 1964a: Próba ustalenia właściwego okresu połowu leszcza (*Abramis brama* L.) [A trial determination of the proper time of bream (*Abramis brama* L.) catches]. Rocz. Nauk. Rol., Ser. B, **84**, 2: 475–491. (In Polish).

Wojno T., 1964b: Sezonowe zmiany wzrostu leszcza (*Abramis brama* L.) z jez. Wdzydze [Seasonal growth variations of bream (*Abramis brama* L.) from Lake Wdzydze]. Rocz. Nauk. Rol., Ser. B **84**, 2: 493–511. (In Polish).

Załachowski W., K. Więski, 1998: Growth rate of bream (*Abramis brama* L.) in Lake Dąbie. Electronic Journal of Polish Agricultural Universities. Vol. 1. ser. Fisheries.

Zawisza J., 1970: Wędrówki leszcza jezior przymorskich [Migrations of coastal lake bream]. Rocz. Nauk. Rol., Ser. H Ryb., **92**, 1: 121–142. (In Polish).

Zimdars U., 1941: Die Fischerei des Stettiner Haffs und seiner Nebengewässern, geographisch betrachtet. Jahrb. der Pommerschen Geographischen Gesellschaft., 59/60: 15–136.

Żukowski Cz., 1962: Badania nad leszczem Zalewu Szczecińskiego i Zatoki Pomorskiej w latach 1953–1955 [Investigations on bream from Szczecin Firth and Pomeranian Bay in 1953–1955]. Pr. Mor. Inst. Ryb. Ser. A, **11**: 443–462. (In Polish).

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NIEKTÓRE DANE Z BIOLOGII LESZCZA, *ABRAMIS BRAMA* (L., 1758) Z WÓD MIĘDZYODRZA

STRESZCZENIE

Stwierdzono lekką krzywoliniowość zależności między długością promienia kaudalnego łuski (powiększonej 17,5-krotnie za pomocą czytnika do mikrofilmów = V (mm)) i długością standardową (*SL*, cm). Zależność tę najlepiej udało się przedstawić w postaci równania potęgowego:

$SL = 0{,}3981 \cdot V^{0{,}9264}$; $n = 279$, $r^2 = 0{,}980$.

Wykazano lekką krzywoliniowość zależności między długością standardową i długością całkowitą (*TL*, cm). Zależność tę bardzo dobrze charakteryzuje równanie:

$\mathrm{TL} = 1{,}424 \cdot SL^{0{,}9645}$; $n = 355$, $r^2 = 0{,}999$

Badania narybku wykazały, że roczne osobniki poławiane w maju, nie miały w większości jeszcze założonego pierwszego pierścienia rocznego na krawędzi łuski. Długość ich (*SL*) zawierała się w granicach 3,9–6,5 cm. W końcu lata (przełom sierpnia i września) narybek leszcza badanej populacji z 0 grupy wieku osiągał długość 2,9–4,7 cm.

Leszcze z Międzyodrza charakteryzują się dobrym tempem wzrostu, lepszym od średniej dla wód Polski. Teoretyczna krzywa wzrostowa wyznaczona równaniem von Bertalanffy`ego z parametrami: $L_\infty = 59{,}3$ cm; $K = 0{,}0999$; $t_0 = -0{,}037$ roku pasuje bardzo dobrze do danych empirycznych.

Zależność długość (*SL*, cm) – masa (*w*, g) badanej populacji można przedstawić w postaci równania: $w = 0{,}0126 \cdot SL^{3{,}1638}$; $n = 378$, $r^2 = 0{,}997$.

Osobniki niedojrzałe miały, niezależnie od pory roku, niższe wartości współczynnika kondycji niż dojrzałe samce i samice.

Jajniki w badanej populacji leszcza stanowiły maksymalnie 24,7% masy całkowitej ciała i 33,7% masy bez wnętrzności, jądra odpowiednio 3,7 i 4,3%. Przy długości *SL* 20 cm 50% osobników miało gonady co najmniej w II stadium dojrzałości według Maiera i tę długość należy uznać za długość I dojrzałości.

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