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VIMBA *VIMBA VIMBA* (L.) FROM THE REGA RIVER – SUPPORT OF NATURAL SPAWNING IN 2004-2008 AND THE NATURAL POPULATION

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Abstract

The paper reports results of a study on the population of vimba in the Rega River aimed at localisation of the spawning sites and support of the natural reproduction by stocking. The spawning sites were localised with the help of electric catching and the coordinates were determined by GPS units. The fish caught to be used for artificial spawning (145 individuals) were measured (*l.t.* and *l.c.*) using an electronic calliper coupled with a PC unit. The sex of the fish was identified and on the basis of scale analysis the age and rate of length and mass increase were estimated. The back-calculation readings were made using the Rosa Lee method. The model of growth was established on the basis of the von Bertalanffy formula. Comparisons of groups of fish were drawn with the help of the nonparametric Mann Whitney U test. Correlations between variables were evaluated by analysis of regression, while the significance of the correlation coefficient was checked by t test. The rate of vimba mass increase was calculated using the modified von Bertalanffy formula was found to be described by $Wt = 1215.103[1-e^{-0.133609(t+0.57322)}]^{2.7559}$. The spawning sites of vimba localised in the Rega River section between Gryfice and Trzebiatów were concluded to be good sources of spawners for artificial spawning and the number of spawners caught in this section of the river ensures continuation of vimba restitution in the Rega River. The hitherto stocking measures aimed at restoration of vimba population have brought satisfactory results as evidenced by the age structure of the fish caught in the electric fishing in 2008.

Key words: biogeography, threatened species, vimba, *Vimba vimba*, stocking, restoration, spawning sites

INTRODUCTION

Vimba (*Vimba vimba*) occurs in the catchment area of the Baltic Sea from the Gulf of Finland to Kattegat, North Sea (Elba and Wesser river basins), Black Sea (in the rivers from Danube to Kuban) and in the catchment area of the Caspian Sea (Heese 2000), however, in the majority of waters it has been classified as threatened or critically endangered with extinction (Lelek 1987).
In Polish waters vimba has been mainly caught in Gulf of Gdańsk and in the Vistula River, where it made about 35-40% of the total freshwater fish caught (Bontemps 1971). The species used to occur in economically important amounts in the Odra River estuary from the Middle Ages (Chełkowski and Filipiak 2000) till the 19th and 20th centuries (Gloger 1833, Wiśniewolski 1987). For instance in the 1960s the mass of this species caught in the Pomeranian Bay, the Szczecin Lagoon and in the Odra River reached 15-20 tons/year (Jaworek 1964, Bontemps 1971). Starting from the early 1970s the mass of catchment of this species has drastically decreased (Wiśniewolski 1987), so that Psuty-Lipska and Garbacik-Wesołowska (1998) who analysed ichtiofauna of the Odra River estuary classified this species as rare, and later Witkowski et al. (2004b) even as critically endangered. The decrease in the amount of vimba in the Odra River basin has stimulated interest in this species and initiated works aimed at its occurence (Witkowski et al. 2004a, b, Mastyński 1992, Witkowski et al. 2007), and studies of its biology and population (Pęczalska and Kraczkiewicz 1973, Raczyński and Keszka 2007, Czerniejewski et al. 2007), production of stocking material (Kleszcz et al. 2001a, b, Pender and Tański 2005, Tański et al. 2008, Bartel et al. 2008) and genetic diversity (Kempter 2010). The latter authors have shown that from among the peregrine vimba populations those from the Odra, Vistula and Rega rivers reveal genetic differences. A very small number of fish from this specific population is still found in the Rega River despite many hydro-technical obstacles (Wiśniewolski et al. 2004). The only literature data on the sex structure, length and age along with fragmentary data on the growth and spawning sites concerning this population in the beginning of the 1970s were published by Trzebiatowski and Narożański (1973), while the morphometric features of this population were also reported by Keszka and Raczyński (2006). Unfortunately, there are no current data on the status of the Rega River population of this species as well as on the spawning sites (Wiśniewolski et al. 2004), necessary to evaluate the effectiveness of the measures undertaken to restore vimba in the Odra River basin and rivers of West Pomerania (Witkowski et al. 2004b).
In view of the above, the aim of this study was to identify the current sites and dates of spawning as well as to determine the biological and population features (including sex structure, length, age, condition and rate of growth) of the spawning school of vimba fish from the Rega River.

MATERIAL AND METHODS

The study was performed in the years 2004-2008 in the months of the natural spawning of vimba in the Rega River basin, that is from April to June. The area of

observations was the Rega River section between Gryfice and Trzebiatów, while the regulated section of 15.75 km from Trzebiatów to the river mouth was not studied. In the section studied the Rega River is the migration route for the fish flowing up the river for spawning. The section studied ended in Gryfice, where at the 42.1 km of the river, there is a dam with incorrectly working fish pass. The length of the river section studied was 26.35 km.

The first spawners caught (in the first year of study in the season of 2004) were from the salmon fish trap at the 15th kilometre of the river, in Trzebiatów. However, because of great stress accompanying the manipulations further catches were decided to be performed only by electric fishing using a current generator. The catch was conducted from a boat with the use of classic set including a current generator and rectifying attachment. Directly after catch the fish were kept on the boat in an insulated plastic barrel. Then they were transported to a basin (1 m^3 of capacity) filled with oxygenated water and mounted on a car for transportation of fish. After catching the fish were transported to the Hatchery belonging to Polish Angling Association in Goleniów. There in the hatching basin the artificial spawning was made and further rearing of the fry was performed in ponds. The fry was introduced to the Rega River to which also the spawners were finally released at the sites of their catching.

The sites at which the spawners were caught (favoured by the fish) were listed with the localisation coordinates established by GPS. In the sections not marked the fish occurred in trace amounts or not at all.

The total number of fish for the metric measurements and scales collection was 145. All of them were subjected to biological measurements of the total length (*l.t.*) and caudal length (*l.c.* = standard lenght) to the accuracy of 0.01 mm with the use of an electronic calliper Helios connected by a special cable for data transmission OPTO RS 232 to a PC unit. The age of the fish, the rate of increase in length and mass were estimated on the basis of the scales. The scales were collected as recommended by Bontemps (1971), from between the first ray of the dorsal fin and the lateral line of the fish. The age of fish and measurements of rays of the scales were made using a PC unit using a special software for image analysis "MultiScan", ensuring the accuracy to 0.001 mm. Making use of the linear R-L relation, the back-calculation was performed according to the Rosa Lee method (Bontemps 1971, Ermolin and Shashulovskii 2006) taking into account the correction for the scale ray of 18 mm (Lusk et al. 2005). The empirical data collected were used to propose a theoretical model of vimba length increase and to calculate the vimba length with the help of the mathematical model of growth proposed by Bertalanffy (Bagenal 1978). In comparative analyses of groups of fish the hypothesis of the equality of averages was verified by the non-parametric Mann Whitney U test. Correlations between variables were checked by the analysis of regression and the degree of correlation was estimated by the correlation coefficients (R) or determination coefficients (R^2). Statistical significance of the correlation coefficient was established by t test (Sokal and Rohlf 1995).

RESULTS

Site and time of spawning

On the basis of the 5 years of observations, 15 spawning sites of vimba in the Rega River section between Gryfice and Trzebiatów were localised (Table 1).

Table 1
List of spawning sites on the Rega River section between Gryfice and Trzebiatów and their positions

No.	GPS coordinates	Spawning site	
		River bed width [m]	Mean depth [m]
1.	N 53° 55′003′′ S 015° 12′157′′	20	0.5
2.	N 53° 55′239′′ S 015° 12′615′′	25	1.1
3.	N 53° 55′627′′ S 015° 12′840′′	20	1.4
4.	N 53° 55′735′′ S 015° 13′437′′	26	1.6
5.	N 53° 55′877′′ S 015° 13′496′′	15	1.0
6.	N 53o 55′963′′ S 015o 13′630′′	25	1.2
7.	N 53° 56′065′′ S 015° 14′048′′	25	1.8
8.	N 53° 56′490′′ S 015° 14′495′′	13	1.3
9.	N 53° 57′190′′ S 015° 14′836′′	25	1.4
10.	N 53° 58′106′′ S 015° 14′922′′	20	2.3
11.	N 53° 58′132′′ S 015° 15′757′′	27	1.0
12.	N 53° 58′640′′ S 015° 16′830′′	27	1.2
13.	N 54° 01′157′′ S 015° 14′593′′	30	1.6
14.	N 54° 01′709′′ S 015°15′590′′	32	1.5

In 2004 from April 25th to May 6th vimba spawners were collected from the salmon fish trap mounted at the 15th kilometre of the Rega River. By this method 50 males and 19 females were collected. On May 28th near Gryfice 21 females and 40 males were caught by electric fishing. The water temperature during the catch was close to 18°C. The effect of the artificial spawning was 437 000 eggs of which nearly 380 000 hatched.

In 2005 from May 6th to June 10th eight catches were made to give 99 individuals including 44 males and 55 females; of the latter 34 females were before spawning. The majority of the males were ready for fertilisation (leaking) so no differentiation between those before and after spawning was made. The water temperature varied from 10.4°C to 17.8°C. The first spawners, classified as after the spawning, were caught on the 11th of May at the water temperature of 13.0°C. The greatest number of vimba individuals, 32 ones, were caught on the 27th of May at the water temperature of 17.8°C.

In 2006 on 6 days between the 9th and 19th of May, 89 vimba individuals were caught, including 34 males and 55 females of which 20 females were before spawning. The water temperature varied from 14.5°C to 16.4°C. The first spawners, classified as after spawning, were caught on the 9th of May at the water temperature of 14.6°C. The greatest number of vimba individuals – 14, were caught on the 9th and 20th of May at the water temperatures of 14.6°C and 16.4°C, respectively.

In 2007, 9 catches were made between the 10th and 25th of May. The number of individuals caught was 104, including 52 males and 52 females. Only 10 of the females were before spawning. The water temperature varied from 14.0°C to 17.0°C. The first 10 spawners classified as after spawning were caught on the 10th of May at the water temperature of 14.0°C. On this day the greatest number of spawners – 25 individuals, were caught.

In 2008, spawners were caught for 15 days from the 15th of April to the 2nd of June. The total number of vimba individuals collected was 231, including 121 males and 110 females. Only 16 females were classified as before spawning. The water temperature on these days varied from 10.4°C do 15.6°C. The first spawners classified as after spawning (3 individuals) were caught on the 24th of April at the water temperature of 14.0°C. The greatest number of individuals, 35, were caught on the 26th of May at the water temperature of 15.6°C.

In total in the years 2005-2008, 40 catches were made taking 228 effective working hours. The lowest number of spawners were caught in 2006, 64 individuals, whereas the highest number of 231 individuals were caught in 2008. Over the period of study the number of eggs collected for artificial spawning was 4 290 000 from 287 females including 80 classified as before spawning. The eggs were obtained from some females belonging to the groups classified as before and after spawning. Vimba has multiple portion spawning so the eggs could also be obtained from those after spawning. The number of eggs from the females classified as before spawning was higher. In 2007 the number of eggs was the smallest – 700 000, obtained from 52 females including 10 before spawning. The highest number of eggs was obtained in 2006, it was 1 250 000 eggs from 110 females, including 16 before spawning.

Over the period of study (2004-2008) after incubation we obtained 3 670 000 of hatched eggs and foraging hatch. The most abundant hatch of 1 200 000 individuals

was obtained in 2006, while the least abundant of 380 000 individuals in 2004. In the years 2004-2008 we successfully obtained the vimba stocking material. The summer, autumn, spring and two-year old fry in the total number of 947 281 individuals, were released to the Rega River. The first stocking was made in 2005, introducing 221 257 individuals of the summer, autumn 0+ and 1+ fry. The highest number of 252 748 fry individuals of 1+ and 2+ were introduced in 2007 (Table 2).

Table 2

Number of vimba individuals reared at the Stocking Centre in Goleniów and introduced to the Rega River in the years 2005-2008

Year	Type of stocking	age	Number of individuals
2005	Summer	0+	139 687
	Autumn	0+	50 000
	Autumn	1+	31 570
	Total:		221 257
2006	Spring	1+	42 373
	Summer	0+	175 410
	Autumn	0+	14 993
	Total:		232 776
2007	Spring	1+	57 920
	2-year old stocking material	2+	39 656
	Autumn	1+	155 172
	Total:		252 748
2008	Autumn*	1+	230 500
	Total		937 281

*270 individuals were labelled in 2008

Total and caudal lengths

The mean total length and caudal length of vimba fish caught in the Rega River were 318.95 mm (range 175.0-445.0 mm) and 263.16 mm (range 144.7-367.0 mm), respectively. The fish caught in 2005 were characterised by the highest values of these two parameters (Table 3), while the greatest ranges of their variation were noted for the fish caught in 2008 (175.0-410.0 mm and 144.7-338.2 mm, respectively). The females had statistically significantly greater mean total and caudal lengths than males ($p<0.05$). The frequency of occurrence in classes of caudal length expressed in percent of fish caught in particular years from the Rega River are presented in Fig. 1.

Table 3

Length, weight and condition of the vimba from the Rega River population collected in the years 2004-2008

Year	Sex	Number of individuals	Total length (mm)	Standard length (mm)	Weight (g)	Fulton's coefficient
2004	♀	16	331.30±24.29	273.36±20.00	376.56±74.27	1.03±0.07
	♂	16	319.94±28.87	263.39±21.84	328.37±92.95	0.99±0.07
	Total	32	325.60±26.87	268.40±21.21	352.50±86.30	1.01±0.07
2005	♀	11	355.10±21.53	301.80±19.65	426.50±86.21	0.98±0.05
	♂	20	335.12±47.25	275.61±34.52	364.21±94.91	0.97±0.05
	Total	31	345.81±35.00	285.34±28.81	392.86±117.51	0.93±0.05
2008	♀	30	333.90±35.80	275.54±29.50	357.60±100.33	0.94±0.02
	♂	52	291.06±46.25	240.27±38.07	252.99±95.17	0.97±0.05
	Total	82	306.21±47.33	252.74±38.97	289.96±108.75	0.96±0.04
In all years	♀	57	332.96±31.91	274.76±26.27	364.00±91.49	0.97±0.06
	♂	88	297.75±44.39	245.60±36.20	270.44±99.29	0.96±0.05
	Total	145	318.95±43.91	263.16±36.02	325.75±113.9	0.96±0.05

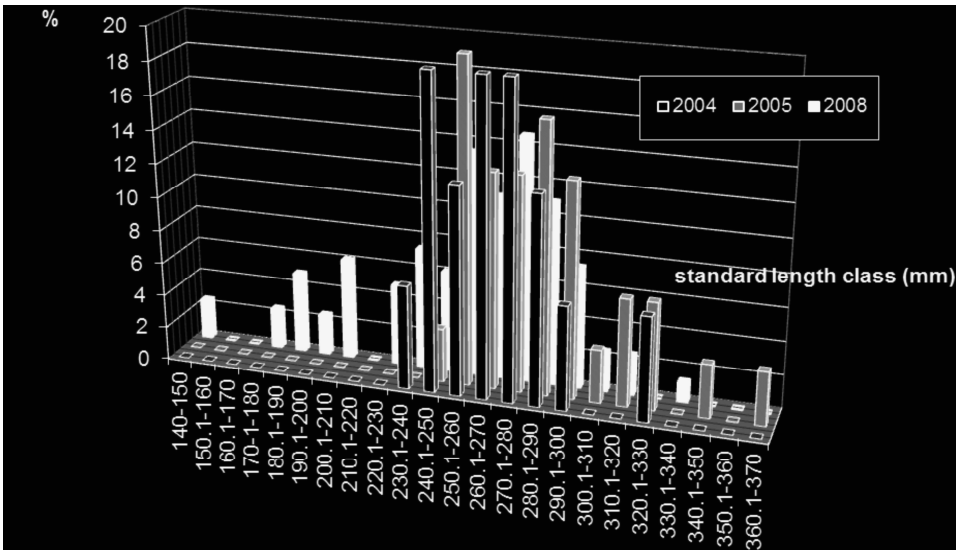

Fig. 1. Frequency of standard length distribution of vimba from the Rega River

In the years 2004-2008, the most abundant was the presence of fish in the 5 following classes of length (SL): 240.1-250.0 mm (8.28% of all fish caught), 250.1-260.0 mm (14.48%), 260.1-270 mm (13.10%), 270.1-280 mm (15.17%) and 280.1-290 mm (12.41%). In particular seasons the same classes of fish length were most abundantly represented, but only in 2008 the presence of fish being included to the class of the length from 140.0 to 230.0 mm, making a contribution of 23.17%, was noted.

Individual weight

The structure of individual weight of vimba caught in the Rega River in the years 2004-2008 is presented in Table 3. The mean mass of individual fish was 325.75 g, at the extreme values of 59.5 and 765.3 g. The mean individual weight was statistically significantly greater for females (mean 364.0 g, range 157.8-765.3 g) than for males (mean 270.4 g, range 59.5-662.0 g).

Condition of fish

The mean value of Fulton's coefficient of condition for vimba from the Rega River was 0.96 (range 0.87-1.13). Generally the females were characterised by higher values of Fulton's coefficient. Only in 2008 higher values of this coefficient were noted for males, which can be explained by the fact that in this year a particularly high number of females was caught with many of them after spawning and it is known that after spawning the condition of females can deteriorate.
Although the values of Fulton's coefficient slightly decrease in subsequent years, no statistically significant differences were found in the positions of the caudal length

dependence on the individual mass of the vimba fish studied. Therefore, Fig. 2 presents such a dependence for all 145 individuals caught in the years 2004-2008.

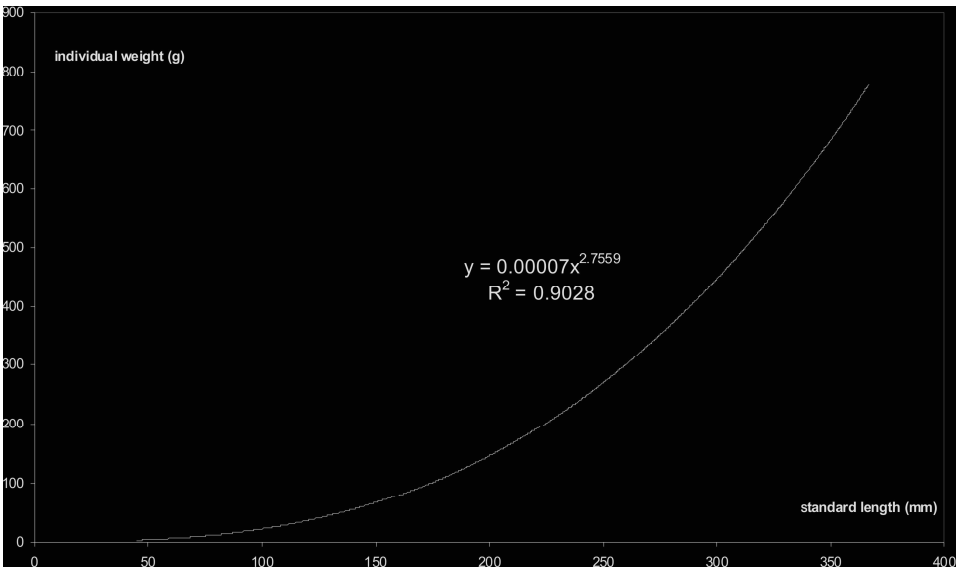

Fig. 2. Realtionship between individual weight and standard length for vimba caught from the Rega River in the years 2004-2008

Age and sex structure

Among 145 individuals studied the females made 39.31%, while the males 60.69%. Greater contribution of males was noted in the years 2005 and 2008 in which they made 64.52 and 63.41%, respectively, while in 2004 as the fish were selected for the study the contribution of each sex was the same. In the years 2004-2008 the spawners caught from the Rega River included individuals from the age of 3+ to 11+ (Table 4), with the dominant age groups of 5+ (22.76%), 6+ (28.28%) and 7+ (22.76%). In 2004 the dominant age groups were 5+ and 6+, making together 65.63% of the fish caught, while in 2005 and 2008 the dominant were the fish age 6+ and 7+. An interesting observation was a considerable increase in the contribution of young fish, aged 3+ and 4+, making 17.08% of the vimba individuals collected in 2008. Similarly as for among whole sample of vimba fish caught also among representatives of particular sexes the most abundantly represented age groups were 5+, 6+ and 7+ (Table 4).

Growth rate

The rate of growth in length of the Rega River vimba was found typical of this species; large increments in the first 4 years of age (over 35 mm) in subsequent two

Table 4

Age structure of the vimba population from the Rega River in the years 2004-2008

Year	Sex	Percent contribution of age groups								
		3+	4+	5+	6+	7+	8+	9+	10+	11+
2004		–	–	31.25	37.50	18.75	6.25	6.25	–	–
2005	♂	–	–	20.00	25.00	20.00	10.00	10.00	10.00	5.00
2008		1.92	19.23	23.08	26.92	26.92	1.92	–	–	–
2004		–	–	25.00	37.50	18.75	12.50	6.25	–	–
2005	♀	–	–	18.18	27.27	27.27	18.18	9.09	–	–
2008		–	10.00	20.00	23.33	20.00	16.67	6.67	3.33	–
2004		–	–	28.13	37.50	18.75	9.38	6.25	–	–
2005	Total	–	–	19.35	25.81	22.58	12.90	9.68	6.45	3.22
2008		1.22	15.86	21.95	25.61	24.39	7.32	2.44	1.22	–

Table 5

Rate of standard length increase in mm for the vimba from the Rega River population

Age	Back-calculation (1)	Mathematical models of growth			Absolute difference		
		Ford-Walford (2)	von Bertalanffy (3)	II degree polynomial (4)	[1–2]	[1–3]	[1–4]
1	82	63.14	80.30	68.28	18.86	1.70	13.72
2	122	116.87	123.23	112.70	5.13	1.23	9.30
3	159	162.59	160.79	153.45	3.59	1.79	5.55
4	195	201.59	193.65	190.52	6.59	1.35	4.48
5	224	234.60	222.41	223.91	10.60	1.59	0.09
6	252	262.77	247.56	253.63	10.77	4.44	1.63
7	272	289.74	269.57	279.68	17.74	2.43	7.68
8	294	307.14	288.83	302.05	13.14	5.17	8.05
9	314	324.49	305.68	320.74	10.49	8.32	6.74
10	337	339.26	320.42	335.76	2.26	16.58	1.24
11	357	351.83	333.32	347.10	5.17	23.68	9.90
Average absolute differences (mm)					9.49	6.21	6.22

years decrease to 29 and 28 mm, and then stabilise at 20-23 mm per year (Table 5). The rate of growth was matched to the three theoretical models of growth, see Table 5. The lowest absolute difference between the results of the back-calculation method and the model predictions was obtained for the von Bertalanffy model and II degree polynomial, so these two models were assumed as more reliable than the third model considered. The rate of mass increase for the vimba fish studied was calculated using the modified von Bertalanffy formula and the expression describing this increase was

$$Wt = 1215.103[1-e^{-0.133609(t+0.57322)}]^{2.7559}$$

Discussion

In the beginning of the study the catching of spawners was unsuccessful because of poor knowledge of specific features of the Rega River. We were looking for clusters of vimba assuming that these were the spawning sites. The first site at which the catch was successful was localised at one kilometre below the first dam in Trzebiatów, i.e. along the section from 15.75 km to 16.75 km of the river as the hydrotechnical construction was a serious obstacle for fish migration, although it was equipped with a fish pass, and some spawners gathered at this site. A similar situation took place near Gryfice, at the weir localised at 42.1 km, which was the next obstacle for the fish who had successfully overcome the first one. According to observations it was assumed that most of the spawning sites should be localised along the section from Trzebiatów and Gryfice. The assumption was verified by the results of catch along the whole section, although the fish were gathering at some specific sites at which the appropriate vegetation favouring spawning success was found among the stones at the bottom.

The sex structure of vimba population in particular years was similar with the domination of males (60.69%). Greater contribution of males follows from the fact that immediately after spawning females flow down the river, while males remain longer at the spawning sites (Suhanova et al. 1970, Bontemps 1971). This rule was also observed in the rivers Tarnawa (Suhanova et al. 1970), Dyje (Lusk et al. 2005), in Kuroński Reservoir (Repečka 2003) and in the early 1970s in Rega (Trzebiatowski and Narożański 1973). Only Raczyński and Keszka (2007) in their analysis of vimba population from the Odra River estuary, reported higher contribution of females, but the fish they studied came from the whole year commercial catch which evidently affected the sex structure.

Analysis of the total and caudal lengths of the vimba fish studied confirmed the observation by Trzebiatowski and Narożański (1973), that females are longer and have greater individual mass than males. However, the current distribution of the caudal length data shows significant differences from that reported nearly 40 years ago by those two authors. Among the fish we studied the dominant position have those belonging to classes of smaller lengths (from 240.1 to 290.0 mm), similarly as reported in the 1960s from the Szczecin Lagoon (Pęczalska and Kraczkiewicz 1973). However, it should be pointed out that the mean values of the total length and caudal length do not differ significantly from those reported for different water courses or

Table 6

Increase in the standard length of vimba according to different authors (in cm)

Water body	Author	Age groups									
		I	II	III	IV	V	VI	VII	VIII	IX	X
Vltava River	Bontemps (1963)	5.3	8.8	12.0	15.4	18.4	21.6	–	–	–	–
Danube Drainage basin		6.0	9.9	13.1	16.6	19.8	–	–	–	–	–
Dyje River	Lusk et al. (2005)	7.1	11.5	14.8	17.8	20.2	23.4	25.4	27.4	28.5	30.0
Dubysa River	Kesminas et al. (1999)	–	–	–	21.0	23.5	26.3	28.5	32.0	–	–
Sventoji River		–	–	–	–	–	27.7	31.8	36.0	–	–
Nemunas River		–	–	–	21.0	23.7	26.6	28.4	29.8	–	–
Niemen River (Lithuania)	Volskis et al. (1970)	3.4	6.9	15.0	19.6	22.1	–	–	–	–	–
Niemen River (Belarus)		6.3	12.3	17.9	22.7	26.6	–	–	–	–	–
Dniepr		7.5	15.0	20.4	26.3	28.3	–	–	–	–	–
Dniestr		14.5	20.0	23.0	26.1	29.4	–	–	–	–	–
Vistula	Bontemps (1960)	5.1	8.8	13.5	18.1	22.4	26.2	29.7	31.4	–	–
Szczeciński Lagoon	Pęczalska and Kraczkiewicz (1973)	5.1	8.8	13.5	18.1	22.4	26.2	29.7	31.4	–	–
Rega River	own data	8.5	11.4	13.5	15.4	18.6	20.5	23.3	26.0	29.0	31.3

reservoirs in Poland (Pęczalska and Kraczkiewicz 1973, Wajdowicz 1974), but differ from those reported by Trzebiatowski and Narożański (1973) for the Rega River population, which indirectly implies considerable changes in biological features of the vimba population from the Rega River taking place over the last 40 years.
In the years 1970-1972, the vimba population from the Rega River was composed of individuals of age varying from 4 to 11 years, with the dominant presence of the 7+ and 8+ age groups (Trzebiatowski and Narożański 1973). A similar age structure was noted in the vimba population from the coastal region of the Baltic Sea, Kuronian Lagoon (Repečka 2003) and in the Odra River estuary (Pęczalska and Kraczkiewicz 1973, Raczyński and Keszka 2007) and the Vistula River estuary (Bontemps 1971, Backiel and Bontemps 1996). However, from some waters Spiryna (1962) reported domination of vimba from age groups from 9 to 12 years old. Recently, the vimba population from the Rega River has been supported with stockings, which seems to be the main reason for the changes in certain biological and population features. Recently, the spawning schools of the vimba from the Rega River show the domination of individuals from age groups 5+, 6+ and 7+, and in the last year a contribution of over 15% of individuals aged 3+ and 4+ was noted. Individuals from the latter age groups were not caught earlier. Most probably their appearance is a result of the stocking made in 2005 for the first time after a break of 24 years, by Polish Angling Association in Szczecin (Pender and Tański 2005, Tański and Pender 2007).
Changes in the age structure and domination of younger vimba in the catch is not unfamiliar. Domination of younger fish in the age structure relative to the data given by Trzebiatowski and Narożański (1973), Repečka (2003), Raczyński and Keszka (2007) has been observed in many water reservoirs. For instance, in the rivers of the Black Sea or the Caspian Sea basins vimba individuals from age groups 3-7 are caught, with the domination of 4 and 6 years old ones (Bontemps 1971, Wajdowicz 1974, Lusk et al. 2005).
Considerable differences in the rate of growth of vimba fish are a consequence of great environmental and hydrological diversity of the rivers and other water reservoirs in which this species occurs. Bontemps (1971) relates these differences to many factors such as temperature, quality and quantity of food. As follows from Table 6, the highest rate of growth has been noted for the populations from the Dniestr and Dniepr rivers (Volskis et al. 1970). Interestingly, the rate of growth of the population from the Rega River in the first four years of life is slightly higher than those of the other Polish (Bontemps 1960, Pęczalska and Kraczkiewicz 1973) and Czech populations (Bontemps 1963, Lusk et al. 2005). On the other hand, the rate of growth of the vimba fish from Rega is much smaller than those from the populations in the waters of south Russia (Volskis et al. 1970, Ermolin and Shashulovskii 2006), Lithuania and Belarus (Kesminas et al. 1999, Volskis et al. 1970), which points to somewhat worse conditions of the initial growth of the species in the Rega River.

Conclusions

The spawning sites of vimba localised in the Rega River section between Gryfice and Trzebiatów have been evaluated as making a good basis for collection of spawners

for artificial spawning and the number of spawners caught permits continuation of restoration of vimba fish in the Rega River. Further stockings aimed at restoration of the vimba population in this river and monitoring of their effects should be undertaken.

The hitherto stockings aimed at restoration of the vimba population in the Rega River have brought satisfactory results. The evidence confirming it is the fact that in the sample caught in 2008 there was a considerable contribution of males from age groups 3+ and 4+, which can be a result of the stockings performed in 2005. The results of this study indicate the need for further activities to support the Rega River population of vimba recommended to include the measures ensuring easy passage along the river (modernisation of the hydrotechnical constructions), restoration of spawning sites and stocking.

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CERTA *VIMBA VIMBA* (L.) Z RZEKI REGI – WSPIERANIE NATURALNEGO TARŁA W LATACH 2005-2008 A NATURALNA POPULACJA

Streszczenie

W pracy przedstawiono dotychczasowe wyniki uzyskane w toku prowadzonych prac nad restytucją certy w rzece Redze. Zlokalizowane drogą elektropołowów łodziowych miejsca naturalnego tarła pozwoliły na pozyskanie do sztucznego tarła 145 osobników, u których wykonano podstawowe pomiary (długość całkowitą, długość ciała) przy użyciu elektronicznej

suwmiarki sprzężonej z komputerem. Płeć ryb oznaczono na podstawie zewnętrznych cech, będących wyrazem dymorfizmu płciowego (ubarwienie, wysypka perłowa). Jako podstawę do obliczenia tempa wzrostu pobrano przyżyciowo łuski, na których dokonano analizy wieku oraz tempa wzrostu długości i masy. Odczyty wsteczne zostały przeprowadzone metodą Rosy Lee. Do przedstawienia modelu wzrostu użyto wzoru von Bertalanffiego. Porównania statystyczne grup ryb zostały przeprowadzone przy użyciu testu nieparametrycznego U – Manna Whitneya. Korelacje pomiędzy poszczególnymi czynnikami zostały zbadane przy użyciu analizy regresji, natomiast istotność współczynnika korelacji została sprawdzona przy użyciu testu t. Tempo wzrostu masy określone za pomocą zmodyfikowanego równania von Bertalanffiego zostało opisane następującą formułą: $Wt = 1215{,}103[1-e^{-0{,}133609(t+0{,}57322)}]^{2{,}7559}$.

Zlokalizowane tarliska certy znajdujące się pomiędzy Gryficami i Trzebiatowem mogą zostać uznane za dobre źródło tarlaków do sztucznego tarła, a ich liczba potwierdza możliwość udanej kontynuacji programu restytucji tego gatunku w Redze. Satysfakcjonujące parametry wzrostu ryb w rzece, struktura wieku i liczebność uzyskane w czasie elektropołowów stanowią dobrą bazę do utrzymania populacji tarłowej w dorzeczu Regi.