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THE IMPACT OF PONDS AND HATCHERIES ON THE ICHTHYOFAUNA OF THE DOBRA RIVER (CENTRAL ODER RIVER TRIBUTARY)

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ABSTRACT. Many fish species migrate through the supply streams of fish cultivation facilities (ponds, farms and hatcheries). These streams are the sources of so-called exotic species which are undesirable in open waters. They appear in the Dobra River when ponds are drained and during other hatchery works conducted in spring (April-May) and autumn (October-November). As a result, the number of species varies seasonally from six to 15. The ichthyofauna density increases from 1.70 to 124.94 specimens 100 m^{-2}, while the biomass grows from 27.86 to 962.95 g 100 m^{-2}. The majority of escapee fish belong to limno- and stagnophilous species. Most of these fish remain in this foreign environment only for a short time of 2 to 4 months.

Key words: LOWLAND RIVER, ICHTHYOFAUNA - SPECIES COMPOSITION, DENSITY, BIOMASS, IMMIGRATION FROM CULTIVATION FACILITIES

INTRODUCTION

A review of the literature regarding the condition of fish stocks in rivers indicate that in sections of rivers located near cultivation facilities (ponds, hatcheries) many species are observed which do not correspond to the physiographic character of the rivers. These are usually fish which escaped to open waters due to malfunctioning hydrotechnical devices, or species which are intentionally released because they are unimportant commercially.

Due to the fact that the majority of ichthyofauna studies are conducted in supply streams on a one-time only basis and in particular seasons, information regarding the presence of atypical fish species is not included.

Therefore, the aim of this "annual monitoring" study (Przybylski 1997) is to describe seasonal dynamics in ichthyofauna species composition, density and biomass in a river which is continuously influenced by intensive fish cultivation in ponds and hatcheries.

STUDY AREA AND METHODS

The Dobra River, a right tributary of the Widawa River in the central drainage area of the Oder River, was selected for the studies. The Dobra River supplies numerous pond complexes, the largest of which is the Polish Anglers' Union Szczodre Stocking Center (approximately 70 ha) and its hatchery.

The Dobra River has the greatest slope of all the Widawa River tributaries at 2.77‰ and is classified as a highland river along its entire length. With the exception of the area near its source and a 2 km-long section near the Szczodre Stocking Center (Domaszyn – Zakrzów), it is fully regulated.

The ichthyofauna of the Dobra River was studied in 1988-1989 (Witkowski et al. 1991). In addition to fish that are typical for small highland streams, several limnophylic species were also observed (*Cyprinus carpio* L., *Tinca tinca* (L.), *Esox lucius* L., *Leucaspius delineatus* (Heck.), *Scardinius erythrophthalmus* (L.), *Misgurnus fossilis* (L.)); their presence was attributed to their escape from cultivation ponds. At the time, the first three species were the principal ones being reared at the center. In the early 1990s the production profile of fry was changed to focus on rheophilous and endan-

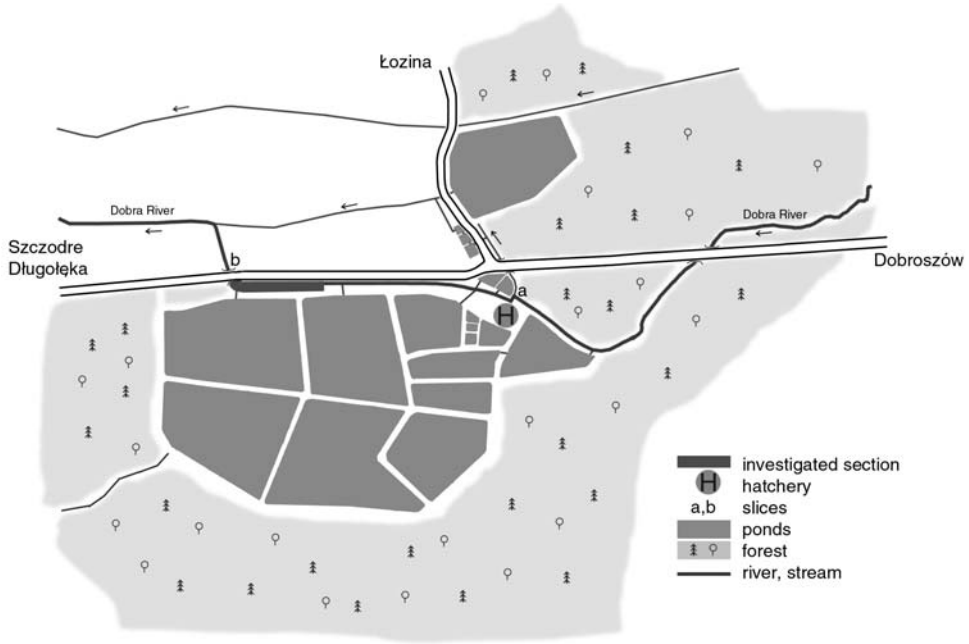

Fig. 1. Study area – the Dobra River and the pond complex and hatchery.

gered species in the middle and upper Oder River drainage area and other parts of Poland (Błachuta and Witkowski 1999, Błachuta 2000, Witkowski et al. 2000). Currently, up to 28 fish species are cultivated annually (Table 1).

A 150 m-long section of the river which supplies water to and receives water from the cultivation ponds and hatcheries in Szczodre near Wrocław was selected for the studies. This segment is located between two weirs (Fig.1). The river's width and depth along this segment varied and depends on the season and work being conducted at the ponds (emptying or taking up water) and the hatchery. The average width was 4 m with a depth of 0.20 m (maximum - 0.9 m). The bottom in the study area is covered with gravel and is not overgrown with vascular flora. The banks are steep and densely overgrown with trees and bushes in the greater part of the study area so that the river is strongly shaded during the vegetation season. Despite earlier regulation, the river is starting to meander in some parts where branches and gravel and silt sediments have deposited. Additionally, there are several fallen trees in the study area, which, along with the meanders, create hiding places for the fish. The river's flow speed increases in these locations and creates habitats for rheophilous fish species.

Since the Dobra River runs through rural areas its waters are high quality. Only the 3 km-long mouth area from Zakrzów to Wrocław is heavily polluted with industrial waste waters (Witkowski et al. 1991).

The studies were conducted monthly from March 2000 to March 2001, excluding July. Sample catches were made with a diesel generator (2.2 kW) equipped with a line to transform DC into AC at an intensity of 3 A and 220 V. Due to the shallowness of the stream, electric fishing was conducted by wading upstream with one anode and a scoop. Since the same fishing gear was used by the same team throughout the study period, the evaluation of the ichthyofauna population parameters was based on a single electric catch, which was regarded as the constant catch per unit effort (CPUE). Following the completion of each catch, the species composition was determined and all the fish were counted, measured to the nearest mm and weighed to the nearest g and then released at the catch site.

The index of the continuity of species occurrence (*Ci*), expressed in percentages, was used to identify changes in the ichthyofauna composition in the study area: $Ci = 100\ mi : m$, where: mi – number of months the i-th species occurred; m – total number of months of the study. Fish biomass (*B*) and density (*N*) in particular study periods were recalculated for a stream area of 100 m^2.

TABLE 1

Fish species cultivated during the study year at the Polish Anglers' Union Szczodre Stocking Center

Species/ form	Hatch	Summer fry	Autumn fry	Yearlings	Spawners, commercial and fodder fish
Acipenser gueldenstaedti Brandt					+
Barbus barbus (L.)	+	+	+		+
Cyprinus carpio (L.)	+	+	+	+	+
- *C. carpio* f. koyi	+	+	+	+	+
Carassius carassius (L.)			+	+	+
- *C. auratus* (L.)			+	+	+
- *C. auratus* (gold fish)		+			+
Ctenopharyngodon idella (Val.)		+	+	+	+
Tinca tinca (L.)	+			+	+
Abramis brama (L.)					+
Vimba vimba (L.)			+		
Rutilus rutilus (L.)					+
Scardinius erythrophthalmus (L.)			+		+
Chondrostoma nasus (L.)		+	+		
Hypophthalmichthys molitrix (Val.)					+
Aspius aspius (L.)	+		+	+	+
Leuciscus idus (L.)	+	+	+	+	+
- *L. idus.* aberr. *orfus*			+		+
- *L. cephalus* (L.)			+		
Silurus glanis L.	+	+	+	+	+
Esox lucius L.	+	+	+	+	+
Thymallus thymallus (L.)	+				
Salmo trutta m. *fario* L.	+	+	+		
Oncorhynchus mykiss Walb.	+	+	+		+
Lota lota (L.)	+	+	+	+	+
Sander lucioperca (L.)		+			+
Perca fluviatilis L.					+

RESULTS

SPECIES COMPOSITION

A total of 23 fish species were observed in the studied segment of the Dobra River over the course of the study year. Of these, only the six following species: *Gobio gobio* (L.), *Rutilus rutilus* (L.), *Lota lota* (L.), *Perca fluviatilis* L., *Leuciscus cephalus* (L.) and

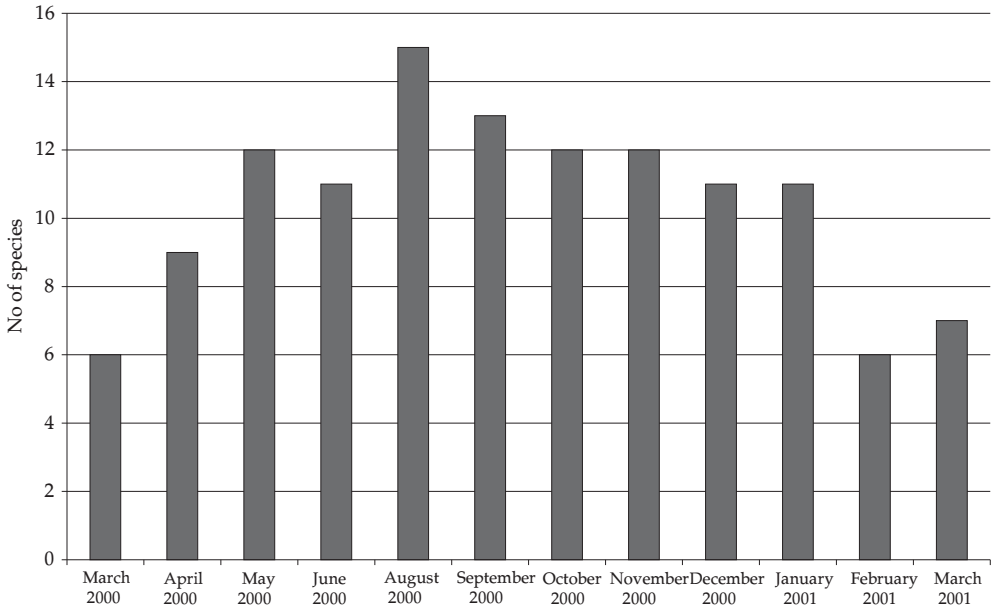

Fig. 2. Annual number of fish species in the Dobra River.

Salmo trutta m. *fario* L., are regarded as typical to the ichthyofauna of small highland rivers.

The number of species varied in different months; the most were observed between May and January (11 to 15 species) and the maximum (15) was noted in August. The fewest species (6-7) was observed in late winter, i.e. in February and March (Fig. 2). Between fall and spring a decreasing number of species was observed each month.

Only two species, *G. gobio* and *R. rutilus,* were present throughout the study period (*Ci* = 100.0). Six species, *Oncorhynchus mykiss* Walb., *Leuciscus idus* (L.), *L. cephalus, L. lota, P. fluviatilis, T. tinca* and *Abramis brama* (L.), were confirmed in eight out of ten catches (*Ci* = 66.6-83.0). Four species, *Gymnocephalus cernuus* (L.), *S. erythrophthalmus, S. trutta* m. *fario* and *Carassius auratus* (L.), were noted in five to seven of the electro-catches (*Ci* = 41.6-58.3). The remaining nine species were observed in one to four study periods (*Ci* = 8.3-33.3) (Fig. 3).

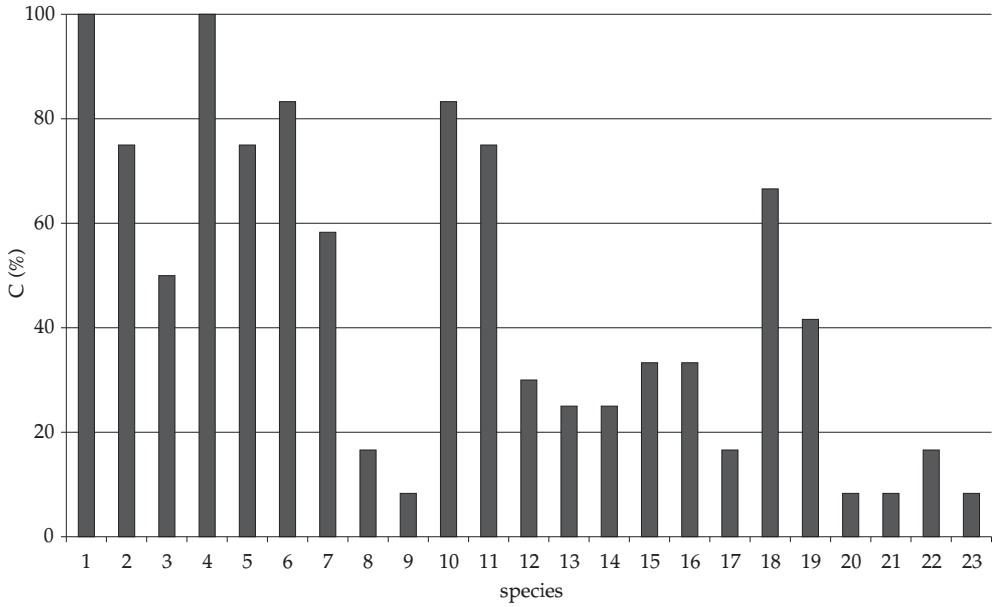

Fig. 3. Continuity (*Ci*) of fish species occurrence in the Dobra River: 1. - *G.gobio*; 2. - *O. mykiss*; 3. - *S. trutta* m. *fario*; 4. - *R. rutilus*; 5. - *L. idus*; 6. - *L. lota*; 7. - *C. auratus*; 8. - *C. carassius*; 9. - *C. carpio*; 10. - *P. fluviatilis*; 11. - *T. tinca*; 12. - *A. brama*; 13. - *B. barbus*; 14. - *G. cernuus*; 15. - *A. anguilla*; 16. - *L. delineatus*; 17. - *Ch. nasus*; 18. - *L. cephalus*; 19. - *S. erythrophthalmus*; 20. - *S. glanis*; 21. - *S. lucioperca*; 22. - *E. lucius*; 23. - *G. aculeatus*.

DENSITY

The fish density changed significantly throughout the year in the studied part of the river. *R. rutilus* dominated for eight months (spring - summer, winter). The sub-dominant in May and June was *C. auratus*. *L. delineatus* clearly dominated in the three autumn months from October to December, and the numbers of *L. idus* and *S. erythrophthalmus* significantly increased.

Three clear "peaks" of fish density occurred during the study. The highest one was observed in October (124.94 specimens 100 m^{-2}), followed by one in May (63.32 specimens 100 m^{-2}) and one in August (87.81 specimens 100 m^{-2}). In the months following the peaks, the concentration decreased and was most pronounced from fall to spring (October-March) (Fig. 4, Table 2).

BIOMASS

The highest fish biomass was noted in May (962.95 g 100 m^{-2}). A steady decrease in biomass to 534.48 g 100 m^{-2} was observed as the summer months progressed into early fall (June to October), and then in November it reached another high level of

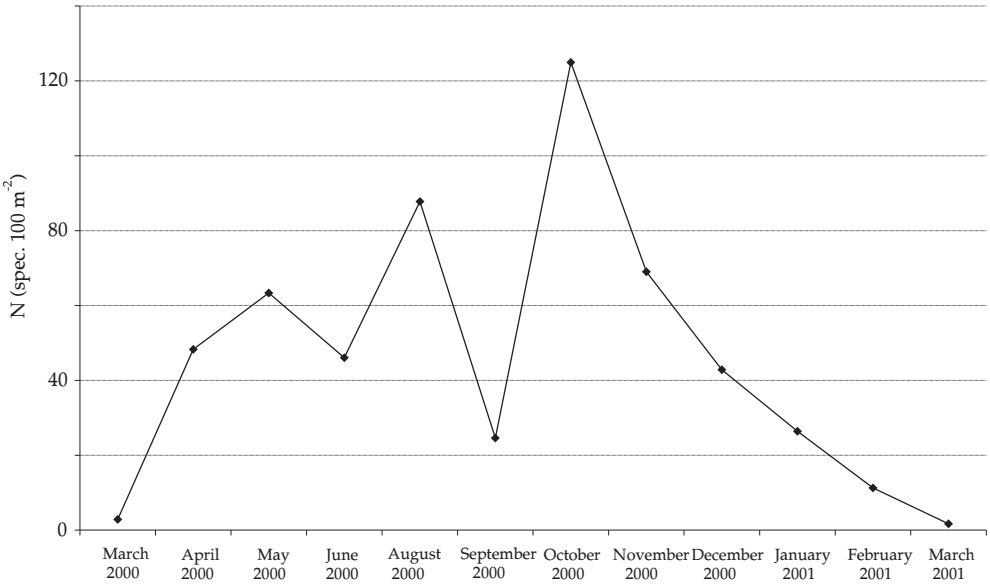

Fig. 4. Annual fish density (*N* – spec. 100 m^{-2}) in the Dobra River.

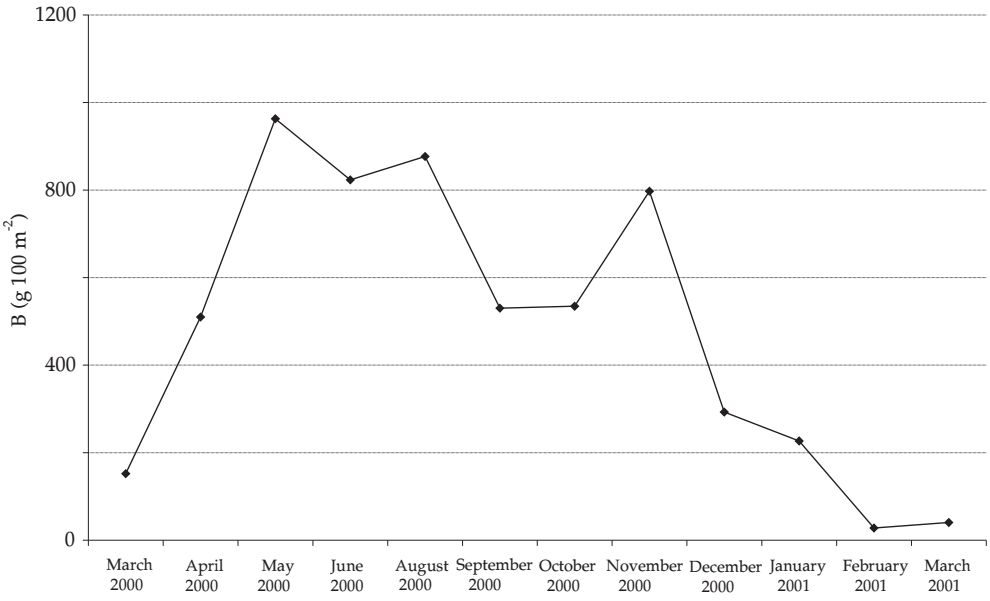

Fig. 5. Annual fish biomass (*B* – g 100 m^{-2}) in the Dobra River.

798.28 g 100 m^{-2}. From this moment until the beginning of spring there was a rapid drop in the fish biomass level to 152.1 in March 2000 and from 27.86 to 40.51 g 100 m^{-2} in February - March 2001 (Fig. 5, Table 3).

As was the case with density, the core of the biomass for eight months was *R. rutilus* (8.28 to 566.56 g 100 m^{-2}). The highest levels were noted from April to August (207.83 to 566.56 g 100 m^{-2}). The percentage of *L. idus* was also high during this period. After the ponds had been drained in October, the dominating species became *L. delineatus* (182.37 g 100 m^{-2}); however, its biomass fell rapidly over the subsequent three months and was only 0.15 g 100 m^{-2} in January.

TABLE 2

Fish density (*N* – spec. 100 m^{-2}) in the Dobra River by month
(Bold print denotes months when ponds were drained)

Species/ form	Month											
	March 2000	**April 2000**	May 2000	June 2000	August 2000	Sep-tember 2000	**Octo-ber 2000**	Novem ber 2000	Decem ber 2000	Janu-ary 2001	Febru-ary 2001	March 2001
A. anguilla	0.15		0.60	0.30		0.30						
B. barbus					0.15	0.45						0.15
C. carpio						0.15						
C. carassius				1.06	0.75							
C. auratus			4.54	3.78	0.45	0.60	**0.90**	0.60	0.75			
G. gobio	0.60	**3.63**	1.81	6.06	3.63	5.90	**1.51**	2.72	1.36	10.06	0.30	0.44
T. tinca		**0.30**	13.6	2.57	0.60	0.45		0.15	0.15	0.15		0.15
A. brama			0.90		0.75	0.90	**0.45**					
R. rutilus	0.45	**41.24**	46.51	28.03	72.12	8.63	**10.75**	18.18	16.06	13.18	10.06	0.66
S. erythrophthalmus							**3.63**	1.21	3.48	0.45	0.30	
Ch. nasus							**0.15**	0.30				
L. delineatus							**96.51**	32.42	18.33	0.15		
L. cephalus	0.30	**0.60**		0.90	0.75		**0.30**	0.75	0.45	0.30		
L. idus		**0.75**	2.10	1.51	2.12	2.27	**9.24**	10.75	1.06	0.45		
S. glanis				0.15								
E. lucius		**0.15**	0.15									
S. trutta m. *fario*			0.30		0.15		**0.30**	0.60		0.15		0.15
O. mykiss	0.30	**0.15**	1.21	0.30	0.15	0.60			0.15	0.15	0.15	
L. lota	1.06	**0.6**	0.75	1.36	1.36	2.42	**0.30**	0.30	0.15	0.60		
G. aculeatus												0.15
P. fluviatilis		**0.90**	3.18		3.33	1.50	**0.60**	0.75	0.60	0.30	0.30	0.44
S. lucioperca					0.60							
G. cernuus					0.90	0.45					0.15	
Σ	2.86	**48.29**	63.32	46.02	87.81	24.62	**124.94**	69.03	42.84	26.39	11.26	1.70

TABLE 3

Fish biomass (B – g 100 m^{-2}) in the Dobra River by month
(Bold print denotes months when ponds were drained)

Species/ form	Month											
	March 2000	**April 2000**	May 2000	June 2000	August 2000	September 2000	**October 2000**	November 2000	December 2000	January 2001	February 2001	March 2001
A. anguilla	5.12		80.87	52.56		21.23						
B. barbus					1.96	7.53						3.31
C. carpio						8.13						
C. carassius				27.40	8.13							
C. auratus			69.12	95.03	10.99	25.30	**13.40**	3.76	5.42			
G. gobio	4.96	**57.53**	17.62	81.92	46.08	89.00	**17.92**	78.31	11.74	9.48	2.56	1.35
T. tinca		**6.62**	20.63	45.18	9.03	13.55		2.10	3.76	5.42		12.50
A. brama			8.28		4.36	8.73	**8.73**					
R. rutilus	2.10	**331.17**	379.96	207.83	566.56	109.78	**107.83**	212.34	170.93	121.68	8.28	3.46
S. erythrophthalmus							**11.44**	63.31	19.27	2.40	1.65	
Ch. nasus							**0.15**	9.18				
L. delineatus							**182.37**	84.78	27.25	0.15		
L. cephalus	2.25	**31.17**		136.29	72.28		**19.27**	30.57	15.81	6.47		
L. idus		**19.87**	237.50	104.06	51.35	126.96	**87.19**	110.09	10.39	1.65		
S. glanis				7.37								
E. lucius		**15.21**	16.41									
S. trutta m. *fario*			4.36		0.60		**51.35**	177.56		38.85		15.66
O. mykiss	111.44	**13.85**	24.39	6.77	1.20	5.72			9.63	10.99	11.59	
L. lota	26.20	**25.60**	41.11	58.88	44.42	72.89	**22.43**	3.46	4.06	20.93		
G. aculeatus												0.15
P. fluviatilis		**8.73**	62.65		48.19	32.53	**10.54**	15.06	10.84	3.16	2.10	4.06
S. lucioperca					4.36							
G. cernuus					6.77	8.58					1.65	
Σ	152.10	**509.78**	962.95	823.34	876.65	529.96	**534.48**	797.28	292.77	226.65	27.86	40.51

DISCUSSION

The majority of cultivation facilities increase the production and sale of stocking material from early spring until mid summer and in early autumn (Guziur 1982, Szczerbowski 1993). A wide range of work is conducted at these times, including draining ponds, transferring fish from hatcheries to ponds and selling stocking material and commercial fish, and, along with malfunctioning hydrotechnical apparatuses, some fish species accidentally escape or are intentionally released.

It is during these periods that many atypical species appear in the streams. The rich literature on this topic is also evidence of this phenomenon (Witkowski and Błachuta 1988, 1992, Koszaliński et al. 1989, Skóra and Włodek 1989, Dębowski 1990, Witkowski et al. 1991, 1997, Błachuta et al. 1993, Penczak et al. 1993, 1998, Przybylski et al. 1993, Skóra et al. 1994, Augustyn et al. 1998, Włodek and Skóra 1999, Dębowski et al. 2000a, b, Kruk et al. 2000, Kostrzewa et al. 2001). These authors state that, in addition to the species that are typical of a given stream type, many other species occur which usually have different ecological preferences.

The studied segment of the Dobra River had an unusually rich species composition which included 23 species recorded during the study period. Only six of these (*G. gobio*, *R. rutilus*, *L. lota*, *P. fluviatilis*, *L. cephalus*, *S. trutta* m. *fario*) are regarded as typical of the ichthyofauna in small highland rivers (Starmach 1956, Holčik 1989, Witkowski et al. 1991). The remaining 17 species belonged to the following groups: phytopylous -12 species; lithophylous – 3; indifferent – 1; special group – 1 (principally lymno- or stagnophylous).

Of the 28 fish species and varieties which were cultivated at the Szczodre Stocking Center (Table 1) only the following species were not recorded: *Hypophthalmichthys molitrix* (Val.); *Ctenopharyngodon idella* (Val.); *Aspis aspius* (L.); *Vimba vimba* (L.); *Acipenser gueldenstaedti* Brandt; *C. carpio* f. koyi; *L. idus* aberr. *orfus*; *C. auratus* (f. gold fish); *Thymallus thymallus* (L.). The absence of these species in the stream is probably connected with the fact that some of them are kept only for sale (*A. gueldenstaedti*, *H. molitrix*, *C. idella*) and others (*T. thymallus*, *A. aspius*) are cultivated for only one to two months. Although the production of *C. carpio*, *Silurus glanis* L. and *E. lucius* stocking material (hatch and fry) in Szczodre is the most intense, very low numbers of them were noted in the river.

The results of the study clearly indicate that the majority of fish which managed to escape to the river left the studied segment relatively quickly. This is probably because some species do not have the appropriate habitat in this partially regulated, shallow segment of the Dobra River and flow with the current to the lower parts of the river and then to the Oder River in a relatively short time (Penczak 1989, Witkowski et al. 1991, 1997, Błachuta et al. 1993).

The appearance of alien fish species in the river corresponds with periods of intense incubation and fry cultivation and especially with pond draining in spring (April) and autumn (October), i.e. the highest numbers and biomass and the greatest concentrations of alien species were observed in the Dobra River at these times. Simi-

lar phenomena have also been observed in rivers after large volumes of water were discharged from dam reservoirs (Kelly et al. 1981, Ney and Mauney 1981, Penczak et al. 1984, 1993, Cowx and Gould 1985) as well in segments of rivers which flow from lakes (Degerman and Sers 1994). The fact that the alien species present in the studied river segment are small also indicates that the majority of them are pond escapees. Single specimen weight in various months varied from 2.47 to 53.4 g (average 14.3). A similar phenomenon was observed when water levels in dam reservoirs were lowered resulting in the release into rivers of mainly juvenile stages of the dominant species - *R. rutilus*, *P. fluviatilis* and *A. bjoerkna* (Penczak et al. 1993). Only specimens of *S. trutta* m. *fario*, *O. mykiss*, *A. anguilla* and *L. cephalus* in the Dobra River were large enough to be of interest to anglers.

The cultivation facilities can and do supply rivers and even their larger drainage areas with native fish species; however, the cultivation of „exotic fish" may also be a source of unwanted species due to malfunctioning monks and other safety systems. The results presented by Witkowski (1996a, b) indicate that the greatest numbers of alien fish species are observed in the open waters of Polish regions with the most ponds, hatcheries and various types of cultivation facilities. Their presence may have a negative impact on the native ichthyofauna as well as the aquatic environment (Witkowski 1989, 2002, Heese 1997). Cortes (1996) and Penczak (1999) confirmed that even introducing native species, especially predatory ones, into habitats in which they previously did not occur may impoverish natural fish assemblages.

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STRESZCZENIE

WPŁYW STAWÓW I WYLĘGARNI NA ICHTIOFAUNĘ RZEKI DOBREJ (ŚRODKOWE DORZECZE ODRY)

Na przykładzie badań przeprowadzonych w rzece Dobrej (rys. 1), pozostającej pod silnym wpływem hodowli ryb prowadzonych w stawach i wylęgarni (tab. 1) można przedstawić następujące wnioski:

1) sąsiedztwo różnego typu ośrodków hodowlanych, nawet przy najlepszych i najsprawniejszych zabezpieczeniach, stanowi źródło z których do wód otwartych przenika wiele gatunków ryb;

2) najwięcej gatunków (12 do 15) na badanym odcinku rzeki występuje w od maja do listopada. W tym okresie odnotowuje się również najwyższe wartości zagęszczenia i biomasy ryb. Najmniej (6-9) gatunków występuje zimą i wczesną wiosną (rys. 2, 4; tab. 2, 3);

3) uciekinierami ze stawów są najczęściej przedstawiciele limnofilnej i stagnofilnej grupy (rys. 3);

4) w nietypowych dla nich naturalnych warunkach środowiskowych oraz w uregulowanych odcinkach cieków przedstawiciele tych grup przebywają zazwyczaj krótko. Takie gatunki jak *E. lucius*, *S. lucioperca*, *S. glanis*, *Ch. nasus*, *B. barbus*, *C. carpio* i *C. carassius* przebywały w badanym odcinku rzeki przez okres od 1 do 2 miesięcy (*Ci* = 8,3-16,6); *S. erythrophthalmus*, *L. delineatus* i *G. cernuus* do 4 miesięcy (*Ci* = 41,6); najdłużej *A. brama* i *T. tinca* - do 8 miesięcy (*Ci* = 66,6) (rys. 3).

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