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Aquaculture

**RESULTS OF REARING TWO-YEAR-OLD EUROPEAN WELS
(*SILURUS GLANIS* L.) IN PONDS STOCKED WITH INTENSIVELY
CULTURED YEARLING**

**WYNIKI INTENSYWNEGO CHOWU DWULETNIEGO SUMA
EUROPEJSKIEGO (*SILURUS GLANIS* L.) W STAWACH
OBSADZANYCH NARYBKIEM JEDNOROCZNYM**

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The aim of the present study was to investigate the ability of intensively reared European wels, (*Silurus glanis* L.) to adapt fish to pond conditions. Studies were carried out in two ponds in 1992 and four in 1993. The wels were stocked into the ponds when they were about 11 months of age and had average weights of: 498 and 469 g (1992) or 138, 281, 394 and 213 g (1993) respectively. When they were harvested at the age of 15–20 months, the average weights had increased to 1.461 and 2.125 g (survival 97 to 100%) for the fish stocked in 1992, and to 659, 1.323, 2.057 and 1.382 g (survival 86, 100, 87 and 100%) for the 1993 stock. Thus, European wels cultured intensively under controlled conditions do not lose their ability to actively seek and feed on live prey. Consequently it appears that intensively cultivated European wels may be stocked into ponds, and intensive rearing enables the stocking of fish at one year of age when the body weight may approach 500 g.

INTRODUCTION

European wels (*Silurus glanis* L.) represents the biggest fish species in the Czech Republic and it is among the largest European freshwater fishes. The question of its intensive breeding and propagation was raised with regard to the need of production of the stocking material up to the stage of increased resistance against environmental effects. It means that it is necessary to produce feeding fry or forced fry and to reach the maximum size of indi-

viduals after the end of the first growing season. In association with the use of heated waste water from power plants for fish farming, European wels became (above all due to its requirements for environmental temperature, intensity of growth and market demand) one of those species which are intensively cultured to reach the market weight.

There are relatively numerous data available in the literature about the wels farming using different methods. Results of studies with the use of dry feedstuffs were published among others by Jungwirth (1986), Manthey et al. (1988), Heymann (1990) and Kohde (1992). On the other hand Müller and Varadi (1980), Ržaničanin et al. (1984), Bogut et al. (1989), Stevič (1989, 1993), Treer et al. (1989), and Stevič et al. (1993) investigated the possibilities of the use of cages for the production of two-year-old European wels. Rearing of two-year-old European wels carried out in cages in postcooling waters by Filipiak et al. (1993, 1995) using different food rations and different protein levels in feed. Results of a study on rearing European wels in polyculture with the use of Trouvit feed mixture were published by Stevič (1989) and the use of four-stage technology of rearing in ponds was described by Krasznai et al. (1980). Zimack (1990) (in Jähnichen, 1992) recommended to produce one-year-old individuals of the European wels in ponds of the area up to one hectare. Steinl (1992) described the rearing of market-size European wels in ponds up to the age of four years. Data about the growth of European wels in ponds and a survey of average data about the length growth in different localities of the Czech and Slovak Republic were published by Piesker (1984) and by Hanel (1992), respectively. Data about the composition of carcass of European wels were published by Hilge (1986) and Filipiak et al. (1993, 1995). Our experiments were focused to the following three aspects:

1. Intensive production of stocking material for the traditional method of rearing in ponds and for angling up to the age of one year.
2. Reduction of costs associated with intensive production on the basis of maximum use of natural production capacity of natural ponds.
3. Selection of individuals with low intensity of growth after the end of winter season and their release into natural waters (i. e. ponds, streams etc.)

Regarding the present situation in fish breeding, when fish is propagated mainly on the base of artificial or semi-artificial rearing of fry and when the intensive rearing is carried out using a combination of various sources of nutrition (natural food, feed mixtures etc.), attention was paid to the capacity of one-year-old individuals of the European wels to adapt themselves to natural conditions of ponds without any further use of supplementary feeding.

The problem of re-adaptation of the fish to natural conditions was followed in the course of two years. The success of re-adaptation of the fish was dependent on the solution of problems resulting from completely different environmental conditions (e.g. the way of feeding, nutritional competition, predators etc.).

MATERIAL AND METHODS

Individuals used in these experiments were reared in tanks with heated water up to the age of 11 months at the Department of Fisheries and Hydrobiology, Mendel University of Agriculture and Forestry Brno (Czech Republic). Fish were fed on commercial pelleted feed mixtures or on experimental feed mixed at the department. In 1991 and 1992, the initial weights were 3.7 g and 12.4 g respectively. In 1991, the experiment lasted since 23 August to the beginning of May and in 1992 the corresponding rearing period started on 10 September and finished in May, i. e. at the age of approximately 11 months. In 1992, the experimental fish were given natural food (i. e. small living trash fish) two weeks before their release to facilitate their adaptation to natural living conditions. In the following year, this method of feeding was not used.

Our study was performed in several ponds of South Moravia in the elevation of approximately 250 m. Details about the stocking of the various ponds are given in Tables 1 (1992), and 2 (1993). In 1992 the initial individual weight range was 321–1 000 g, the body length 357–550 mm. In 1993 individual weight ranged from 52 to 493 g, the body length from 209 to 429 mm. At the moment of release, the water temperature ranged from 16.5 to 20°C. The survival of the fish and the intensity of growth (SGR, individual daily gain) were followed up in the ponds mentioned above. In the course of rearing in experimental ponds, no supplementary feeding was used and the fish consumed natural food only. All these ponds were stocked with one-year-old carp; the only exception was the Zámecký pond in Lednice which was used for the production of market fish (above all of carp) and the Heršpický pond where two-year-old carp were released. The Zámecký pond was used due to the fact that its stocking involved predatory fish of higher weight categories. This study was not focused to the problem of maximum production of European wels in ponds.

The biochemical composition of muscle tissue and yield of European wels for various market forms from individual ponds was analysed as well. In the samples of muscle tissue, contents of dry matter, protein and fat were estimated. The following formula was used for calculation of SGR:

$$\text{SGR} = 100 [(W_t/W_0)^{1/t} - 1] \quad [\% \cdot \text{d}^{-1}]$$

RESULTS

In 1992, the total body weights of European wels in the Heršpický and Zámecký ponds were 42 375 g and 42 500 g, respectively; these figures corresponded with the average body weights of 1 461.2 g (range of 720–2 035 g) and 2 125.0 g (range of 1 600 to 2 650 g). The total body lengths of the fish under study were 596.1 mm in average (range of 480 to 650 mm) and 628.8 mm (range of 545 to 680 mm), respectively. The average gains

Table 1

Result in 1992 (ponds: Heršpický, Zámecký)

Pond	Heršpický	Zámecký
Area (ha)	3.6	25
Date of stocking	21 May	25 May
Number of fish stocked	30	20
Initial average weight (g)	498 ±131	469 ±137
Initial average length (mm)	429 ±30	422 ±38
Biomass stocked (kg)	14.9	9.4
Date of harvesting	30 Sept.	26 Oct.
Number of fish harvested	29	20
Biomass harvested (kg)	42.4	42.5
Average weight (g)	1 461 ±304	2 125 ±288
Average length (mm)	596 ±39	629 ±33
Biomass gain (kg)	27.4	33.1
Individual biomass gain (%)	294	454
Individual daily gain (g · d ⁻¹)	7.36	10.83
Individual daily gain (%)	1.48	2.31
SGR (% · d ⁻¹)	0.83	0.99
Number of days	131	153
Survival rate (%)	96.6	100

of 963.6 g and 1 656.4 g corresponded with the increase in body weight by 293.6 and 453.5 per cent of the stocked fish or with 284.6 and 453.5 per cent of the total body weight of the released European wels. In the course of growing season, the total body length of released fish increased by 38.86 and 49.16 per cent in the Heršpický and the Zámecký ponds, respectively. For detailed data see Table 1.

In 1993, the total body weights of harvested fish were as follows: the Heršpický pond 27 792 g, the pond in Moravské Prusy 28 335 g, the Uhřický pond 14 400 g, and the Černá Hora pond 49 763 g. The corresponding average body weights were 1 323.4 g (range of 1 018 to 1 698 g), 659.0 g (390 to 918 g), 2 057.1 g (range 1 590 to 2 570 g) and 1 382.3 (range of 1.075 to 1.725 g). The corresponding total

Table 2

Result in 1993 (ponds: Heršpický, Moravské Prusy, Uhřický, Černá Hora)

Pond	Heršpický	Mor. Prusy	Uhřický	Černá Hora
Area (ha)	3.6	10.9	13.1	3.8
Date of stocking	12 May	12 May	12 May	12 May
Number of fish stocked	21	50	8	36
Initial average weight (g)	281 ±45	138 ±42	394 ±48	213 ±41
Initial average length (mm)	356 ±27	279 ±25	397 ±16	324 ±20
Biomass stocked (kg)	5.9	6.9	3.1	7.7
Date of harvesting	12 Oct	27 Oct.	3 Nov.	21 Mar. 94
Number of fish harvested	21	43	8	36
Biomass harvested (kg)	27.8	28.3	14.7	49.7
Average weight (g)	1 323 ±191	659 ±134	2 057 ±373	1 382 ±156
Average length (mm)	576 ±22	478 ±25	645 ±36	581 ±19
Biomass gain (kg)	21.9	21.4	11.3	42.0
Individual biomass gain (%)	471	477	522	649
Individual daily gain (g · d ⁻¹)	6.86	3.11	9.56	3.76
Individual daily gain (%)	2.44	2.25	2.43	1.76
SGR (% · d ⁻¹)	1.01	0.94	0.96	0.60
Number of days	131	167	174	311
Survival rate (%)	100	86.0	87.5	100

body lengths were 575.8 mm (range of 525 to 612 mm), 478.4 mm (range of 428 to 535 mm), 645.0 mm (range of 610 to 695 mm) and 581.8 mm (range of 542 to 616 mm). The average weight gains of 1 042.5 g, 520.0 g, 1 663.7 g and 1 169.2 g obtained in individual ponds corresponded with the increase in individual body weights by 471.1%, 477.5%, 522.8% and 648.8%, respectively. The increases in the total weight of released European wels were 471.1%, 410.3%, 457.44% and 648.8%, respectively. In the Heršpický pond, the average body length increased by 61.93 %; the corresponding values for the pond in Moravské Prusy and Uhřický pond were 71.67 % and 62.31 %, in the Černá Hora pond were 79.28 %. Details are presented in Table 2.

The yield of different market form of the European wels is presented in Table 3 and the biochemical composition of musculature of the fish harvested from individual ponds is presented in Table 4. For analyses, the musculature was used in the form of fillet with and without skin.

Table 3

Yield of European wels for various market forms (in % of total weight)

Pond	Average weight (g)	Dressed fish*	Fillet with skin	Fillet without skin
1992				
Heršpický	1 461 ±304	64.71 ±1.80	46.79 ±2.36	41.58 ±2.02
Zámecký	2 125 ±288	65.81 ±0.85	49.78 ±0.69	43.59 ±0.71
1993				
Heršpický	1 323 ±191	66.96 ±1.68	51.25 ±2.34	44.55 ±2.28
Moravské Prusy	659 ±134	63.64 ±1.79	44.32 ±3.44	37.98 ±3.93
Uhřický	2 057 ±373	67.85 ±1.15	50.19 ±1.19	42.42 ±1.33
Černá Hora	1 382 ±156	68.24 ±1.20	49.77 ±1.00	42.53 ±1.07

* (eviscerated, head and fins removed)

Table 4

Composition of musculature (in % of fresh matter)

Pond	Fillet with skin			Fillet without skin		
	Dry matter	Protein	Lipids	Dry matter	Protein	Lipids
1992						
Heršpický	25.67	21.14	3.69	23.66	19.18	3.18
Zámecký	25.46	17.05	7.73	23.26	19.83	2.27
1993						
Heršpický	22.88	18.86	3.21	23.51	19.81	2.80
Moravské Prusy	19.15	17.29	0.72	18.35	16.56	0.90
Uhřický	28.97	21.55	8.25	25.09	19.63	4.06
Černá Hora	29.08	20.07	8.60	21.94	16.32	5.75

DISCUSSION

In 1992, one-year-old European wels released in natural ponds reached average body weights of 497.6 g and 468.6 g, respectively. In the following year, the corresponding values were 280.9 g, 138.1 g, 393.5 g, and 213.1 g. Zimack (1990, In: Jähnichen 1992), who recommended the production of yearlings of the European wels in ponds of the size up to 1 hectare, obtained weights of 20 to 150 g in the spring of the following year. However, the growth potential of the European wels is considerably higher. Heymann (1990), for instance, reported a weight of 1 000 g at the age of 215 days. The necessary precondition of this high weight gain was rearing in a special facility containing water with the temperatures above 27°C and using food of top quality.

To produce market European wels at the age of two years, it is necessary to use bigger yearlings. The size of market fish must be adapted to the demand. The problem of the production of two-year-old European wels of the market size was studied by many authors, especially in cages. Bogut et al. (1989) reared European wels from the initial weight of 74.6 g and obtained daily weight gains within the range of 3.1 to 10.6 g (0.2 to 3.1%). The results of these authors corresponded with the results of pond culture with an above-average supply of food. In our experiments, the average daily weight gains were 7.36 g and 10.83 g (i.e. 1.48% and 2.31%) in 1992. In 1993, the average daily gains in individual ponds ranged from 3.11 g to 9.56 g (i.e. 1.76% to 2.44%). Our results corresponded with data published by other authors about experiments in cages. Müller and Váradí (1980) obtained in 1976 the average body weight of 397.5 g within the period of 147 feeding days (the initial weight was 127 g, survival 88.5%, and average daily gain 1.95 g or 1.5%). Treer et al. (1989) obtained in cages the individual daily weight gain of 4.9 g when producing European wels up to the weight of 712 g (7% mortality). Stevič et al. (1993) presented results of a five-year study on rearing European wels in cages from the age of one or two years up to the final weight of 555 to 1 188 g. In this experiment, the average daily gain and mortality ranged from 1.17% to 3.79% and 1.55 to 35.7%, respectively. As compared with these data, our average daily gains were higher. Filipiak (1993) in the cages in post-cooling waters obtained in 1990 individual body weight (154 days) ranging from 1 385 to 1 471 g and mean values of SGR from 0.38 to 2.23 % · d⁻¹. In the most favorable variants and in the year 1994 (Filipiak 1995) (64 days) he obtained from 1,600 to 1,649 g and 1.62 % · d⁻¹ respectively. Jungwirth (1986) mentioned as an optimum the average daily gain of 2.60% when using pelleted feeds and at water temperature of 26°C. Kohde (1992) obtained in cages the average daily gain of 4.38 g (2.68%) and the final body weight of 680 g (within the period of 118 days). When using laminate troughs, the average daily gain and the final body weight were 2.82 g (i.e. 2.56%) and 377 g (within 93 days), respectively.

In our experiments, the average final body weights of two-year-old European wels were 1 461 g (596 mm) and 2 125 g (629 mm), respectively, in the year 1992. In the autumn of 1993, the average body weights in the individual ponds were 1 323 g (576 mm); 659 g (478 mm) and 2 057 g (645 mm) at the mortality of 0 to 14%. In the spring 1994, the average body weight was 1 382 g (581 mm) at the 0% mortality. The highest losses (14%) were observed in the pond Moravské Prusy where, due to the release of pike, the number of small fish substantially decreased. According to Krasznai et al. (1980) the four-stage technology of rearing enabled to produce individuals with the weight of about 60 g (100–120 mm) to the end of stage III (i.e. to the end of the first year) when using pelleted feeds. The rearing of market individuals of European wels together with *Cyprinidae* and fed on pelleted feed mixtures enabled to reach body weights ranging from 300 to 600 g. These authors recommended to select individuals with reduced growth and to release them into natural waters. Stevič (1989) produced successfully European wels in polycultural stocking of ponds when using the feed mixture TROUVIT. This author released yearlings of body weight of 11 to 43 g and harvested two-year-old fish with the average body weight of 500 g. Manthey et al. (1988) intensively cultured the European wels for a period of two years (from the stage of yolk-sac fry) in tanks with water temperature of 23–27°C and using commercial feed mixture for trouts. At this age, the average body weight of European wels was 2 649 g (720 mm). Steinl (1992) reared European wels in ponds without artificial feeding for the period of four years (i.e. using a six-stage technology). At the age of three years, the average body weight of fish was 1 000 g. Piester (1984) reported three-year-old individuals of European wels reaching the size of 2 to 4 kg in ponds.

The total body length of the European wels produced by means of our technology was 478 to 629 mm at the age of two years. As compared with data published by Hanel (1992) about the length growth of the European wels in different localities of the Czech and Slovak Republic, these results corresponded with fish 3 to 5 year old.

The chemical composition of musculature of our experimental fish characterised the conditions of rearing. Especially the fat content corresponded with the food supply. The markedly lowest content of fat (0.72%) was recorded in the pond in Moravské Prusy in 1993 where the lowest supply of food and the highest mortality were observed. As compared with the results published by Hilge (1986) who analysed fillets of the European wels and reported 1.9% of fat, we have found an increased content of fat (3.21% to 8.25% of fresh matter). Filipiak et al. in the culture cages obtained fat content of in the tissue ranging from 2.65 to 4.27 % in the year 1990 (Filipiak et al. 1993) and from 5.5 to 11.3 % in the year 1994 (Filipiak et al. 1995).

It is necessary however, to remember that the individuals of the European wels accumulated fat in certain body regions and that this fat was not included into the analysed samples.

CONCLUSION

In this study attention was paid to the possibilities of using a combined technology of rearing two-year-old individuals of the European wels. Yearlings were cultured intensively in warm water and artificially fed on pelleted feed mixtures. After eleven months, the yearlings were stocked into natural ponds. The results obtained indicate that it is possible to use these intensively reared yearlings as stocking material for ponds and open waters. Using this technology, it is possible to obtain two-year-old (in 16 months age respectively) market fish of the size of about 2 kg without supplementary feeding in ponds. The weight of harvested fish is dependent on that of the yearlings released and on the supply of food (i.e. on concentration of trash fish). As indicated both by our own and the data published, it is possible to obtain yearlings of the European wels with body weight of about 1 000 g at the age of 11 months. Relatively low losses in the period of rearing in the ponds demonstrated that even during the period of intensive rearing the European wels does not lose its natural instincts and that it is quickly readapted to natural conditions of life. This was also demonstrated by the fact that the gains were comparable with results obtained in special facilities with intensive feeding. The average daily gains ranged from 1.5% to 2.5% of body weight (i.e. about $1\% \cdot d^{-1}$ of actual body weight). In view of our experience it is not suitable to release yearlings of European wels from intensive rearing facilities into ponds with water temperature below 15–16°C or with the absence and/or lack of natural food.

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WYNIKI INTENSYWNEGO CHOWU DWULETNIEGO SUMA EUROPEJSKIEGO
(*SILURUS GLANIS* L.) W STAWACH OBSADZANYCH NARYBKIEM
JEDNOROCZNYM

STRESZCZENIE

Przedstawione doświadczenie miało na celu zbadanie możliwości intensywnego chowu sumy europejskiego (*Silurus glanis*) i jego adaptacji w warunkach stawowych. Badania przeprowadzono w dwóch stawach ziemnych w 1992 i w czterech w 1993 r.

Stawy obsadzono sumami w wieku ok. 11 miesięcy o średniej masie jednostkowej 498 i 469 g (1992 r.) oraz 138, 281, 394 i 213 g (1993 r.). Odławiane ryby w wieku 15-20 miesięcy uzyskały w 1992 r. średnią masę jednostkową: 1 461 i 2 125 g (przeżywalność - 97-100%) oraz w 1993 r. odpowiednio: 658, 1 323, 2 057 i 1 382 g (przeżywalność - 86, 100, 87 i 100%).

Sum europejski chowany intensywnie w warunkach kontrolowanych nie traci swoich zdolności szukania i zdobywania żywego pokarmu. W związku z tym wydaje się, że chów intensywny sumy europejskiego może być prowadzony w stawach gdy jednoroczne ryby mają masę ok. 500 g.

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