ELECTRONIC
JOURNAL
OF POLISH
AGRICULTURAL
UNIVERSITIES

1999
Volume 2
Issue 2
Series
FISHERIES

FILIPIAK J., CZERNIEJEWSKI P., SADOWSKI J., TRZEBIATOWSKI R. 1999. COMPARISON OF THE EFFECTS OF CAGE–REARING OF STERLET (*Acipenser ruthenus*) AND RUSSIAN × SIBERIAN STURGEON (*Acipenser gueldenstadetdti* × A. *baeri*) HYBRID FRY IN COOLING WATER **Electronic Journal of Polish Agricultural Universities**, Fisheries, Volume 2, Issue 2.
Available Online http://www.ejpau.media.pl

COMPARISON OF THE EFFECTS OF CAGE–REARING OF STERLET (*Acipenser ruthenus*) AND RUSSIAN × SIBERIAN STURGEON (*Acipenser gueldenstadetdti* × A. *baeri*) HYBRID FRY IN COOLING WATER

Jarosław Filipiak[1], Przemysław Czerniejewski[1], Jacek Sadowski[2], Rajmund Trzebiatowski[2]
[1]*Department of Fisheries Management in Inland Waters, Agricultural University of Szczecin, Poland*
[2]*Department of Aquaculture, Agricultural University of Szczecin, Poland*

ABSTRACT

Within 17 September – 31 October 1997, fry of the Russian × Siberian sturgeon hybrid of 31.1 g mean individual weight and sterlet fry of 25.4 g mean individual weight were fed two trout feeds: the Dana–ex 4.85

and the Safir differing, i.a., in their gross energy content (5470 and 5173 Kcal·g^{-1}, respectively), each feed being offered in triplicate. The fish were kept in cages, stocked at 80 ind./cage, placed in power station cooling water of temperature changing within 12.2–23°C. Water temperature–dependent differences in fish growth were revealed: the hybrid grew better at 19–23°C, while the sterlet growth was better at 12–18°C. In both fish groups, the Dana–ex 4.85 produced better food conversion rate (FCR) and apparent net protein utilisation (aNPU).

Key words: sturgeon, feeding, cooling water, cage.

INTRODUCTION

In early 1990's, a potential of rearing certain acipenserid species under different environmental conditions, e.g., in trout ponds and in cooling water–deployed cages, was started to be investigated (Bogdan and Mastynski 1993; Pyka 1994; Kolman et al., 1994, 1996; Filipiak and Trzebiatowski 1995). Experiments showed Siberian sturgeon, due to its appropriately high growth rate and low mortality, to be the species most amenable for intensive cage culture (Filipiak et al. 1996). The existing evidence on the potential for intensive culture of sterlet (Kolman 1993; Prokes et al. 1997) provided an incentive for the study described in the present paper. The study was aimed at comparing the effects of cage rearing of sterlet and Russian × Siberian sturgeon hybrid fry, fed high–energy extruded feeds, in power station cooling water.

MATERIALS AND METHODS

The experiment was run within 17 September – 31 October 1998 at the Department of Aquaculture's Fisheries Research Station (FRS), situated in the vicinity of the Dolna Odra power station at Nowe Czarnowo. The feeding experiment involved 480 individuals of 25.4 (±2.0)·g^{-1} mean individual weight sterlet fry and 480 individuals of 31.1 (±2.0)·g^{-1} mean individual weight Siberian x Russian sturgeon hybrid fry. The fish in both groups were of identical age (6 months) and had been purchased from PPHU "Ryba" in Olesnica. The sterlet fry were obtained from spawners cultured in Poland (they yielded eggs to be successfully incubated in 1997, for the first time in Poland), while the hybrid fry were obtained from eggs imported from Russia.

The fish were kept in 12 net cages measuring 0.7 × 1.8 × 0.7 m (0.9 m^3 working capacity), 3 cages being allotted to each experimental treatment. The sides and the bottom of each cage were made of 6 mm mesh size net. In addition, two–thirds of the bottom of each cage was covered with fine–meshed (0.2 mm mesh size) plastic net to prevent mouth damage to the feeding fish and to prevent feed losses. Each cage was stocked with 80 fry individuals.

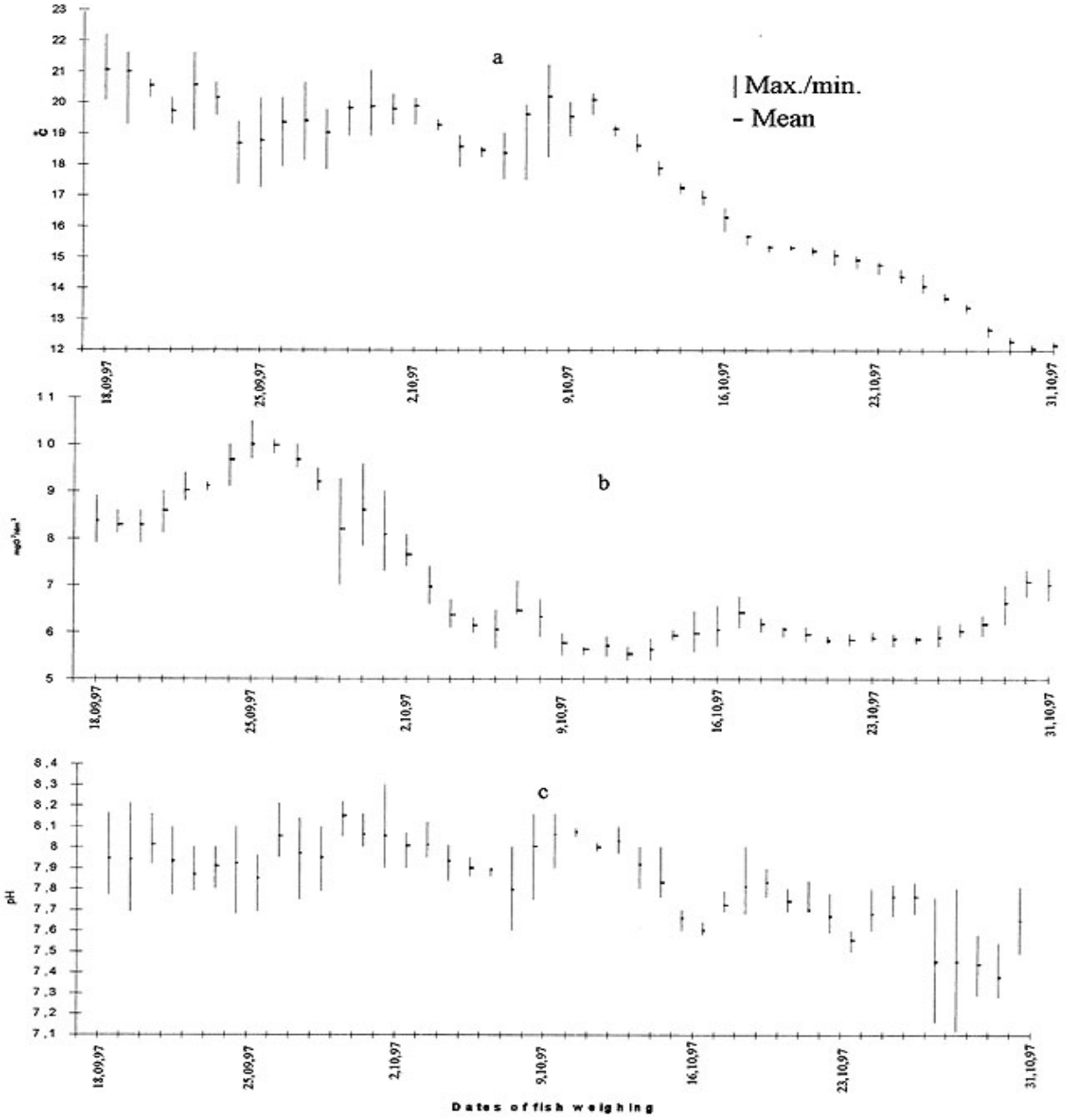
Throughout the period of the experiment, both groups of fish were fed two commercial Danish feeds: the Dana–ex 4.85 and the Safir the pellet size of which ranged within 3–5 mm. The feeds were offered daily (6–8 times within 9^{00} – 15^{00} hours).

To analyse the dynamics of the major culture efficiency indices and to adjust the feed ration, all the fish in each cage were weighed, to 0.05 kg, at 7–d intervals (at 8–d intervals at the terminal stage of the experiment). Based on the results, interim values of the food conversion rate (FCR) and specific growth rate (SGR) were calculated. At the end of the feeding experiment, the values of apparent net protein utilisation (aNPU), apparent fat utilisation (aFU), and energy retained (ER) were calculated (Filipiak and Trzebiatowski 1992). The results were subjected to the LSD test (at P=0.05) to check for statistical significance of differences between the experimental treatments.

At the beginning and on termination of the experiment, 4 individuals were picked out from each experimental treatment to determine, following total homogenisation, contents of crude protein (Kjeltec 1026), lipids (Soxhlet ether ethyl extraction), dry matter (12 h drying at 105°C), and ash (10 h combustion at 550°C). The feed was assayed in the identical way, the carbohydrate content being calculated from the difference between the dry weight and the sum of crude protein, lipids, and ash contents. The feed gross energy level was calculated by using appropriate conversion factors (5.65 Kcal·g^{-1} crude protein; 9.45 Kcal·g^{-1} lipids; and 4.1 Kcal·g^{-1} carbohydrates; Brody 1945) for the feed components.

The cooling water temperature, oxygen content, and pH were automatically recorded. Daily means and ranges of the environmental factors are shown in Fig. 1.

Figure 1. Diurnal changes in temperature (a), oxygen content (b) and pH (c) in cooling water during the experiment



RESULTS AND DISCUSSION

Feed characteristics

The feeds used, Dana–ex 4.85 and Safir, were commercial extruded trout mixes made in Denmark. The assays showed the feeds to differ substantially in terms of their chemical composition. In comparison with the former, the latter showed, i.a., a higher (by 3.7%) crude protein content, a lower (by 3.8%) lipid level, and a lower (by 296.3 Kcal·g^{-1}) gross energy content (Table 1). Previously, the two feeds were successfully used in experiments involving Siberian sturgeon fry (Filipiak et al. 1997, 1998).

Table 1. Chemical composition (%) of feeds offered to the Russian × Siberian sturgeon and sterlet during the experiment

Component	Feed	
	Dana-ex 4,85	Safir
Dry matter	93.8	91.0
Crude protein	41.3	44.0
Fat	23.3	19.5
Ash	7.0	7.4
Carbohydrates	22.1	20.2
Gross energy (Kcal·g^{-1})	5470.3	5173.6

Environmental conditions

Throughout the experiment, the water physical and chemical parameters monitored did not deviate from values recorded during the same period of time (September–October) in previous years. The daily mean water temperature, oxygen content, and pH varied within 12.2–23°C; 5.39–10.5 mg·dm^{-3}; and 7.1–8.3, respectively (Fig. 1a–c). The optimum temperature for growth of both the Siberian sturgeon and the sterlet, determined by Micheev (1982) to be 20–22°C, was maintained at that level for 16 days only and was clearly lower during the remaining period of time.

Culture results

Following delivery to the Fisheries Research Station and stocking in cages, the two groups of fish were allowed to acclimate to new conditions. Observations made in previous years proved two weeks to be a period of time sufficient for a full acclimation of different acipenserid species to cooling water conditions, the successful acclimation manifesting itself as, i.a., intensive feeding in cages.

The unstable environmental conditions prevailing during the experiment, the temporal variability in water temperature in particular, clearly affected the culture efficiency indices in the two groups. During the first two stages of the experiment, when the water temperature was at its highest (19.5–23°C), large differences in culture indices between the two groups were recorded (Fig. 1a; Table 2). Compared to the hybrid, the sterlet showed much worse values of SGR and FCR. As mentioned by Hochleithner (1996) and Prokes et al. (1997), the species

grows at a much slower rate than do both the Siberian and Russian sturgeons (the differences during the fry period may be as high as 250–350%). It should be emphasised that, at the first stage of the experiment, the Dana–ex 4.85 yielded much lower FCR values in both groups. During the subsequent two stages (terminating on 9 and 16 October), the feed mentioned produced lower FCR values in both groups as well, although the difference with respect to the Safir was less pronounced. As of mid–point of the experimental period, a more and more clear reduction in SGR was evident in both groups, concurrent with the water temperature dropping from 20 to 12°C. It is interesting to note that, contrary to what was observed in the initial, warmer, part of the experimental period, during its second – cooler – part it was the sterlet that showed clearly higher SGR values. For instance, during the final two weeks of feeding the Dana–ex 4.85, the mean SGR values were 2.09 and 1.11 %/day in the sterlet and the hybrid, respectively, the respective values obtained with the Safir being 1.82 and 1.30%/day. The values shown above as well as the data contained in Table 2 point to the fact that the relatively low water temperature (12–17°C) was not appropriate for the Russian × Siberian sturgeon hybrid which, similarly to the parental species, seems to be more thermophilous than the sterlet. As reported by Arlati and Bronzi (1990), the latter can be successfully cultured at 15–20°C.

Table 2. Mean individual weight, specific growth rate (SGR), and food conversion ratio (FCR) of Russian × Siberian sturgeon hybrid and sterlet at different stages of the experiment

Species and feed	Date of fish weighing						
	18 Sep	25 Sep	2 Oct	9 Oct	16 Oct	23 Oct	31 Oct
	mean individual weight (g)						
Sterlet-D*	23.75	29.07	37.10	49.59	64.0	75.90	87.55
Sterlet-S*	25.21	29.96	37.29	47.81	59.92	70.14	78.82
Hybrid-D*	31.67	43.25	58.97	77.94	96.94	111.56	114.52
Hybrid-S*	30.55	40.02	52.75	67.62	82.23	95.72	100.03
SGR (%/day)							
Sterlet-D*		2.89^{c}	3.48^{c}	4.15^{a}	3.65^{a}	2.44^{a}	2.04^{a}
Sterlet-S*		2.47^{d}	3.13^{d}	3.55^{b}	3.22^{b}	2.25^{ab}	1.67^{b}
Hybrid-D*		4.45^{a}	4.43^{a}	3.98^{a}	3.12^{b}	2.01^{c}	0.37^{d}
Hybrid-S*		3.86^{b}	3.94^{b}	3.55^{b}	2.79^{c}	2.17^{bc}	0.63^{c}
SE		0.14	0.07	0.08	0.16	0.06	0.14
FCR							
Sterlet-D*		2.04^{b}	1.91^{b}	1.35^{a}	1.13^{a}	1.31^{a}	2.57^{a}
Sterlet-S*		2.56^{c}	1.77^{b}	1.58^{a}	1.3^{bc}	1.49^{a}	2.71^{a}
Hybrid-D*		1.20^{a}	1.13^{a}	1.14^{a}	1.18^{ab}	1.46^{a}	16.91^{b}
Hybrid-S*		1.47^{a}	1.27^{a}	1.33^{a}	1.38^{c}	1.45^{a}	14.76^{b}

SE		0.11	0.03	0.13	0.10	0.06	1.54
Daily food ration (%W$^{0.8}$)		3.00	3.00	2.75	2.50	2.00	2.00

*D, Dana-4.85, S, Safir.
Results in a column denoted by the same letters are not significantly different (P=0.05)

The interim results of the 43–d culture were reflected in the final outcome of the experiment. Rather low mortality rates were recorded in different experimental treatments, the highest mortality (1–8%) being found in the Dana–ex 4.85–fed sterlet; most frequently, the fish died after getting entangled in cage walls. As shown by the data in Table 3, the highest mean individual weight increments were obtained by the Dana–ex 4.85–fed sterlet (3.7–fold increase) and hybrids (3.6–fold increase). Those fish fed the Safir increased their mean individual weight by a factor of 3.1 (sterlet) and 3.3 (hybrids). The better utility of the Dana–ex 4.85 in feeding the two fish types is indicated also by the FCR values, lower by about 12% than those obtained in the Safir. The aNPU values, too, were better by about 3.5% (in absolute values) for the Dana–ex 4.85 than for the Safir. No statistically significant differences between the feeds could be found with respect to aFU; however, statistically significant differences in aFU were found between the fish groups, the sterlet showing aFU values higher by 5.9% on the average than the hybrid. The difference was brought about by, i.a., the higher body lipid content in the sterlet than in the hybrid (Table 4).

Table 3. Specific growth rate (SGR), food conversion ratio (FCR), apparent Net Protein Utilisation (aNPU), apparent fat utilisation (aFU), and energy retained (ER) of Russian × Siberian sturgeon hybrid and sterlet on termination of the experiment

Species feed	Mortality		SGR (%/day)	FCR	aNPU (%)	aFU (%)	ER (%)
	no. of ind.	%					
Sterlet-D*	26	10.8	3.03^{a}	1.57^{a}	20.9^{a}	42.55^{a}	26.18^{a}
Sterlet-S*	21	6.7	2.65^{c}	1.76^{b}	17.45^{b}	41.99^{a}	23.42^{ab}
Hybrid-D*	12	5.4	2.99^{a}	1.53^{a}	21.99^{a}	35.7^{b}	23.87^{ab}
Hybrid-S	14	5.8	2.76^{b}	1.71^{b}	18.36^{ab}	37.01^{b}	22.08^{b}
SE			0.05	0.07	0.89	1.53	1.00

For explanations see in Table 2.

Table 4. Body chemical composition (%) of sterlet and Russian × Siberian sturgeon hybrid at the start and on termination of the experiment

Species feed	Dry matter (%)	Crude protein* (%)	Lipids* (%)	Ash* (%)
Start of experiment				
Sterlet	22.23	12.06	7.89	2.26

Hybrid	24.38	12.28	9.97	2.13
End of experiment				
Sterlet-D*	28.32	13.05	13.16	2.07
Sterlet-S*	31.47	12.98	12.13	2.13
Hybrid-D*	27.48	13.41	11.98	2.11
Hybrid-S*	26.98	13.29	11.55	2.17

* – wet weight.
For explanations see in Table 2.

Noteworthy is also the fact that the feeds used in the experiment were rich in both crude protein and fat, the levels being appropriate for feeding the rainbow trout. No data on the dietary crude protein requirement of the sterlet and Russian sturgeon could be found in the available literature. According to Kauschik et al. (1989), the feeds to be offered to the Siberian sturgeon should contain 36–42% crude protein. Other authors narrow the protein optimum range of acipenserids to about 40% (at a 13% lipid level) (Moore et al. 1988). According to Skliarov et al. (1984), the lipid level in a feed offered to bester (a beluga × sterlet hybrid) should not exceed 8%. Observations on *A.transmontanus*, reported by Hung and Lutes (1988), showed that higher weight increments had been obtained with a feed containing 15% fat derived from a mixture of equal parts (5% each) of fish oil, corn oil, and lard. It seems that the demand for feed protein and fat, hence energy, by the Russian x Siberian sturgeon hybrid and sterlet cultured in cooling water should be higher than that reported by the authors referred to above. For this reason, the energy and protein demand of the fry of both acipenserids under study were met much better by the Dana–ex 4.85 than by the Safir.

CONCLUSIONS

1. No significant differences in final values of FCR and SGR could be found between fry (0+) of the Russian × Siberian sturgeon and sterlet.
2. Better effects of culture were obtained when feeding the two acipenserids the Dana–ex 4,85, a more energy–rich feed.
3. Under a cooling water culture, a higher growth rate at a higher water temperature (19–23°C) was recorded in the hybrid, while the sterlet grew better in a period of a lower water temperature (12–18°C).

REFERENCES

1. Arlati G., Bronzi P., 1990, La stourionicultura in Italia. Conf. Internazionale di Acquacoltura. Sez. Poster. Nr. 5. (ENEL/CRTN Rel. E4/90/23). Acquacoltura ’90 – Verona.
2. Brody S., 1945, Bioenergetics and growth. Reinhold (ed.). New York.
3. Bogdan E., Mastynski J., 1993, Acipenserid culture in Poland, Prz. Ryb. 1: 24–26. [In Polish].
4. Filipiak J., Trzebiatowski R., 1992: Effects of feed mixes enriched with different fats on basic efficiency indices of carp fry culture in cooling water, Zesz. Nauk. AR Wroc. 218: 81–88. [In Polish].
5. Filipiak J., Trzebiatowski R., 1995: Preliminary results of rearing Acipenserid fish in cages in cooling water. Intern. Conf.: News fish species in aquaculture. Szczecin 23–24 Oct 1995. Spec. Publ. Agricult. Univ. of Szczec.: 83–84.

6. Filipiak J., Trzebiatowski R., Sadowski J., 1996, A potential for intensive cage culture of some acipenserids in cooling water. Conf. 9–11 Sep 1996, PKosz.: 39–40.
7. Filipiak J., Sadowski J., Trzebiatowski R. 1997, Feeding of the Siberian sturgeon (*Acipenser baeri*) with different commercial feeds in cooling water. Zesz. Nauk. AR Szczec. 179: 5–13.
8. Filipiak J., Sadowski J., Trzebiatowski R., Plust M. 1998, Effects of different conditions of wintering and feeding intensity on results of rearing the Siberian sturgeon (*Acipenser baeri*) in cooling water. Folia Univ. Agric. Stetin. 184 Piscaria (24): 25–34.
9. Hochleithner M., 1996, Störe–Verbreitung, Lebensweise, Aquacultur. Österreichischer Agrarverlag – Ratgeber (ed.).
10. Hung S. S. O., Lutes P. B., 1988, A preliminary study on the non essentiality of lecithin for hatchery–produced juvenile white sturgeon (*Acipenser transmontanus*). Aquaculture, 80: 147–153.
11. Kauschik S. J., Luquet P., Blanc D., Paba, 1989, Studies on the nutrition of Siberian sturgeon, *Acipenser baeri*. I. Uttilization of digestible carbohydrates by sturgeon. Aquaculture, 76: 97–107.
12. Kolman R., 1993, A potential for developing sturgeon production in Poland, Kom. Ryb. 4: 21–23. . [In Polish].
13. Kolman R., Falkowski P., Sidorowicz R. 1994, Sturgeon culture in trout ponds, Kom. Ryb. 2: 1–3. . [In Polish].
14. Kolman R., Stanny L., Szczepkowski M., 1996, Comparison of effects of rearing sturgeon fry using various starters. Arch. Ryb. Pol. 4: 45–56.
15. Micheev V. P., 1982: Sadkovoe vyraščivanie tovarnoj ryby. Legkaja i Piščevaja Promyšlennost. Moskva.
16. Moore B. J., Hung S. S. O., Medrano J. F., 1988, Protein requirements of hatchery produced juvenile white sturgeon (*Acipenser transmontanus*). Aquaculture 71:235–245.
17. Prokeš M., Barus V., Penaz M. 1997, Comparative growth of juvenile sterlet (*Acipenser ruthenus*) and Siberian sturgeon (*A. baerii*) under identical experimental conditions. Fol. Zoolog. 46,2: 163–176.
18. Pyka J., 1994, Feeding of the Siberian sturgeon (*Acipenser baeri*) fry in a pond culture, Kom. Ryb. 3:1–2. [In Polish].
19. Skliarov V. J., Gamygin E. A., Ryzkov L. L., 1984, Kormlenije ryb, Legkaja i Piščevaja Promyšlennost.: 117. Moskva.

Submited:

Jarosław Filipiak[1], Przemysław Czerniejewski[1],
Jacek Sadowski[2], Rajmund Trzebiatowski[2]
[1]Department of Fisheries Management in Inland Waters
Agricultural University of Szczecin
Poland
[2]Department of Aquaculture
Agricultural University of Szczecin
Poland