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FEEDING OF SIBERIAN STURGEON *Acipenser baeri* (Brandt) UNDER POND CONDITIONS

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A B S T R A C T. Diet composition and feeding intensity of pond-reared Siberian sturgeon fry 52-130 days old (average body mass 0.72-50.45 g, and average body length 50.2-215.4 mm) were analysed. Insecta larvae predominated in the gut contents of the fish, mainly *Chironomidae* and Ephemeroptera *(Clo on dipterum)*. Additionally, some large cladocerans were found such as *Ceriodaphnia sp., Moina sp., Daphnia longispina* and *Simocephalus sp.* The weight of Insecta larvae eaten by the fish determined feeding intensity coefficients.

Key words: STURGEON, FRY, FOOD, POND.

INTRODUCTION

Share of sturgeon in world's fish production has gradually decreased over a long time. At the beginning of the century about 40 thousand tons of sturgeon were harvested per year from the Caspian Sea basin alone (Grigoriev 1974). At present only 25 thousand tons per year are obtained from the Caspian, Azov and Black seas together, and 90% of this amount is harvested in the countries of the former Soviet Union (Hochleithner 1991). Common sturgeon *(Acipenser sturio* L.*)*, the only species of Acipenseridae which occured in Poland up to the sixties, became extinct despite rigorous protection in force from 1936 (Michalski 1969).

Considerble decrease of sturgeon population density results from improper stock management (overfishing) and deterioration of environmental conditions, mainly pollution, water level fluctuations, and river regulation (Bartel 1992, Rochard, Castelnand, Lepage 1990).

In many countries, among other in Japan, USA, and in the countries of the former USSR, as well as in Western Europe (France, Germany, Italy), sturgeons are reared under fully controlled conditions: in thermally controlled tanks, most often with water recirculation systems (Gordienko, Afonic, Soldatova 1970, Reichle, Bercsenyi, Bergler 1991, Sercova 1991). Much attention is paid to rearing of sturgeons and their hyb-

rids in fish ponds, in polyculture with common carp, tench, and phytophagous fish (Bercsenyi, Bergler 1991, Elyseva 1974, Knoschke 1969, Kryleva, Sokolova 1976, Nikiforova, Lysina 1971, Merla 1975, Schlotfeld 1971, Slivka 1974 a, b, Slivka, Tichonova 1977, Szablin 1973).

In Poland, rearing of sturgeons started in 1992 (Kolman 1993 a, b). The first attempts involved stocking material production and rearing of market-size Russian sturgeon, *Acipenser guldenstaedti* (Brandt), and bester - intergeneric hybrid of great sturgeon, *Huso huso* L., and sterlet, *Acipenser ruthenus* L.

Fish rearing is carried out in tanks supplied with thermally controlled water, in water recirculation systems, and in cages situated in heated waters or in trout ponds. Fish are fed with comercial feeds (Kolman *et al.* 1994).

Siberian sturgeon seems one of the most interesting species, particularly in terms of ecology. The fish show considerable ecological, and especially feeding versatility. They are able to live and grow well in various climatic zones (Milstein 1975). Siberian sturgeon grow even better in European waters comparing to their native environment (Maljutin, Stroganova 1971).

The species was extensively studied, however, little attention was paid to its natural diet, especially of the juveniles. Some general information on the Siberian sturgeon feeding can be obtained from the papers of Maljutin, Stroganova (1971), and Ruban, Aklimova (1991). Rearing of Siberian sturgeon (and bester) under pond conditions seems most promising, so it is necessary to undertake detailed studies on the natural diet of sturgeons at various stages of development.

The aim of the present study was an assessment of the variability of natural food composition and feeding intensity of Siberian sturgeon fry under pond conditions.

MATERIAL AND METHODS

The study of the diet of Siberian sturgeon fry was carried out in fish stocking centre Montowo, in Grzmięca Fish Farm (Brodnickie Lake District), from June 5 to August 22, 1994.

Sturgeon fry aged 52-130 days were used in the experiment. Average individual body weight of fish varied from 0.72 g (0.59-0.94 g) to 50.45g (45.36-65.70 g), and the average body length from 50.2 mm (45.5-57.0 mm) to 215.4 mm (200.0-240-5 mm). The

TABLE 1

The results of the experiment

Date	Fish age (days)	n	Lc. (mm)	Lc_1-Lc_n(mm)	W (g)	W_n-W_2 (g)
5.06.	52	10	50.2	45.5 - 57.0	0.72	0.59 - 0.94
8.06.	55	12	51.5	46.0 - 58.0	0.99	0.84 - 1.29
11.06.	58	14	52.2	46.5 - 65.5	1.00	0.85 - 1.51
14.06.	61	14	60.0	56.5 - 66.0	1.24	1.00 - 1.55
17.06	64	15	62.3	58.0 - 67.0	1.32	1.17 - 1.58
20.06	67	12	65.3	59.5 - 75.0	1.56	1.18 - 2.11
27.06	74	13	68.5	60.0 - 85.5	1.75	1.28 - 2.50
4.07	81	14	69.8	62.5 - 88.5	2.00	1.50 - 2.85
11.07	88	12	130.2	88.5-142.2	7.50	6.20 - 8.50
18.07	95	10	161.0	140.0-180.0	13.30	7.59-18.55
25.07	102	13	165.3	153.0-190.0	17.47	11.74-27.10
1.08	109	12	180.3	176.0-195.5	23.96	18.99-28.52
8.08	116	10	209.5	186.5-230.0	38.85	22.50-49.86

fish were obtained from an initial rearing earthen pond of 0.03 ha, 1.7 m maximum depth, and 0.8 m average depth. The results are shown in Table 1.

The fish were sampled using a dip-net every 3 or 7 days, about 9 A.M. They were immediately fixed in 4% formaldehyde solution. Water temperature measured at 1 P.M. was assumed as a diurnal mean. Simultaneously, zooplankton, benthic and vegetation-dwelling fauna were sampled.

Zooplankton samples were collected from 5 sites using 1 dm^3 Patalas sampler. Volume of each sample was equal to 5 dm^3. Density of the animals was calculated per 1 dm^3.

Benthic animals were sampled from 5 sites using a pipe sampler of 20 cm^2 surface area. Each sample contained benthos from 100 cm^2 of the bottom. The number of organisms was calculated per 1 m^2. Vegetation-dwelling *Cloon dipterum* larvae were counted within five 400 cm^2 squares covered with a dense net placed over the bottom and the vegetation.

The fish were measured with 0.5 mm (l. c.) and weighed with 0.01 g accuracy. Then, the gut contents were analysed. All the animals found were counted and measured up to 0.01 mm, and then their weight was estimated using convertion tables (Starmach 1955) and own calculations (for Ostracoda and Insecta larvae).

Composition of the diet of Siberian sturgeon was calculated in per cents of all food organisms found in the gut contents. Frequency of each component was calculated as per cents of digestive tract filling. Per cent of each component was also calculated in terms of weight. The food consumption coefficient "I" was determined as a per cent of fish body mass in order to assess feeding intensity.

RESULTS

FOOD CONDITONS IN THE PONDS

Zooplankton. The community consisted of 5 taxa of Cladocera: *Bosmina longirostris* (O. F. M ller), *Daphnia longispina* (O. F. M ller), *Ceriodaphnia sp.*, *Moina sp.*, and *Simocephalus sp*, and one copepod, *Eucyclops serrulatus* (Tab. 2). Small sized *Bosmina longirostris* predominated in all samples and comprised over 50% of the zooplankton. *Daphnia longispina* was also very numerous and comprised 10.1-50% of the zooplankton, with the exception of 3 summer samples in which this cladoceran was absent. The other Cladocera *(Ceriodaphnia sp., Moina sp., Simocephalus sp.)*, and the only Copepoda representative, *Eucyclops serrulatus*, were only sporadically found in the samples, and comprised under 1%, sometimes 1.1-5%, and very rarely 5.1-10.0% of total zooplankton numbers.

Insect larvae. Species diversity of the community was poor (Tab. 3). In terms of numbers Chironomidae larvae predominated, and among them *Chironomus plumosus* Linn were much less abundant. In summer (July-August) small Ostracoda: *Cyclocypris laevis* (O. F. M ller), *Condona candida* (O. F. M ller) and *Cypris pubera* (O. F. M ller) occurred very abundantly and dominated in the community.

FISH DIET COMPOSITION

The following invertebrate taxa were found in the digestive tract contents of the Siberian sturgeon fry: Cladocera - *Ceriodaphnia sp., Moina sp., Daphnia longispina, Simocephalus sp.*; Ostracoda - *Cyclocypris laevis, Condona candida, Cypris pubera*, and insect larvae - Chironomidae and *Clo on dipterum*. *Bosmina longirostris*, very abundant in water, was avoided by the fish. Planktonic crustaceans predominated only in terms of number in food of fry that had just started active feeding, and comprised from 75.4% to 10.0-10.6% of the food organisms. In older fish, they subdominated (18.7-33.9% of

TABLE 2

Zooplankton composition in the pond ind./dm^3 (1), % (2)

Taxon-size (mm)	5.06		8.06		11.06		14.06		17.06		20.06		27.06		4.07		11.07		18.07		25.07		1.08		8.08		15.08		22.08	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bosmina longirosris 0.2-0.5	800	70.2	1000	65.1	1134	63.0	1000	65.2	500	56.8	400	66.5	350	65.4	450	86.9	500	93.5	600	97.9	650	97.9	600	97.1	650	97.4	700	98.1	500	99.2
Daphnia longispina 1.0-2.0	300	26.3	500	32.6	617	34.3	450	29.4	300	34.0	100	16.6	85	15.9	10	1.9	-	-	-	-	-	-	-	-	-	-	5	0.7	2	0.4
Ceriodaphnia sp. 0.8-1.2	10	0.9	16	1.0	20	1.2	15	1.0	34	3.9	50	8.3	40	7.5	8	1.6	5	0.9	3	0.5	-	-	-	-	-	-	2	0.3	-	-
Moina sp. 0.8-1.5	15	1.3	10	0.7	15	0.8	68	4.4	22	2.5	30	5.0	35	6.5	20	3.9	15	2.8	5	0.8	-	-	-	-	3	0.4	2	0.3	-	-
Simocephalus sp. 1.5-2.5	-	-	-	-	-	-	-	-	-	-	5	0.8	15	2.8	25	4.7	10	1.9	5	0.8	14	2.1	18	2.9	15	2.2	4	0.6	2	0.4
CLADOCERA-total	1125	98.7	1526	99.3	1786	99.3	1533	100	856	97.0	585	97.2	525	98.1	513	99.0	530	99.1	613	100	664	100	618	100	668	100	713	100	504	100
Eucyclops serrulatus 1.0-1.5	15	1.3	10	0.7	15	0.7	-	-	25	2.8	17	2.8	10	1.9	5	1.0	5	0.9	-	-	-	-	-	-	-	-	-	-	-	-
ZOOPLANKTON-total	1140	100	1536	100	1801	100	1533	100	881	100	602	100	535	100	518	100	535	100	613	100	664	100	618	100	668	100	713	100	504	100

TABLE 3

Composition of benthos and vegetation-dwelling animals in the pond

Taxon-size (mm)	5.06		14.06		27.06		11.07		25.07		8.08		22.08	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Chironomus plumosus 10-25	2610	86.7	1300	83.7	1000	85.5	550	11.8	600	15.7	600	31.7	700	31.8
Chironomidae indetermined 7-12	290	10.0	200	12.9	150	12.8	100	2.2	200	5.2	250	12.2	300	13.6
Cloeon dipterum 5-9	100	3.3	50	3.2	20	1.7	5	0.1	10	0.3	150	7.3	200	9.1
LARVAE *INSECTA* total	3000	100	1550	100	1170	100	655	14.1	810	21.2	1050	51.2	1200	54.5
Ostracoda 1-3	-	-	-	-	-	-	4000	85.9	3000	78.8	1000	48.8	1000	45.5
Total	3000	100	1550	100	1170	100	4655	100	3810	100	2050	100	2200	100

food), or were rare (2.6%), and sporadical (0.1%)(Fig. 1). Their share in total weight of consumed organisms was low and did not exceed several per cents (Fig. 2).

Sturgeon fry fed mostly on Insecta larvae, mainly on Chironomidae (most commonly found in the pond), among which *Chironomus plumosus* was most abundant. Insects predominated in sturgeon gut contents, comprising from 66.1 to 93.9% of the total number of food organisms. Their share was lower only in the initial period of active feeding (24.6%), and they were rarely found in the digestive tracts of the fish in July, when the fish consumed mainly Ostracoda (Fig. 1). Share of insect larvae in total fish food weight fluctuated usually from 91.2 to 99.9%, and only sometimes from 16.5 to 21.2%, or dropped down to 6.1%. (Fig. 2).

Unlike zooplankton, insect larvae were found in the digestive tracts of all the fish examined (Fig. 3).

FEEDING INTENSITY

Food consumption indices showing feeding intensity of Siberian sturgeon fry decreased with fish growth (Fig. 4). This followed a common physiological rule, according to which metabolic rate decreases during growth of an organism. In Siberian sturgeon fry of individual body weight between 0.6 to 60 g food uptake significantly correlated with fish size ($p<0.05$). Values of the food consumption indices were determined, mainly insect larvae, Chironomidae most of all.

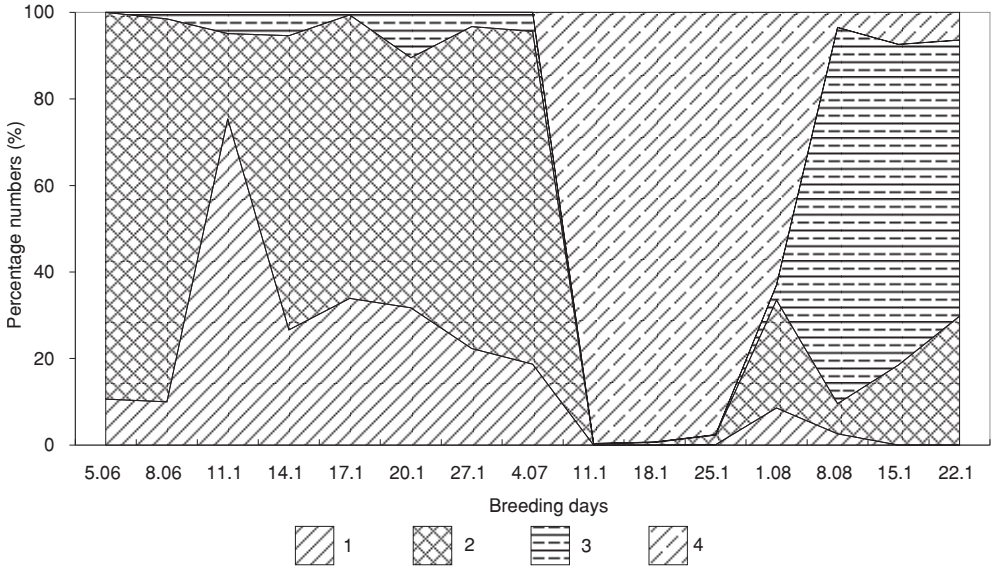

Fig. 1. Dynamics of Siberian sturgeon fry food composition (expressed as a percentage of total number of eaten organisms)

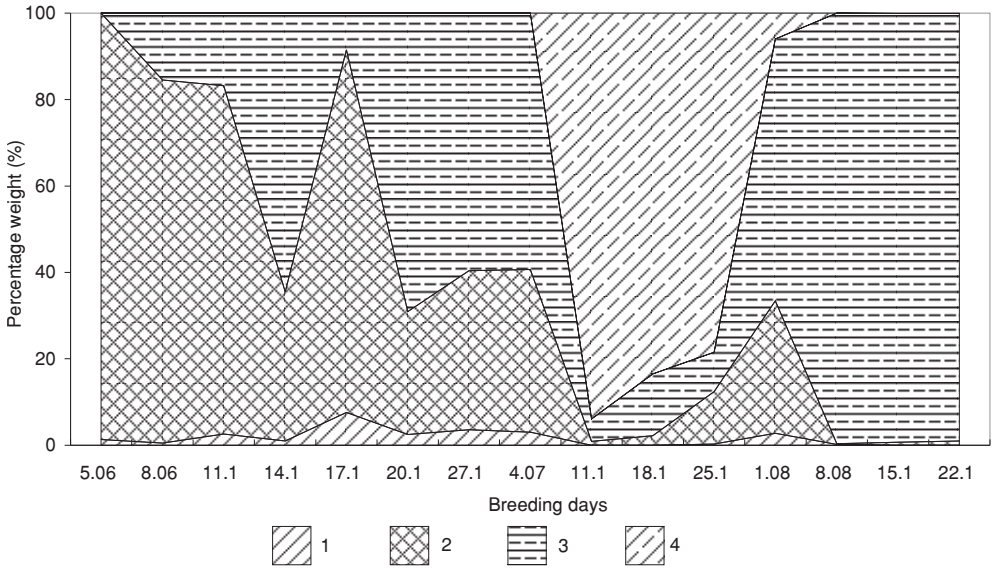

Fig. 2. Dynamics of Siberian sturgeon fry food composition (expressed as a percentage of total weight of eaten organisms)

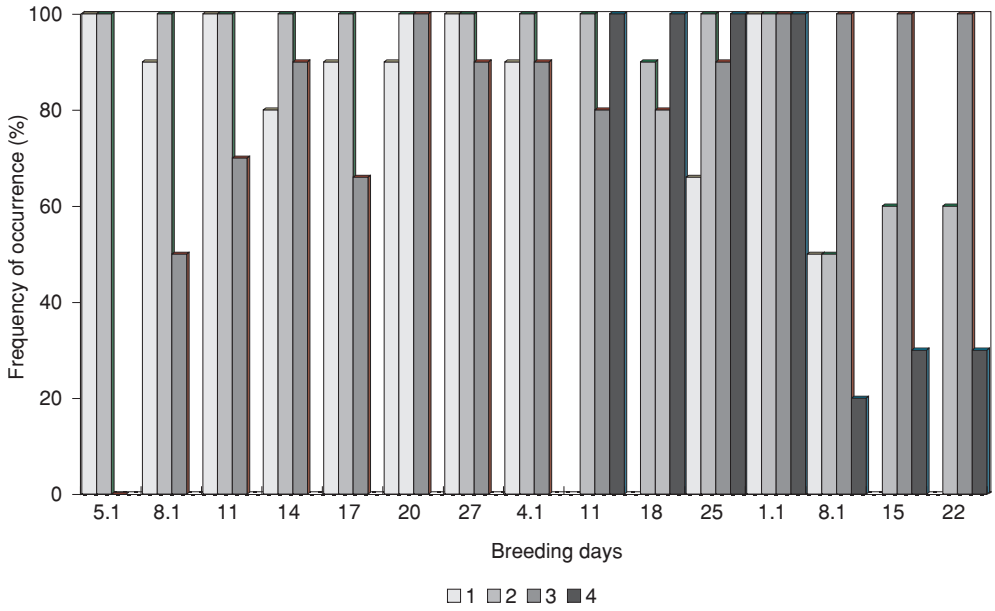

Fig. 3. Frequency of zooplankton and Insecta larvae in the food of Siberian sturgeon fry

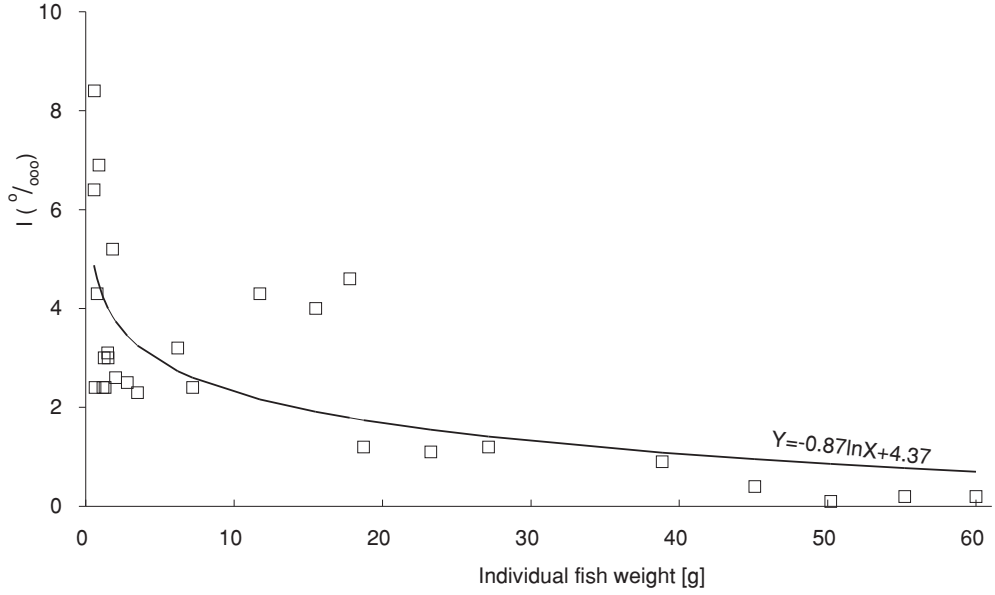

Fig. 4. Changes of the food composition coefficient versus Siberian sturgeon fry body weight

RECAPITULATION

The results of the study indicate that Siberian sturgeon fry fed mainly on the bottom animals, among which Chironomidae predomianted, mostly *Chironomus plumosus*. Due to abundance of this species in the pond community, Siberian sturgeon became an intensely feeding stenophagous fish. The fish diet was little diversified in terms of species composition, and sufficient in terms of calorific value. Maljutin, Stroganova (1971), and Ruban, Aklimova (1991) found that Siberian sturgeon juveniles and adults showed considerable feeding plasticity. Thus, it seems that under the conditions of competition for food, for example in polyculture with more active fish such as carp, Siberian sturgeon may become a stenophagous fish of poor feeding intensity. Feeding versality of Siberian sturgeon may play an important role in pond rearing in polyculture with cyprinid fishes. In ponds, some organisms are avoided or little utilised by the latter. Thus, the sturgeon is able to shift to these organisms and to avoid competition with more active common carp, which would result in better utilisation of the pond fod resources.

CONCLUSIONS

1. Pond-reared sturgeon fry aged from 52 to 130 days, of average individual body mass 0.72-50,49 g, and average body length 50.2-215.4 mm, fed mainly on Insecta larvae - mostly on *Chironomus plumosus*, with an addition of planktonic crustaceans (Cladocera), and ocasionally Ostracoda.
2. Siberian sturgeon fry reared under monoculture pond conditions was a stenophagous fish of high feeding activity.
3. Feeding intensity indices decreased with fish growth and were detrmined by the amount of Insecta larvae eaten by the fish.

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STRESZCZENIE

ODŻYWIANIE SIĘ JESIOTRA SYBERYJSKIEGO *Acipenser Baeri* (Brandt) W WARUNKACH CHOWU STAWOWEGO

W pracy omówiono skład pokarmu narybku jesiotra syberyjskiego oraz jego zmienność w miarę wzrostu ryb, w warunkach chowu stawowego.

W treści pokarmowej narybku w wieku od 52 do 130 dni i średniej masie jednostkowej od 0,72 do 50,45 g i średniej długości ciała od 52,2 do 65,3 mm, zdecydowanie przeważały larwy Insecta, a wśród nich Chironomidae. Pokarm dodatkowy stanowiły duże formy zooplanktonu: *Ceriodaphnia* sp., *Moina* sp., *Daphnia longispina* i *Simocephalus* sp. W okresie masowego występowania w stawie Ostracoda, skorupiaki te były chętnie pobierane przez narybek jesiotra syberyjskiego.

Przedstawiono ponadto zmienność wskaźników spożycia pokarmu, określających intensywność żerowania. 0 ich wielkości decydowała masa zjadanych larw *Insecta*.

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