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TWENTY-FOUR HOUR FEEDING CYCLE OF SIBERIAN STURGEON (*ACIPENSER BAERI* BRANDT) REARED IN A POND MONOCULTURE

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ABSTRACT. The present study evaluated the weight composition of Siberian sturgeon food, the species feeding intensity in a 24-hour cycle (as consumption index I - ‰), and its daily food ration (as a percentage of average fish body mass). The study was conducted on fish in their first year of life which were being reared in a 0.05 ha pond with a maximum depth of 2 m and an average depth of 1.2 m. Chironomid larvae, mainly *Chironomus plumosus* L., were the principal food component found in the digestive tracts of all the fish in all the samples. Some butterfly and stone-fly larvae were also noted. Feeding intensity reached the highest values at night. Calculated according to Thorpe (1977), the daily food ration of Siberian sturgeon with an average body mass of 20.3 g and at an average daily water temperature of 14.2°C was 5.4% of fish body weight.

Key words: SIBERIAN STURGEON, FOOD, DAILY FOOD RATION, POND REARING

INTRODUCTION

Siberian sturgeon *Acipenser baeri* Brandt is an interesting species, especially in terms of its habitat ecology. It exhibits high ecological and feeding adaptability which enables the species to live and grow satisfactorily in various climatic zones (Milstein 1975). Sturgeon are being reared under controlled conditions, i.e. in thermally controlled tanks that are usually part of a water recirculation system, in many countries, including the USA, Japan, the former USSR, France, Germany, Italy and Poland (Gordienko et al. 1970, Reichle et al. 1991, Sercova 1991, Kolman 1993). Sturgeon and hybrids of them are also often pond-reared in monocultures or polycultures with other non-predatory fish (Knosche 1969, Nikiforova and Lytkina 1971, Schlotfeldt 1971, Shablin 1973, Elyseva 1974, Slivka 1974a, b, Kryleva and Sokolova 1976, Berczenyi and Bergler 1991). Our earlier studies (Pyka and Kolman 1997, 1999) revealed that Siberian sturgeon and bester, a hybrid of beluga *Huso huso* (L.) and sterlet *Acipenser ruthenus* L., are promising species for Polish pond aquaculture.

Siberian sturgeon has been studied quite thoroughly, yet little is known about how it feeds on natural food, especially during its early life period. This most likely stems from the fact that such investigations require labor-intensive material collec-

tion and analysis. Some general data on Siberian sturgeon feeding under natural conditions were reported by Maljutin and Stroganova (1971), Sokolov and Vasilev (1989), and Ruban and Alkimova (1991).

The aim of the present study was to analyze Siberian sturgeon food composition over a 24-hour period in late summer (at the beginning of September), determine its quantitative variability and attempt to evaluate the daily food ration.

MATERIAL AND METHODS

The 24-hour feeding cycle and daily food consumption were evaluated for Siberian sturgeon in their first year of life. The average weight of the specimens studied was 20.3 g (11.1-31.0 g) and their average total length was 19.3 cm (16.8-22.0 cm). The fish were sampled on September 3-4, 1998 from a 0.05 ha pond with a maximum depth of 2 m and an average depth of 1.2 m at the Montowo Fish Farm in central Poland. The facility belongs to the Toruń section of the Polish Anglers Union.

The fish were harvested at three-hour intervals from behind the pond outlet by taking advantage of the sturgeon's negative tropism – it reacts rapidly to water movement and will swim downstream even with the slight water flow. The water temperature was measured when the fish were collected. They were immediately preserved in a 4% formaldehyde solution. They were then blot-dried, measured to the nearest 0.1 cm and weighed to the nearest 0. 1 g. The digestive tracts were isolated using preparatory needles under binocular magnification. Their contents were weighed to the nearest 0.01 g, and the food organisms were identified.

The sturgeon food composition is presented in terms of weight and the consumption indices were calculated (I - ‰). The contents of 50 digestive tracts were analyzed from specimens that were harvested over a 24-hour period, with an average of seven fish in each sample.

The daily food ration of Siberian sturgeon was calculated for an average daily water temperature of 14.2°C using Thorpe's method (Thorpe 1977), which had been previously used for non-predatory fishes at lower temperatures (Pyka 1999), according to the following formula:

$$C = S_2 - S_1 + A \qquad (1)$$

where:

C – amount of food consumed by the fish over t hours between consecutive samplings ($t_2 - t_1$),

S_1, S_2 – relative contents of digestive tract at the beginning (t_1), and at the end (t_2) of the time interval,

A – food evacuation over ($t_2 - t_1$) period (equivalent of defecation from digestive tract of an average relative food content equal to 0.5 ($S_1 + S_2$)).

$$A = 0.5 (S_1 + S_2) - S_r \quad (2)$$

where:

S_r – theoretical relative food mass that should be present in the fish digestive tract at the end of the time interval:

$$S_r = 0.5 (S_1 + S_2) e^{-k_2 (t_2 - t_1)} \quad (3)$$

where:

e – natural logarithm base,

k_2 – digestion rate constant calculated from Thorpe's (1977) exponential function and R in Persson's model (1982). The amount of food consumed by the fish during the ($t_2 - t_1$) period can be calculated using the following formula:

$$C = 0.5 (3S_2 - S_1 - 2S_r) \quad (4)$$

The daily food ration is equal to the sum of C values calculated for consecutive time intervals (the weight of consumed and digested food).

RESULTS

SIBERIAN STURGEON FOOD COMPOSITION AND ITS VARIABILITY OVER A 24-HOUR CYCLE

The sturgeon digestive tracts contained Diptera larvae of the Chironomidae family, mainly *Chironomus plumosus* L., sometimes *Ch. tentans* and *Ceratopogon* sp. (Heleidae). In the daytime samples these organisms were digested and condensed in the anterior part of digestive tract, but they were almost intact in the night samples.

The digestive tracts also contained remnants of butterfly *Paraponyx* sp. (Lepidoptera) larvae and stone-fly *Perlodes* sp. (Plecoptera) larvae and imagines, usually limbs, abdominal bristles and wings. *Chironomus plumosus*, the main sturgeon dietary component, was found in the digestive tracts of all the fish examined and in all the samples. This insect clearly dominated, especially in the night samples. Butterfly and stone-fly larvae were observed, although they were always scarce and occurred mainly in daytime samples.

The daily consumption variability is presented in Table 1.

TABLE 1

Quantitative changes in Siberian sturgeon food composition over a 24-hour cycle

Time of day (h)	06.00	09.00	12.00	15.00	18.00	21.30	01.00	04.00
Average food weight per fish [g]	0.39	0.50	0.31	0.16	0.46	0.52	0.63	0.40
Range [g]	0.22 - 0.60	0.40 - 0.60	0.22 - 0.50	0.12 - 0.20	0.42 - 0.52	0.37 - 0.63	0.50 - 0.73	0.30 - 0.65

TWENTY-FOUR HOUR FEEDING CYCLE OF SIBERIAN STURGEON

The food consumption indices (I) that describe the feeding intensity of sturgeon in a 24-hour cycle reached the highest values at night and the lowest in the morning and afternoon. The sturgeon feeding intensity curve shows one distinct peak (Fig. 1).

DAILY FOOD RATION OF SIBERIAN STURGEON

The value of the food evacuation constant (k_2) for Siberian sturgeon with an average body weight of 20.3 g at an average daily water temperature of 14.2°C was about 0.173. The daily food requirement was calculated according to Thorpe (1977) and was equal to 5.4% of the average fish body weight.

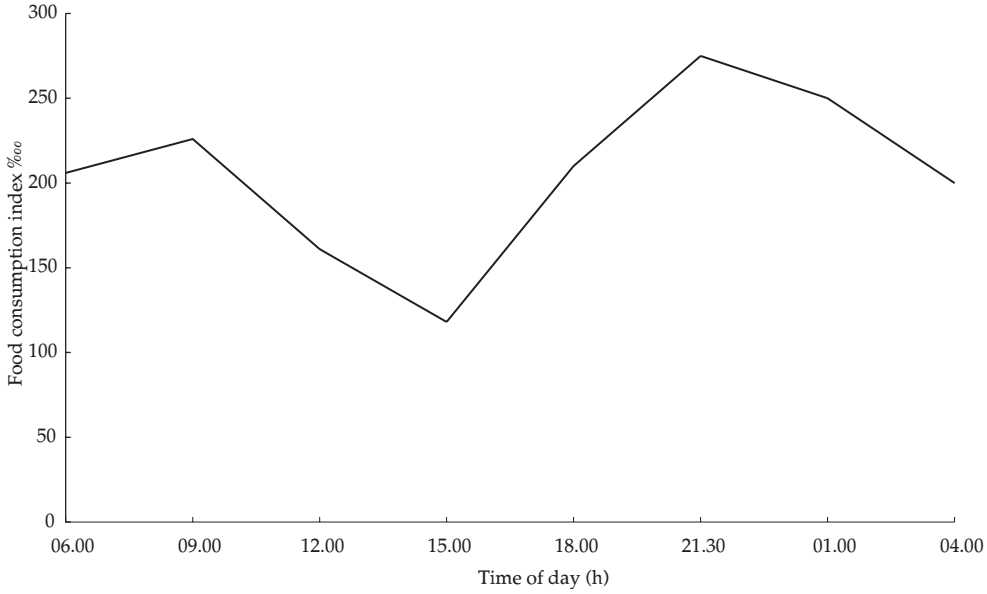

Fig. 1. Siberian sturgeon feeding intensity in a 24-hour cycle expressed as the average food consumption index (I - ‰).

DISCUSSION

The analysis of juvenile Siberian sturgeon food composition revealed the distinct predominance of Diptera larvae, mainly *Chironomus plumosus*. This preference probably resulted from the abundance, availability and the size of food organisms present in the pond. The species composition of the Siberian sturgeon diet is not highly-diversified, but its energetic value is sufficient. Diet composition is probably largely determined by the lack of feeding specialization and feeding plasticity. The results obtained by Maljutin and Stroganova (1971), and by Ruban and Aklimova (1991) indicate the considerable feeding plasticity of Siberian sturgeon juveniles and adults. Therefore, one can assume that under food competition conditions, for example in a polyculture with more active species such as common carp *Cyprinus carpio* L. or tench *Tinca tinca* (L.). Siberian sturgeon may become a stenophagous fish of poor feeding activity. Feeding plasticity might play an important role in rearing this species in polycultures with cyprinid fishes that avoid or ignore certain food organisms. Siberian sturgeon might consume organisms ignored by other species to avoid competition with more active fish, thus contributing to the better utilization of pond food resources.

The increased nocturnal feeding activity of sturgeon and its diurnal decrease is typical of non-predatory fishes. Visual predators feed most actively during daytime when there are good light conditions. Some non-predatory species, however, such as peled *Coregonus peled* (Gmelin) or sunbleak *Leucaspius delineatus* (Heckel) (Susser 1971, after Sozinov 1978), tench juveniles (Pyka 1997), and roach *Rutilus rutilus* (L.) (Pyka 1999) also exhibit daytime feeding activity.

The daily food ration is closely related to water temperature which affects the standard metabolic rate (Backiel and Horoszewicz 1970). It also depends on food composition and fish age. All of these factors determine the level of the food digestion rate index – k_2 described by the exponential function. In comparison to data in the literature, the daily food ration of pond-reared Siberian sturgeon juveniles, calculated at 14.2°C and equal to 5.4% of the average fish body weight, is assumed to be reliable.

CONCLUSIONS

1. The diet of Siberian sturgeon specimens with an average individual body weight of 20.3 g and an average total length of 19.3 cm consisted mainly of Chironomidae

larvae, among which *Ch. plumosus* predominated. Additionally, the sturgeon consumed small numbers of *Ch. tentans*, *Ceratopogon* sp., butterfly *Paraponyx* sp. (Lepidoptera) larvae and stone-fly *Perlodes* sp. (Plecoptera) larvae and imagines.

2. The Siberian sturgeon juveniles showed the highest feeding intensity at nighttime and the lowest during daytime.
3. The daily food ration of Siberian sturgeon juveniles calculated according to Thorpe (1977) was equal to 5.4% of the average fish body weight.

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STRESZCZENIE

DOBOWY CYKL ODŻYWIANIA SIĘ JESIOTRA SYBERYJSKIEGO *ACIPENSER BAERI* (BRANDT) W WARUNKACH CHOWU STAWOWEGO, W MONOKULTURZE

W pracy omówiono odżywianie się młodocianych stadiów rozwojowych jesiotra syberyjskiego podchowywanego w monokulturze, w stawie o powierzchni 0,05 ha, głębokości maksymalnej 2 m, średniej 1,2 m. Badania przeprowadzono w ośrodku zarybieniowym Montowo, należącym do Okręgu PZW Toruń. Przedstawiono zmienność składu pokarmu w cyklu dobowym. Udział poszczególnych składników pokarmowych przedstawiono w ujęciu wagowym oraz prześledzono przebieg intensywności żerowania ryb w różnych porach doby. Składnikiem najchętniej pobieranym przez jesiotry syberyjskie były larwalne formy Chironomidae - *Chironomus plumosus* L., które występowały w przewodach pokarmowych wszystkich ryb, w każdej próbie. W niewielkich ilościach pobierane były larwy motyli i widelnic. Jesiotry syberyjskie najintensywniej żerowały w godzinach nocnych (tab. 1, rys. 1). Metodą Thorpe'go (1977) oszacowano wielkość dobowego spożycia, które dla jesiotra syberyjskiego o średniej masie jednostkowej 20,3 g, w średniej dobowej temperaturze wody 14,2°C wyniosło 5,4% średniej masy ciała ryby.

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