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COMPARISON OF OXYGEN CONSUMPTION AND AMMONIA EXCRETION BY SIBERIAN STURGEON (*ACIPENSER BAERI* BRANDT) AND ITS HYBRID WITH GREEN STURGEON (*ACIPENSER MEDIROSTRIS* AYRES)

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ABSTRACT. Studies were carried out on diurnal changes of oxygen consumption and ammonia excretion by Siberian sturgeon (*Acipenser baeri* Brandt) and its hybrid with green sturgeon (*Acipenser medirostris* Ayres). Different behaviour of Siberian sturgeon and the hybrid resulted in different diurnal pattern of the two metabolic indices. In case of the hybrid oxygen consumption and ammonia excretion were higher at night than during daytime (12-36% and 10-27% respectively). In Siberian sturgeon the values of the two indices were similar over the 24 h period. Maximum oxygen consumption by the hybrid was observed at night, from 10 p.m. to 2 a.m., and the highest ammonia excretion – early in the morning, from 6 to 10 a. m.

Keywords: STURGEONS, INTENSIVE REARING, METABOLISM, OXYGEN CONSUMPTION, AMMONIA EXCRETION

INTRODUCTION

Among many species and hybrids of sturgeons, Siberian sturgeon and its hybrid with the green sturgeon show exceptionally high growth rate under intensive tank rearing conditions, thus they are interesting for fish aquaculturists. The hybrid differs from the original species not only in many meristic and plastic features, such as shape and size of the head, but also in behaviour (Kolman et al. 1997, Kolman et al. 1999). Under aquaculture conditions Siberian sturgeon feeds actively all day, while the hybrid rests on tank bottom during daytime and becomes active at night. Low daytime activity is characteristic for its paternal species, i.e. the green sturgeon (Artiukhin and Andronov 1990). Such behaviour of the hybrid reduces energetic losses during daytime, resulting in more efficient food utilisation for growth compared to Siberian sturgeon (Kolman et al. 1997).

The present study was carried out to evaluate the effect of different behaviour of the sturgeons on some metabolic indices such as oxygen consumption and ammonia excretion, and on their diurnal changes.

MATERIAL AND METHODS

The study was performed during an experimental comparative rearing of Siberian sturgeon (*Acipenser baeri* Brandt) and its hybrid with green sturgeon (*Acipenser medirostris* Ayres). The fish were aged 1+ and their average body weights were 827 and 878 g respectively. They were reared in tanks with water recirculation and purification, at constant temperature 20±0.3^{o}C, and fed trout pellets Aller 45/15.

Controlled photoperiod of the same light and dark phases was applied, changed at 8 a.m. and 8 p.m. The fish were adapted to experimental conditions for 20 days. Four 24-hour cycles of measurements were carried out, during which water was sampled for analyses every two hours. Each cycle consisted of two replicates and average values were used in the final calculations. Oxygen consumption and ammonia excretion were calculated according to the following formulas:

$$KT = (T_d - T_o)\ x\ P\ x\ m^{-1}$$

where:

KT – oxygen consumption [mg kg^{-1} h^{-1}],

T_d – oxygen concentration at water inflow [mg dm^{-3}],

T_o - oxygen concentration at water outflow [mg dm^{-3}],

P – water flow [dm^3 h^{-1}], m – fish weight [kg];

$$WA = (A_o - A_d)\ x\ P\ x\ m^{-1}$$

where:

WA -ammonia excretion [mg kg^{-1} h^{-1}],

A_o - ammonia concentration at water outflow [mg dm^{-3}],

A_d – ammonia concentration at water inflow [mg dm^{-3}],

P – water flow [dm^3 h^{-1}],

m – fish weight [kg].

Dissolved oxygen concentration was measured using DO-meter, Hanna Instruments, and total ammonia concentration with colorimetric method of direct nesslerization using spectrophotometer Specol-11, Zeiss – Jena.

RESULTS

Average body weight of Siberian sturgeon increased during the experiment from 827 to 1146 g, and body weight of the hybrid from 973 to 1307 g. Average daily oxygen

consumption decreased with increasing body weight of the fish, in Siberian sturgeon from 179 to 110 mg O_2 kg^{-1} h^{-1} and in the hybrid from 158 to 103 mg O_2 kg^{-1} h^{-1} (Tab. 1). Average daily ammonia excretion also decreased with increasing body weight, in Siberian sturgeon from 15.3 to 10.55 mg NH_3 kg^{-1} h^{-1} and in the hybrid from 10.1 to 5.43 mg NH_3 kg^{-1} h^{-1}.

TABLE 1

Oxygen consumption and ammonia excretion by Siberian sturgeon (*Acipenser baeri* Brandt) and its hybrid with green sturgeon (*Acipenser medirostris* Ayres).

Fish stock	Mean fish weight [g]		Stock density [kg/m^{-3}]		Mean daily oxygen consumption [mg kg^{-1} h^{-1}]		Mean daily ammonia excretion [mg kg^{-1} h^{-1}]	
	Siberian s.	Hybrid	Siberian s.	Hybrid	Siberian s.	Hybrid	Siberian s.	Hybrid
1	827	973	16.5	19.5	179.07	157.92	15.34	10.06
2	927	1064	18.5	21.3	123.83	120.96	13.24	7.44
3	1081	1259	21.6	25.2	110.27	117.50	10.55	6.26
4	1146	1307	22.9	26.1	110.21	103.48	11.40	5.43

Oxygen consumption differed in the diurnal cycle in both groups. Oxygen consumption by the hybrid increased in the dark phase. The increase was observed for several hours, and then oxygen consumption decreased. The highest values occurred between 10 p.m. and 2 a.m., and the lowest – between 12 a.m. to 6 p.m. (Fig. 1). The difference between night-time and day-time oxygen consumption by the hybrid ranged from 12 to 36%.

In Siberian sturgeon diurnal changes of oxygen consumption were different. No direct effect of light and dark phases was observed: average night-time values were similar or just slightly lower than day-time consumption (up to 6%). Changes were also less regular than in the hybrid – the highest and the lowest values were observed at various times of the day (Fig. 2).

Ammonia excretion in the hybrid increased at night (10-27%) compared to day-time. Maximum values were observed in the morning (between 6 and 10 a.m.) (Fig. 3). Ammonia excretion by Siberian sturgeon was not so closely time-related, and the extreme values occurred at various times of the day (Fig. 4). Ammonia excretion proved to be more variable than oxygen consumption in both groups: in Siberian sturgeon maximum values were higher than minimum ones by from 57 to 97% and from 23 to 39% respectively, while in the hybrid the differences were higher and reached 102-239% and 34-101% respectively.

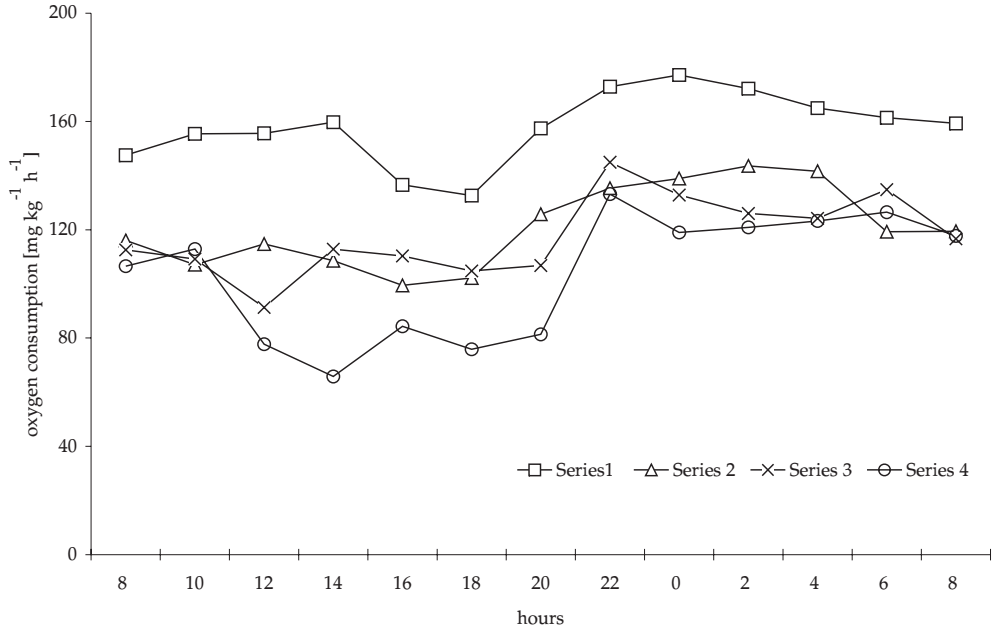

Fig. 1. Diurnal changes of oxygen consumption by the hybrid of Siberian sturgeon (*Acipenser baeri* Brandt) and green sturgeon (*Acipenser medirostris* Ayres).

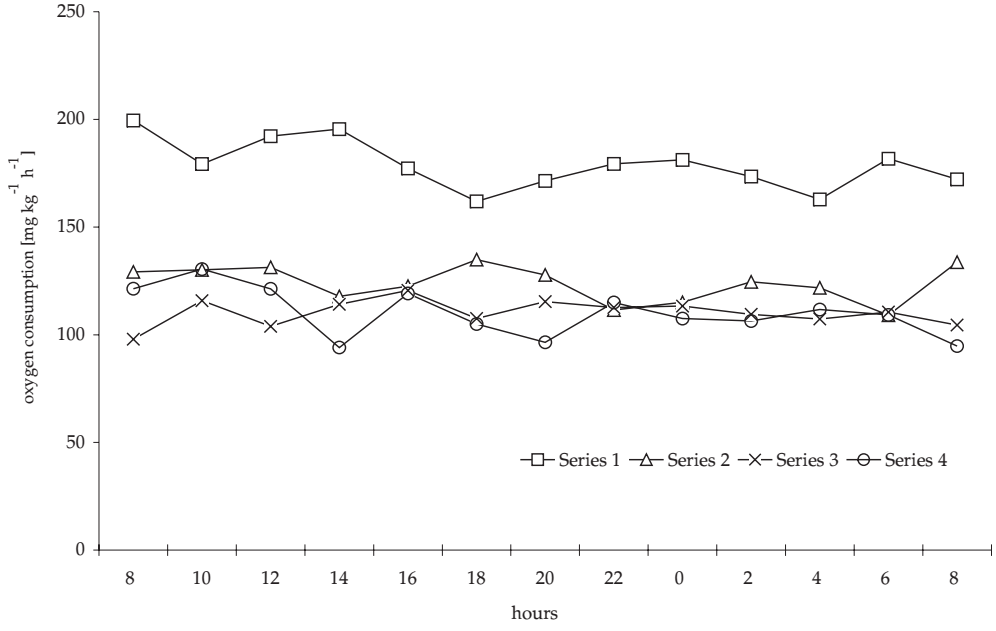

Fig. 2. Diurnal changes of oxygen consumption by Siberian sturgeon (*Acipenser baeri* Brandt).

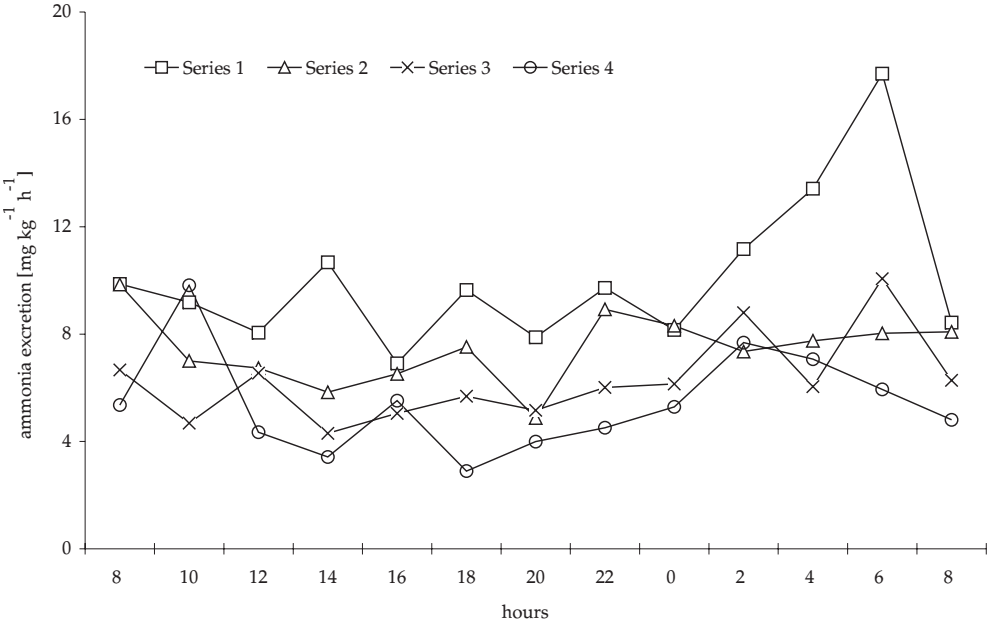

Fig. 3. Diurnal changes of ammonia excretion by the hybrid of Siberian sturgeon (*Acipenser baeri* Brandt) and green sturgeon (*Acipenser medirostris* Ayres).

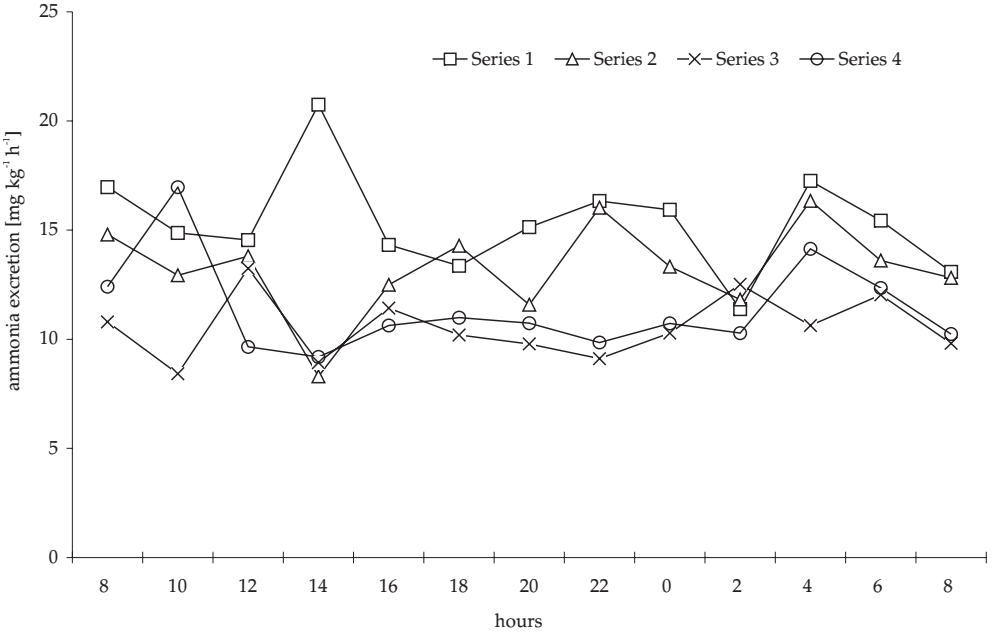

Fig. 4. Diurnal changes of ammonia excretion by Siberian sturgeon (*Acipenser baeri* Brandt).

DISCUSSION

Metabolic rate of sturgeons decreased with fish size. This confirms the data of other authors (Gershanovich and Pototsky 1993, Jatteau 1997). Protein content in feed is an important factor, according to some authors – even the most important, which affects oxygen consumption and ammonia excretion (Dąbrowski et al. 1987, Thomas and Piedrahita 1997, 1998). In the present study sturgeons were given the same feed at a constant feeding rate, thus the values of metabolic indices were related to fish size only.

The results of the present study revealed differences in the metabolism of Siberian sturgeon and its hybrid with the green sturgeon. At similar levels of oxygen consumption, the hybrid excreted much less ammonia than Siberian sturgeon. This difference might have resulted from excretion of protein metabolites in other form, such as urea. Urea may comprise up to 40% of nitrogen metabolites in sturgeons (Gershanovich and Pototsky 1993).

Observations of higher locomotory activity of the hybrid were confirmed by higher metabolic rates observed at night. Such differences of oxygen consumption between daytime and night were not observed in Siberian sturgeon in the present study. They were, however, noted in smaller fish of this species, of less than 100 g (Szczepkowski 1999). Diurnal changes of metabolic rate in Russian sturgeon (*Acipenser guldenstaedtii* Brandt) and in Siberian sturgeon were observed by Afonich and Sokolova (1984) and Dąbrowski et al. (1987). These changes involved increase of metabolic rate at night which occurred only in small fish.

Under natural conditions diurnal changes of metabolic rate in young sturgeons are usually caused by feeding patterns related to food availability (Afonich and Sokolova 1984). Under aquaculture conditions such changes may result from portion feeding which affects ammonia excretion most of all. According to Jatteau (1997) ammonia excretion by Siberian sturgeon increased within 3 hours from the beginning of feeding irrespective of the fish size (from 40 to 1700 g), and in white sturgeon (*Acipenser transmontanus*) – within 2 to 6 hours (Thomas and Piedrahita 1998).

In the present study time of feeding did not affect diurnal metabolic rate of fish since the feed was supplied continuously. In case of the hybrid, diurnal changes of ammonia excretion and oxygen consumption resulted from increased locomotory and feeding activity at night. Such behaviour caused an increase of oxygen consumption at the beginning of the night, and an increase of ammonia excretion after the end of intensive feeding.

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STRESZCZENIE

PORÓWNANIE KONSUMPCJI TLENU I WYDALANIA AMONIAKU U JESIOTRA SYBERYJSKIEGO (*ACIPENSER BAERI* BRANDT) I JEGO HYBRYDA Z JESIOTREM ZIELONYM (*ACIPENSER MEDITOSTRIS* AYRES)

W trakcie intensywnego chowu w warunkach zamkniętego obiegu wody narybku jesiotra syberyjskiego (*Acipenser baeri* Brandt) i jego hybryda z jesiotrem zielonym (*Acipenser meditostris* Ayres) przeprowadzono badania dobowych zmian wielkości konsumpcji tlenu i wydalania amoniaku. Ryby karmione były w ciągu doby w sposób ciągły i równą intensywnością. Stwierdzono, że odmienny sposób zachowania się jesiotra syberyjskiego i jego hybryda z jesiotrem zielonym powoduje dobowe zmiany badanych wskaźników metabolizmu tzn. intensywności wydalania amoniaku oraz konsumpcji tlenu. U hybryda poziom konsumpcji tlenu i wydalania amoniaku w nocy jest wyższy niz w ciagu dnia: konsumpcja tlenu o 12 do 36%, a wydalanie amoniaku o 10 do 27%. U jesiotra syberyjskiego wielkości obydwu wskaźników w ciagu dnia i nocy są mniej więcej równe. Maksymalne wartosci konsumpcji tlenu występowały u hybryda w początkowej fazie nocy, od godziny 22.00 do 2.00 i były one związane z poszukiwaniem pokarmu i najsilniejszą aktywnością ruchową ryb w tym czasie, a najwyższe wartości wydalania amoniaku odnotowywano w godzinach rannych od 6.00 do 10.00.

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