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A COMPARISON OF SELECTED MORPHOMETRIC CHARACTERISTICS OF THE JUVENILES OF SIBERIAN STURGEON (*ACIPENSER BAERI* BRANDT) AND ITS HYBRID WITH RUSSIAN STURGEON (*ACIPENSER GUELDENSTAEDTI* BRANDT)

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ABSTRACT. Sturgeon fry were obtained through the artificial spawning of Siberian sturgeon (*Acipenser baeri* Brandt) and the hybrid of Siberian and Russian sturgeon (*Acipenser baeri* Brandt × *Acipenser gueldenstaedti* Brandt). Selected biotechnological factors of the fish were compared and biometric measurements were taken during a 60-day long rearing period in a recirculation system. A higher growth rate was confirmed in the hybrid sturgeon. The average body weight of the hybrid at an age of nine months was 1,078 g, while that of the Siberian sturgeon was 872 g. The hybrid also utilized feed more efficiently. The food conversion rate during the study period was 0.64 for the hybrid and 0.66 for the Siberian sturgeon. The greatest differences in the plastic features of the studied fish were found for those related to the head. The Siberian sturgeon had a longer rostrum (R) and a shorter post-orbital space (op) than did the hybrid. Significant differences were also observed in the numbers of lateral bony plates (Sl), the number of rays in the dorsal fins (D) and the number of rays in the anal fins (A).

Key words: *ACIPENSER BAERI, ACIPENSER GUELDENSTAEDTI*, HYBRIDS, MERISTIC FEATURES, BIOMETRIC FEATURES, GROWTH RATE

INTRODUCTION

The dynamic development of sturgeon husbandry under controlled conditions has been observed for many years (Gershanovich and Burtsev 1993, Bronzi et al. 1999). This is also true of sturgeon culture in Poland (Kolman 1999). The interest in rearing sturgeon is not limited to the value of its meat and eggs, which is used to prepare black caviar, but also by a number of advantageous features such as its rapid growth rate, tolerance to manipulation and a relatively high resistance to environmental conditions. In addition to the original species, sturgeon hybrids are also bred. This process produces fish which are better adapted than the original species to various rearing conditions, and heterosis is responsible for offspring with more rapid growth rates (Kolman et al. 1999). It is also desirable for the hybrid to have advantageous commercial features such as the shortest possible head, a wide body and a significant pre-dorsal length.

The continuous creation of new sturgeon hybrids can pose identification difficulties. Therefore, it is necessary to devise proper criteria for identifying the different hybrids; they can include meristic features, such as the number of bony plates and fin rays, and some plastic features.

The aim of the present study was to compare some biometric, meristic and biotechnical features of Siberian sturgeon (*Acipenser baeri* Brandt) with those of its hybrid with Russian sturgeon (*Acipenser baeri* Brandt × *Acipenser gueldenstaedti* Brandt).

MATERIAL AND METHODS

The study material consisted of fry of Siberian sturgeon and the hybrid of the Siberian and the Russian sturgeon which were obtained from artificial spawning and preliminary rearing. Initially, the weight of the Siberian sturgeon was 206.9 ± 29.8 g, and that of the hybrid was 216.6 ± 36.2 g. A comparison of the biotechnical indexes was conducted throughout the 60-day long rearing period of four-month-old juveniles in a recirculation system in the Dgał Experimental Hatchery of the Inland Fisheries Institute in Olsztyn. Once weekly, the fish body weight (to the nearest 0.1 g) and total length (l_1) (to the nearest 0.5 cm) were measured. These measurements were used to determine the feed dosage and calculate the food conversion rate (FCR), the relative, diurnal body weight increments (SGR) and the Fulton condition coefficients.

The parameters of water quality were maintained within an acceptable range for sturgeon rearing (Kolman 1999), i.e. the average water temperature during rearing was 20°C, the oxygen content at the outflow did not fall below 5.4 mg l^{-1}, and the amount of the total ammonia nitrogen (TAN = NH_4^+-N + NH_3-N) and nitrites (NO_2-N) did not exceed 0.4 and 0.05 mg l^{-1}, respectively. The water pH ranged from 7.8 and 8.0.

The plastic and meristic features of nine-month-old fish were studied according to the scheme developed by Krilova and Sokolova (1981). Measurements were taken of body weight W [g] and 29 plastic and 5 meristic features (Table 1). Thirty individuals of Russian and hybrid sturgeon were used. The hybridization index (HI) was calculated using the Verigin and Makeeva formula (1972):

$$HI = [(M_h - M_f) \times 100 / (M_m - M_f) - 50] \times 2 \qquad (1)$$

where:

M_h – average value of the hybrid feature;

TABLE 1

Plastic and meristic features measured for Siberian sturgeon (*Acipenser baeri* Brandt) and its hybrid with Russian sturgeon (*Acipenser gueldenstaedti* Brandt)

Symbol	Feature name
	Plastic features
L	total length
l_1	standard length
l_2	body tail length
aD	pre-dorsal distance
aV	pre-ventral distance
aA	pre-anal distance
C	head length
R	rostrum length
op	post-orbital space
o	eye diameter
HC	greatest head height
hCo	smallest head height
io	inter-eye space
BC	greatest head width
bC	head width at the upper edge of the operculum
r_r	distance from rostrum end to cartilaginous snout edge
r_c	distance from rostrum end to base of the middle barbs
l_c	external barb length
SR_c	rostrum breadth at barb base
SR_r	rostrum breadth at cartilaginous vault
SO	width of mouth cavity
il	width of the lower-lip gap
H	greatest body height
h	smallest body height
pl	length of the tail shaft
lD	length of the dorsal fin base
hD	height of dorsal fin
lA	length of anal fin base
hA	height of the anal fin
	Meristic features
Sd	number of dorsal bony plates
Sl	number of lateral plates
Sv	number ventral bony plates
D	number of rays in the dorsal fin
A	number of rays in the anal fin

M_f – average value of the feature for the maternal species (Siberian sturgeon);

M_m – average value of the feature for the paternal species (Russian sturgeon);

In addition to the authors' own data, the values of meristic features of Russian sturgeon reported by Filipova (1985) were also used to calculate the hybridization index. The coefficient of difference was also calculated using the Mayr (1971) formula, as follows:

$$CD = (M_1 - M_2)/(\sigma_1 - \sigma_2) > 1.28 \quad (2)$$

where:

M_1, M_2 – average value of a feature in comparable groups;

σ_1, σ_2 – standard deviations for these features.

RESULTS

GROWTH RATE

During the two-month long rearing period the average body weight nearly doubled – the Siberian sturgeon reached 410 ± 62 g and the hybrid 428 ± 76 g (Fig. 1). The growth rate, expressed as the relative, diurnal body weight increase, was slightly higher for the hybrid at 1.63% of body weight diurnally, while for the Siberian sturgeon this figure was 1.61%. The difference in the average weight increased as rearing progressed. By the time morphometric measurements were taken of nine-month-old fish, this difference was over 200 g with the hybrid weighing 1,078 ± 157 g and the Siberian sturgeon 872 ± 145 g (this was statistically significant; $P < 0.05$, ANOVA). The food conversion rate was also slightly better for the hybrid at 0.64, while it was 0.66 for the Siberian sturgeon. Differences in the character of growth of the two fish were confirmed. In the Siberian sturgeon, body weight increments grew uniformly with those of body length, and the Fulton index for the study period remained almost unchanged at an average of 0.67. The hybrid's body weight increments exceeded linear growth and the Fulton index increased from 0.64 at the beginning of rearing to 1.01 on the last day of rearing (Fig. 2).

MORPHOMETRIC FEATURES

Significant differences in the number of spiny rays in the anal (A) and dorsal (D) fins as well as the number of lateral bony plates were confirmed between the Siberian sturgeon and the hybrid (Table 2). The hybridization indexes calculated for meristic

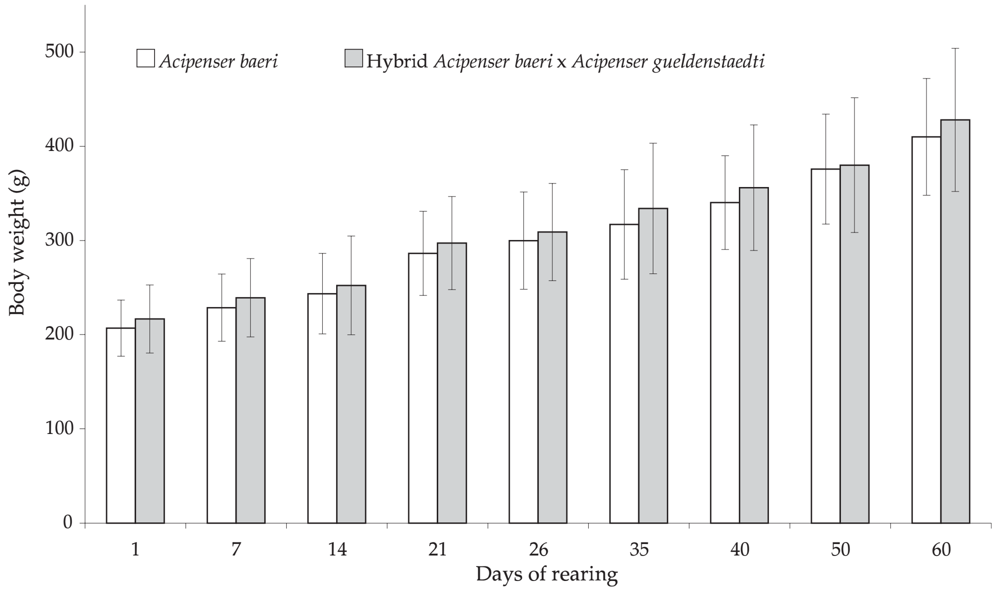

Fig. 1. Comparison of the increase of average body weight of Siberian sturgeon versus that of its hybrid with Russian sturgeon (mean ± SD).

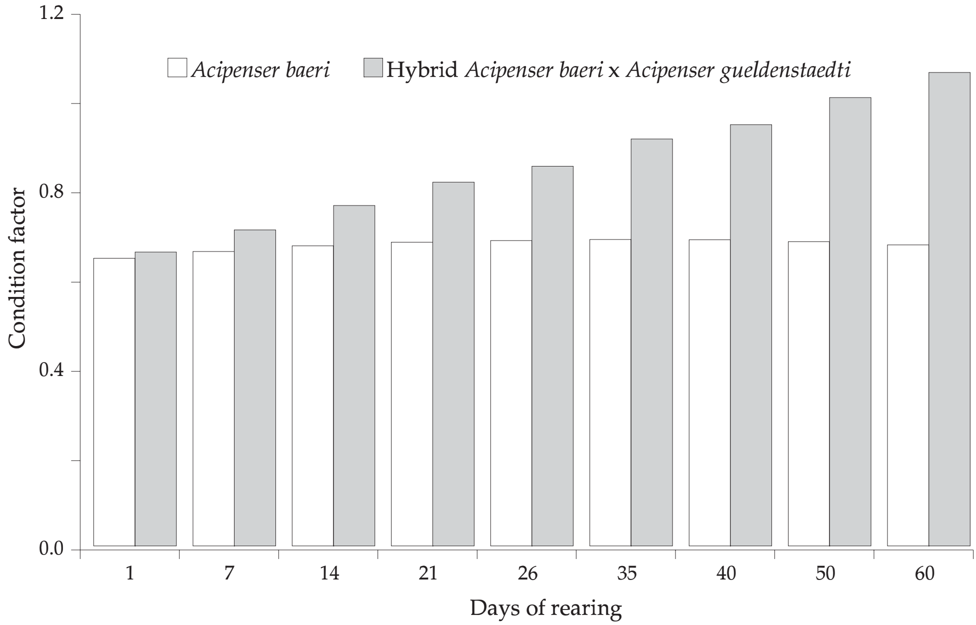

Fig. 2. Values of condition coefficients for Siberian sturgeon versus its hybrid with Russian sturgeon as observed during rearing.

TABLE 2

Values of meristic features of Siberian sturgeon (*Acipenser baeri* Brandt) and its hybrid with Russian sturgeon (*Acipenser gueldenstaedti* Brandt) (average values and standard deviations)

Meristic feature	*Acipenser baeri*	Hybrid of *Acipenser baeri* × *Acipenser gueldenstaedti*
number of dorsal bony plates – Sd	14.4 ± 1.2	11.9 ± 1.6
number of lateral bony plates – Sl	47.5 ± 2.1	37.9 ± 2.8
number of ventral bony plates – Sv	9.0 ± 0.5	8.3 ± 0.9
number of rays in the dorsal fin - D	46.5 ± 2.4	41.6 ± 2.1
number of rays in the anal fin - A	33.4 ± 2.6	26.4 ± 1.8

features revealed that the number of dorsal (Sd) and ventral bony plates (Sv) for the hybrid was closer to the paternal species, i.e. the Russian sturgeon (HI above 100) (Fig. 3). Only the HI value for the lateral bony plates and spiny rays in the anal fins of the hybrid were between the two parental species at 9.96 and 9.55, respectively, and only the number of spiny rays in the dorsal fin (D) was closer to the maternal species, i.e. the Siberian sturgeon (HI of 41.28).

Measurements of the plastic features revealed a number of differences between the Siberian sturgeon and the hybrid (Figs. 4 and 5). The greatest differences, for

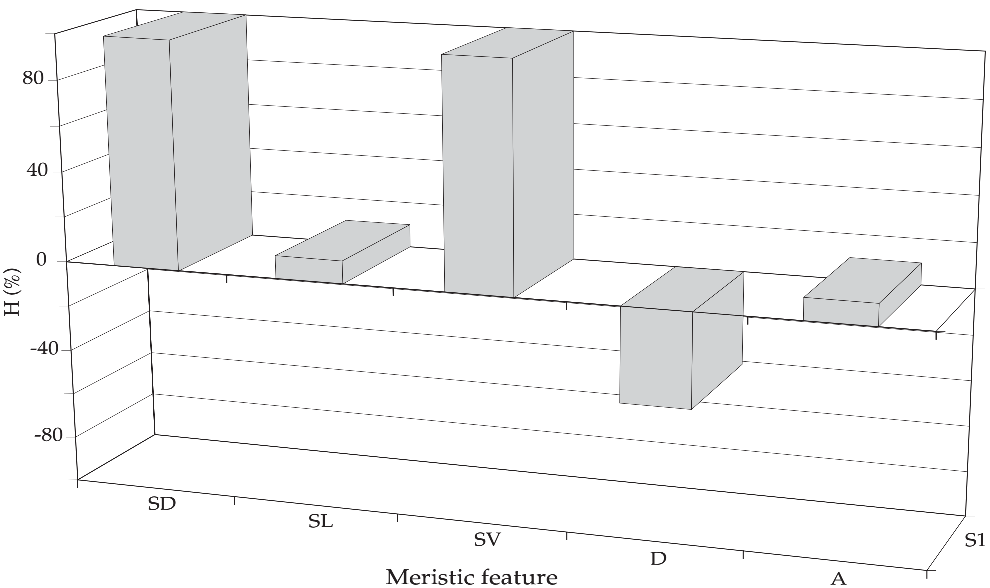

Fig. 3. Comparison of the values of hybridization indexes of the meristic hybrid indexes for Siberian and Russian sturgeon.

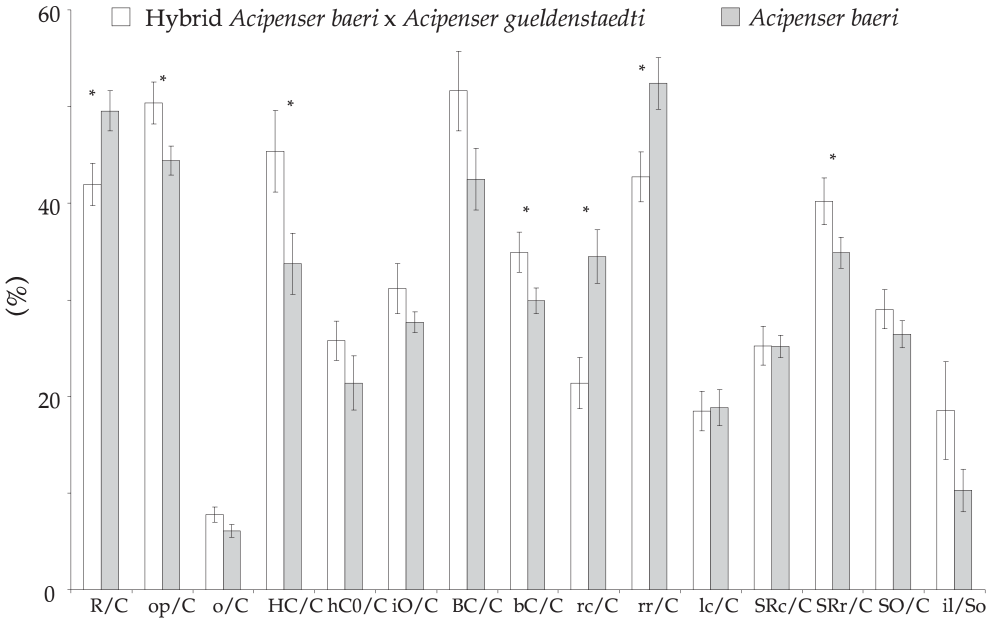

Fig. 4. Comparison of selected plastic features of Siberian sturgeon and the hybrid (in relation to head length)(mean ± SD). The coefficient of differences CD is > 1.28 for features denoted with asteriks.

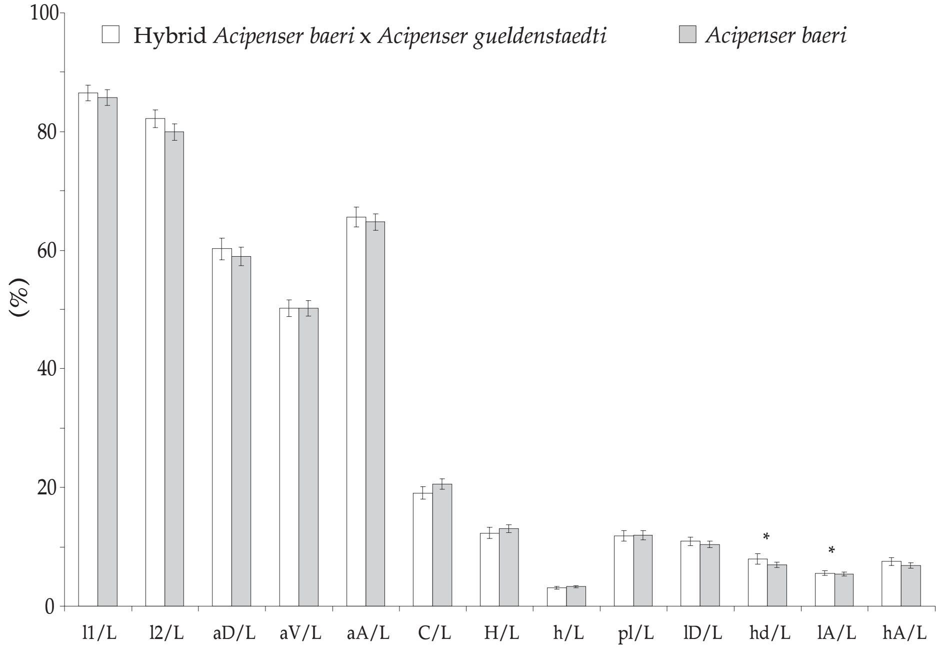

Fig. 5. Comparison of selected plastic features of Siberian sturgeon and the hybrid (in relation to body length) (mean ± SD). The coefficient of differences CD is > 1.28 for features denoted with asteriks.

which the coefficient was higher than 1.28, were observed for the following features: rostrum length (R), distance between the end of the rostrum to the base of the middle barbs (r_c), distance between the end of the rostrum to the cartilaginous snout edge (r_r), post-orbital space (op), the greatest head height (HC), head width (bC), rostrum breadth at the cartilaginous snout vault (SR_r), the width of the lower-lip gap (il), height of the dorsal fin (hD) and the length of the base of the anal fin (lA).

DISCUSSION

The results of the study indicate that the hybrid of the Siberian and Russian sturgeon has a higher body weight growth rate than the Siberian sturgeon. This may be caused by the effect of heterosis, which occurs in hybrids. Faster body weight growth than in the parent species was also obtained for the hybrid of the Russian and Siberian sturgeon; fish at ages 0+ weighed about 20% more than Siberian sturgeon at the same age and exceeded Russian sturgeon weight by 50% (Safronov and Filipova 2000a). Similar results were obtained for the hybrid of sterlet (*Acipenser ruthenus* L.) and Siberian sturgeon (Ronyai and Peteri 1990).

Of the meristic features studied, three differ enough to be used to distinguish the hybrid from the Siberian sturgeon. These are the number of spiny rays in the dorsal (D) and anal fins (A) and the number of lateral bony plates (Sl). The hybridization indexes of meristic features indicate that the numbers of dorsal (Sd) and ventral bony plates (Sv) are similar to those in the paternal species, that the Sl and A features are between the parental species and that the similarity of the number of spiny rays in the dorsal fin (D) is similar to the maternal species. The same similarities with the parental species were observed in the hybrid of Siberian and Green sturgeon (*Acipenser medirostris* Ayres) (Kolman et al. 1999). Features Sd, D and A were similar to the maternal species in the Russian and Siberian sturgeon hybrid, while features Sl and Sv were between the parental species (Filipova 1985). The hybrid of Siberian and Russian sturgeon was phenotypically similar to the paternal species with similar body color, bony plates and head shape (shortened anterior part). External similarity with the paternal species was also observed in the reverse hybrid of Russian and Siberian sturgeon which resembles the Siberian sturgeon (Chebanov, personal communication). Similar observations were made for the Siberian and Green sturgeon hybrid (Kolman et al. 1999).

The measurements of plastic features indicated that the most significant differences between the Siberian sturgeon and its hybrid with the Russian sturgeon relate to the head. Although the head size versus body length is roughly the same for the two fish, the rostrum (R) is longer in the Siberian sturgeon and the post-orbital space (op) is shorter; this is just the opposite for the hybrid which has a shorter rostrum and longer post-orbital space. The hybrid also has a higher (H) and broader head (distances bC and SR_r).

The hybrid's rapid growth rate and good feed utilization index indicate that it can be a valuable fish in aquaculture. In the future, it may also be used to create new hybrid generations, since, as the hybrid of sturgeon with a similar number of chromosomes, it should be fertile, as is the case with the reverse hybrid of Russian and Siberian sturgeon (Safronov and Filipova 2000b).

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STRESZCZENIE

PORÓWNANIE NIEKTÓRYCH CECH MORFOLOGICZNYCH NARYBKU JESIOTRA SYBERYJSKIEGO (*ACIPENSER BAERI* BRANDT) I JEGO KRZYŻÓWKI Z JESIOTREM ROSYJSKIM (*ACIPENSER GUELDENSTAEDTI* BRANDT)

W wyniku sztucznego tarła uzyskano narybek jesiotra syberyjskiego (*Acipenser baeri* Brandt) i hybryda jesiotra syberyjskiego z jesiotrem rosyjskim (*Acipenser baeri* Brandt x *Acipenser gueldenstaedti* Brandt). Podczas wychowu w obiegu recyrkulacyjnym porównano wybrane wskaźniki biotechnologiczne badanych ryb oraz wykonano pomiary biometryczne (tab. 1). Stwierdzono wyższe tempo wzrostu u hybryda (rys. 1). W wieku 9 miesięcy masa średnia hybryda wyniosła 1078 g, a jesiotra syberyjskiego 872 g. Wykorzystanie paszy było również lepsze u hybryda. W badanym okresie współczynnik pokarmowy wyniósł 0,64 u hybryda i 0,66 u jesiotra syberyjskiego. Wraz z wiekiem ryb wartość współczynnika kondycji Fultona pozostawała względnie stała u jesiotra syberyjskiego i wzrastała u hybryda (rys. 2).

Wartości cech merystycznych dla hybryda są następujące: liczba grzbietowych płytek kostnych Sd 11,9 ± 1,6, liczba bocznych płytek kostnych Sl 37,9 ± 2,8, liczba brzusznych płytek kostnych Sv 8,3 ± 0,9, liczba promieni w płetwie grzbietowej D 41,6 ± 2,1, liczba promieni w płetwie odbytowej A 26,4 ± 1,8 (tab. 1). Znaleziono istotne różnice między hybrydem a jesiotrem syberyjskim w liczbie płytek bocznych Sl, liczbie promieni w płetwie grzbietowej (D) i liczbie promieni w płetwie odbytowej (A). Indeksy hybrydyzacji dla cech merystycznych pokazują zbieżność liczby płytek grzbietowych (Sd) i brzusznych (Sv) z gatunkiem ojcowskim, pośrednie miejsce między gatunkami wyjściowymi dla cech Sl i A oraz zbieżność liczby promieni w płetwie grzbietowej (D) z gatunkiem matczynym (rys. 3).

Wśród cech plastycznych największe różnice między badanymi rybami znaleziono dla cech charakteryzujących głowę (rys. 4). Jesiotr syberyjski posiada dłuższe rostrum (R) i krótszą przestrzeń zaoczną (op) niż hybryd. Wartości współczynnika różnicy powyżej 1,28 znaleziono również dla wysokości płetwy grzbietowej (hD) i długości podstawy płetwy odbytowej (lA) (rys. 5).

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