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COMPARATIVE MORPHOMETRIC ANALYSIS OF MALE AND FEMALE HYBRIDS (F1 *ACIPENSER BAERII* × *ACIPENSER GUELDENSTAEDTII*) AT THE AGE OF SEVEN YEARS

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Abstract

A comparative analysis on 36 metric, 7 meristic features was performed and 7 morphometric indices were calculated in seven-year-old male and female hybrids (F1 Acipenser baerii x Acipenser gueldenstaedtii) grown under the same conditions on a super-intensive cage farm. The antiventral (P<0.05) and pecto-ventral (P<0.01) distance are bigger in female fish. Their head, compared to males, is wider, higher in the area above the eye and has a relatively larger space behind the eye (P<0.05). Female fish have a relatively larger eye diameter (P<0.01), wider mouth (P<0.001) and snout (P<0.001), higher dorsal (P<0.05) and anal, (P<0.05) and longer pectoral (P<0.001) and abdominal (P<0.05) fin. Male hybrids have a higher body relative to total length (P<0.01), a higher caudal stalk (P<0.05), and a longer anal fin (P<0.01). Their head has more massive and long snout (P<0.001), a bigger distance from the snout end to the mouth (P<0.001) and a greater width of the lower lip brake (P<0.05). The ratio of lower lip brake to the mouth length was higher (P<0.001) in male fish. The values of the high backed index (P<0.01) and the fatness index, including the body girth (P<0.05) in female fish are higher.

Key words: *aquaculture, exterior indices, hybridization, sturgeon.*

INTRODUCTION

Sturgeon aquaculture is developing at a very good pace (Bronzi et al., 2019). One of the most important aquaculture species are Siberian and Russian sturgeon. They are grown in pure form and are used as parental forms in hybridization. Sturgeons have a high ability to hybridize, and in the wild in sympatric populations hybridized species are often observed (Chebanov & Galich, 2013). Hybridization has been successfully applied in sturgeon aquaculture as a method to increase production efficiency (Miburo et al., 2018, etc.). Sturgeons have more than 20 interspecific hybrids (Havelka et al., 2011). Chebanov et al. (2018) emphasize that the cultivation of different Siberian sturgeon hybrids has practical significance for sturgeon aquaculture in different climatic and technological conditions.

Although phylogenetically Siberian and Russian sturgeons are closely related, the two species differ significantly; Russian sturgeon is a Ponto-Caspian anadromous species, while Siberian sturgeon is a potamodromous species inhabiting Siberian rivers and Lake Baikal (Ruban, 1997; Birstein & Ruban, 2004; Bogutskaya et al., 2013).

The qualities of hybrids between individual parental forms, when grown in aquaculture, have been the subject of a number of studies (Efimov, 2004; Filipova & Zuevsky, 2008; Linhartová et al., 2018; Shivaramu, 2019).

Morphometric analysis is used to characterize species and hybrids in sturgeon farming (Salmanov et al., 2016, etc.). It is an important part of creating test criteria for evaluating individual hybrids and breeds (Efimov & Krilova, 2006).

Morphometric studies are of paramount importance when working with fish farmed in aquaculture, as aquaculture conditions affect the morphotype of farmed fish (Shishanova & Kavtarov, 2015). Ruban (2019) points out that when breeding Siberian sturgeon in warm-water aquaculture there are major changes in a number of plastic and meristic features in the second generation.

Morev (1999) emphasizes that systematic morphometric analysis is an adequate tool for genetic study of collections of sturgeon and other fish species. The author points out that with the help of morphometric analysis the structure of the artificial populations is clarified, reflecting the genetic heterogeneity of the latter in terms of their adaptation to certain growing conditions.

We set ourselves the goal to make a morphometric characteristic of male and female hybrids [F1 *Acipenser baerii* (Ab) x *Acipenser gueldenstaedtii* (Ag)] at the age of seven years, when grown in an industrial cage farm located in southeastern Bulgaria.

MATERIALS AND METHODS

The study was carried out with seven-year-old male (n = 25) and female (n = 25) hybrids (F1 Ab x Ag), from a net-cage farm, located in a warm water reservoir. According to its type, the reservoir refers to large and deep ones. Its area is 16.07 km^2, the volume is 532.9 x 10^6 m^3. The reservoir is located in South-East Bulgaria, at 41°37 'N latitude and 25°20' E longitude. It falls into the South Bulgarian climate zone, East Rhodope climate region. The average altitude is about 280 m. Fish of different age groups were grown in separate net-cages. The cages were 8 × 8 m in size, the water depth being 6 m. Each cage had a double polyamide net. Feeding was performed with commercial granulated sturgeon feed (Table 1).

Table 1. Composition of the commercial feed

Indices	Value	Indices	Value
Protein, %	46	Vitamin A, $IU.kg^{-1}$	10 000
Fat, %	15	Vitamin C, $mg.kg^{-1}$	520
Crude fibre, %	1.4	Vitamin E, $mg.kg^{-1}$	200
Ash, %	6.5	Vitamin D3, $IU.kg^{-1}$	2 303
Total P, %	1.03	Gross energy, $MJ.kg^{-1}$	21.0
Ca, %	1.4	Digestible energy, $MJ.kg^{-1}$	19.2
Na, %	0.3%		

Twenty five fish were randomly selected from the hybrid of different sex for morphometric analyzes at the end of the vegetation period (in November). The mean body weight of females was 5000.3±120 g and of males 4000.9±130 g.

Classical methods developed for the study of alive hydrobionts were applied for the study of sturgeon species (Pravdin, 1966; Krilova & Sokolov, 1981; Morev, 1999; Svirski & Skirin, 2005, etc.). In Table 2 the studied indicators and codes for their designation are presented. A measurement scheme proposed by Krilova & Sokolov (1981) specifically for sturgeon and their hybrids was used (Figure 1). Measurements of individual body parts are made with a caliper with an accuracy of 0.1 mm, a strip measure with an accuracy of 1 mm (for body girth measurements) and a graduated ichthyological board with an accuracy of 1 mm for measuring lengths, thicknesses and heights of the body.

Table 2. Metric and meristic features used in the study.

Features	Code
Total body weight, g	BW
Metric body features	
Total length, cm	TL
Fork length, cm	FL
Standart length, cm	SL
Antidorsal distance, cm	AD
Antiventral distance, cm	AV
Antianal distance, cm	AA
Maximum body width, cm	SC
Maximum body height, cm	H
Minimum body height, cm	H1
Tail stalk length - from the end of the anal fin to the roots of the middle rays of the caudal fin, cm	PL1
Tail stalk length - from the end of anal fin to the end of the middle rays of the caudal fin, cm	PL2
Dorsal fin length, cm	LD
Dorsal fin height, cm	HD
Anal fin length, cm	LA
Anal fin height, cm	HA
Pectoral fin length, cm	LP
Abdominal fin length, cm	LV
Pecto – ventral distance, cm	PV
Ventro – anal distance, cm	VA
Maximum body girth, cm	CC
Metric head features	
Head lenght, cm	C
Snout length, cm	R
Maximum head height (before the 1st dorsal bony scute), cm	HC
Minimum head height (above the eye), cm	HCO
Behind eye area length, cm	CP
Horizontal eye diameter, cm	O
Inter orbital distance, cm	IO
Maximum head width, cm	BC
Distance from the beginning of the snout to a line passing through the middle of the front barbels` roots, cm	RC
Distance from the end of the snout to the mouth cartilaginous arch, cm	RR
Distance from the middle barbels` roots to the mouth cartilaginous arch, cm	RL
Longest / lateral / barbel`s length, cm	LC
Snout width at the middle barbels` roots, cm	SRC
Snout width at the mouth cartilaginous arch, cm	SRR
Mouth width, cm	SO
Lower lip`s break width, cm	IL
Meristic features	
Number of dorsal bony scutes	SD
Number of lateral bony scutes from the left side of the fish	SL1
Number of lateral bony scutes from the right side of the fish	SL2
Number of ventral bony scutes from the left side of the fish	SV1
Number of ventral bony scutes from the right side of the fish	SV2
Number of rays in the dorsal fin	D
Number of rays in the anal fin	A

Morphometric indices were calculated on the basis of morphometric measurements (Table 3). For statistical data processing IBM SPSS Statistics 21 was used.

RESULTS AND DISCUSSIONS

Metric features of the body in seven-year-old Siberian and Russian sturgeon hybrid of different sexes are shown in Table 4. Except the two indicators characterizing body height

(H, H1) and anal fin length (LA), female fish had higher average values. The total length of the body in females varied from 93.60 to 109 cm, and in males - from 91.8 to 107.00 cm. There is a slight variation (<10%) of the features related to the proportions of the individual body parts. The variation is higher (11.10%) only along the abdominal fin of female individuals.

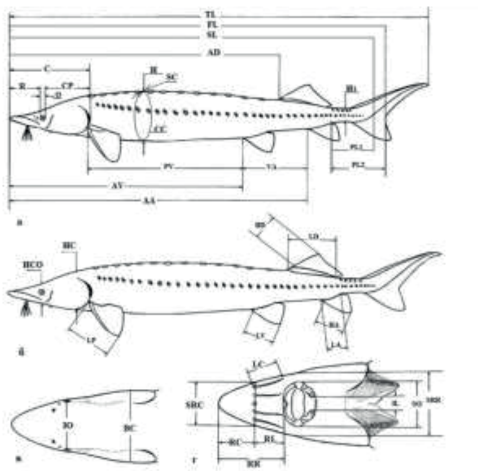

Figure 1. Sturgeon fish measurements scheme (Krylova and Sokolov, 1981; Svirski and Skirin, 2005)

Table 3. Morphometric indices

Indices	
CFF	Fulton's coefficient [(BW/SL^3)*100], %
IC	Condition index [BW/(SL*H*CC)*100], %
ICR	Modified Fulton's coefficient by Jones et al., 1999 (acording Richter et al., 2000) [BW/(SL^{2}H)*100]
IHB	High-backed index (SL/H)
IBB	Broad-backed index [(SC/SL)*100], %
ILH	Long-headed index [(C/SL)*100], %
IH	Hardness index [(CC/SL)*100)], %

Generally, in sturgeon species, sexual dimorphism is poorly developed, but some morphometric characteristics can show differences between the two sexes. In a study of *Huso huso* Falahatkar & Poursaeid (2014) did not establish a reliable relationship with sex in most of the studied morphological indices, but found one at the ratio of fork length to distance of snout to anterior of dorsal fin.

Maltsev & Merkulov (2006) developed a method for biometric sex determination in sturgeons based on head measurements using discriminant analysis. Barulin (2018) has developed a sex determination system in *A. ruthenus* based on the morphological features of dorsal scutes. Podushka (2008) reported differences in the shape of the pectoral fins in the Amur sturgeon *A. schrenckii*. Morphometric characteristics depend on the hybridization scheme and the participation of one species as the maternal or paternal form in interspecific hybrids. In case of hybridization between Russian and Siberian sturgeon more often research concerns the GUBA hybrid (with maternal form Russian sturgeon). The hybrid was first obtained in 1979 in Russia at the VNIRO Research Institute, and studies show that GUBA have better productive performance than their parental forms (Filipova & Zuevsky, 2008).

Hybrids, in aquaculture conditions, have higher survival and growth compared to purebred parental forms (Shivaramu et al., 2019). Efimov (2004) in a study of the GUBA hybrid found that most metric features are inherited patroclinically (by father), with the number of ventral and dorsal scutes also having patroclinal and lateral matroclinal (by mother) inheritance. The author notes that the variability in the hybrid is less compared to the parental forms on meristic features.

The hybrid with the participation of Siberian sturgeon as a maternal form (Ab x Ag) is less popular in sturgeon farming, but is assessed as promising for commercial sturgeon aquaculture (Chebanov et al., 2018). It shows good results in cultivation in various production technologies (Iskhakova & Khulmanova, 2014; Nikolova & Bonev, 2020). Such a hybrid in aquaculture conditions at the age of 5 years forms normally developed gonads, similar to pure Siberian sturgeon of the same age (Linhartová et al., 2018).

Szczepkowski et al. (2002) noted the importance of developing appropriate criteria, including meristic features - bony scutes, finrays and some metric features, to identify different Sturgeon hybrids.

Usually the ratio of individual measurements to the body length of the fish is calculated in morphometric studies. The analysis of the ratio of individual measurements to the body total length obtained in our study showed a significant difference on several indicators between individuals of different sexes (Table 5).

H/TL values (P<0.01) were higher in males than in females; H1/TL (P<0.05); LA/TL (P<0.01) and lower in AD/TL (P<0.05); AV/TL (P<0.05); AA/TL (P<0.05); HD/TL (P<0.05); HA/TL (P<0.05); LP/TL (P<0.001); LV/TL (P<0.05); PV/TL (P<0.01).

Table 4. Metric features of the body, cm

Features	Sex	X	Min	Max	±Sx	CV
TL	F	102.00	93.60	109.00	0.85	4.06
	M	99.3	91.8	107.00	0.86	4.25
FL	F	89.20	82.00	96.50	0.69	3.81
	M	86.00	75.3	93.3	0.85	4.82
SL	F	83.60	76.10	89.40	0.65	3.79
	M	80.5	73.00	87.60	0.70	4.27
AD	F	63.80	60.20	67.40	0.51	3.94
	M	60.9	54.60	67.00	0.54	4.37
AV	F	55.30	49.30	76.60	1.04	9.22
	M	51.60	46.90	57.00	0.54	5.13
AA	F	69.30	64.60	73.30	0.58	4.07
	M	66.10	58.80	72.70	0.68	5.07
SC	F	10.60	9.20	11.70	0.11	4.98
	M	10.20	9.00	11.40	0.11	5.43
H	F	11.90	11.00	12.90	0.12	4.74
	M	12.20	10.60	13.60	0.13	5.40
H1	F	3.30	2.94	3.62	0.03	5.19
	M	3.35	2.92	3.66	0.04	6.12
PL1	F	8.83	7.90	10.10	0.11	6.28
	M	8.61	7.85	10.60	0.15	8.30
PL2	F	14.80	13.10	16.30	0.16	5.25
	M	14.20	12.90	15.40	0.15	5.03
LD	F	11.50	9.10	12.70	0.16	6.77
	M	10.9	9.60	12.50	0.16	7.03
HD	F	9.84	8.50	11.30	0.14	7.07
	M	9.13	8.26	10.50	0.11	6.16
LA	F	5.55	4.00	6.30	0.10	9.16
	M	5.85	4.68	6.70	0.10	8.39
HA	F	10.20	7.80	11.70	0.18	8.64
	M	9.56	8.55	10.70	0.13	6.86
LP	F	13.2	11.70	14.70	0.16	6.07
	M	11.50	9.95	13.40	0.18	7.49
LV	F	8.48	5.39	9.80	0.19	11.10
	M	7.87	6.63	9.05	0.12	7.39
PV	F	35.60	31.80	38.30	0.34	4.66
	M	33.50	29.40	38.00	0.43	6.28
VA	F	15.20	13.70	17.30	0.18	5.89
	M	14.90	12.70	17.30	0.20	6.73
CC	F	37.40	36.00	40.40	0.33	4.26
	M	36.30	33.40	40.40	0.39	5.32

The differences between individuals of different sexes are clearly seen in Figure 2, where the exterior body and head profiles are presented.

A shorter head, broader body and longer back are desirable for sturgeon hybrids (Szczepkowski et al., 2002). Body shapes are associated with meat-producing characteristics. Szczepkowska et al. (2011) found the best commercially advantageous body proportions in five-year-old fish, with a relative head length of 24% of TL and a body height of 11.82% of TL studying the characteristics of the Siberian and Green Sturgeon hybrid.

The hybrids in our study are seven years old, which suggests a well-formed morphotype. The relative length of the head from TL is smaller than in the above study and is 18.4% in female and 18.6% in male fish, while in body height (H) the differences are not so great (in females 11.60%, and in males 12.30%).

Table 5. Individual measurements to the total length ratio of seven year old hybrid (Ab x Ag) body, %

Features	Sex	X	Min	Max	±Sx	CV
FL/TL	F	87.20	85.30	87.90	0.20	1.11
	M	86.60	75.10	89.80	0.58	3.31
SL/TL	F	81.70	78.80	84.20	0.27	1.60
	M	81.10	70.90	83.80	0.54	3.24
AD/TL	F	62.40*	60.00	64.60	0.27	2.10
	M	61.30*	58.40	63.90	0.30	2.37
AV/TL	F	54.00*	49.30	70.40	0.80	7.26
	M	51.90*	49.40	54.20	0.26	2.44
AA/TL	F	67.70*	63.90	70.10	0.29	2.09
	M	66.50*	60.60	69.90	0.41	3.01
SC/TL	F	10.30	9.08	11.00	0.10	4.71
	M	10.30	9.10	11.10	0.11	5.08
H/TL	F	11.60**	11.00	13.20	0.11	4.47
	M	12.30**	10.70	14.10	0.16	6.37
H1/TL	F	3.23*	2.91	3.85	0.04	5.75
	M	3.37*	2.91	3.83	0.04	6.35
C/TL	F	18.40	16.40	20.10	0.20	5.25
	M	18.60	16.50	21.0	0.18	4.83
PL1/TL	F	8.64	7.64	10.10	0.13	7.09
	M	8.68	7.48	10.80	0.14	7.94
PL2/TL	F	14.40	12.80	16.60	0.18	5.98
	M	14.30	13.00	15.20	0.13	4.39
LD/TL	F	11.24	9.72	12.62	0.12	5.26
	M	11.02	9.71	12.18	0.14	6.01
HD/TL	F	9.63*	8.02	10.70	0.13	6.77
	M	9.20*	8.22	10.60	0.13	6.76
LA/TL	F	5.43**	4.27	6.02	0.09	7.98
	M	5.89**	4.73	6.80	0.10	8.41
HA/TL	F	10.00*	8.21	11.10	0.14	6.96
	M	9.63*	7.99	10.40	0.12	6.20
LP/TL	F	12.90***	11.10	14.60	0.19	7.17
	M	11.60***	9.93	13.10	0.18	7.61
LV/TL	F	8.29*	5.09	9.71	0.18	10.50
	M	7.93*	6.99	8.83	0.10	5.89
PV/TL	F	34.80**	31.40	36.10	0.25	3.52
	M	33.70**	31.80	36.00	0.29	4.15
VA/TL	F	14.90	13.80	16.00	0.11	3.69
	M	15.00	13.40	17.10	0.15	4.89
CC/TL	F	36.60	34.10	40.60	0.32	4.35
	M	36.50	32.90	40.00	0.34	4.56

Differences between the values within the feature are significant: ****P<0.001, **P<0.01, *P<0.05*

Chebanov et al. (2018) indicate that the hybrid of Russian and Siberian sturgeon is more similar to Siberian, and in most metric and meristic features the hybrid occupies an intermediate position with a bias to the paternal species. Efimov (2004) found that age variability of morphometric features is observed in the Russian and Siberian sturgeon hybrid. The author notes that at an older age the hybrid phenotypically begins to resemble the Russian sturgeon more than at an younger age, and with age the head proportions change (the relative head length to the body length decreases and the snout length to the head length too). The results of the head metric features study in the hybrid of both sexes are presented in Table 6.

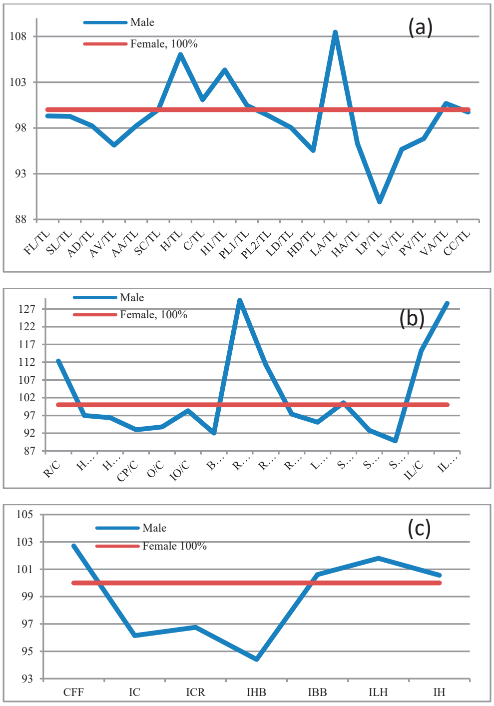

Figure 2. Exterior body profiles (a), head (b) and indices (c) in the hybrid of different sex.

Table 6. Metric features of hybrid (Ab x Ag) head at the age of seven years, cm

Features	Sex	X	Min	Max	±Sx	CV
C	F	18.8	17.30	21.00	0.20	5.25
	M	18.50	16.30	19.70	0.15	3.94
R	F	7.03	5.97	7.94	0.09	6.16
	M	7.75	6.30	8.95	0.13	8.01
HC	F	8.42	7.50	9.25	0.09	5.35
	M	8.02	7.12	8.88	0.09	5.80
HCO	F	5.76	5.20	6.30	0.07	5.94
	M	5.44	4.80	6.00	0.07	6.16
CP	F	10.8	9.45	11.60	0.12	5.35
	M	9.80	8.60	10.70	0.11	5.29
O	F	1.46	1.32	1.70	0.02	6.00
	M	1.34	1.21	1.45	0.02	6.23
IO	F	6.44	5.10	6.94	0.08	5.81
	M	6.20	5.70	6.70	0.06	4.44
BC	F	8.46	7.45	9.44	0.09	5.11
	M	7.63	6.92	8.25	0.07	4.57
RC	F	3.02	2.41	3.60	0.06	9.58
	M	3.83	2.45	4.80	0.13	16.10
RR	F	7.32	6.50	8.00	0.09	5.72
	M	8.00	6.05	9.28	0.14	8.56
RL	F	4.45	3.60	5.10	0.06	6.89
	M	4.25	3.70	4.82	0.06	6.94
LC	F	3.94	2.80	4.80	0.09	10.60
	M	3.68	2.50	4.30	0.10	13.10
SRC	F	5.87	4.60	6.77	0.08	6.79
	M	5.78	5.00	6.42	0.08	6.90
SRR	F	8.84	8.35	9.78	0.09	4.94
	M	8.04	7.30	8.78	0.08	4.73
SO	F	6.75	6.20	7.48	0.08	5.71
	M	5.94	5.20	6.70	0.07	5.70
IL	F	1.05	0.40	1.50	0.05	24.50
	M	1.18	0.80	1.75	0.05	22.60

The variation is low (<10%) for most of the features.

Mean levels of variation (16.10%) were found with respect to head length from the snout to the roots of the anterior barbels in male fish; the length of the lateral barbels in both sexes (10.60 and 13.10%). Significant variation (22.60 and 24.50%) in both sexes was found in the width of the lower lip break.

Table 7 shows the relationships between the metric features of the head and its length. The shape and proportions of individual parts of the head in sturgeons are an important diagnostic features.

Table 7. Head metric features to head length ratio of seven years old hybrid (Ab x Ag), %

Features	Sex	X	Min	Max	±Sx	CV
% of head length						
R/C	F	37.30***	34.30	39.50	0.27	3.61
	M	42.00***	36.60	46.50	0.51	5.97
HC/C	F	44.80	39.00	53.60	0.72	7.89
	M	43.50	37.70	49.10	0.52	5.84
HCO/C	F	30.60*	26.60	33.70	0.36	5.83
	M	29.50*	26.50	32.50	0.38	6.32
CP/C	F	57.20***	51.70	60.10	0.38	3.27
	M	53.20***	47.80	58.30	0.57	5.25
O/C	F	7.74**	7.10	8.63	0.09	6.00
	M	7.26**	6.60	8.77	0.10	6.84
IO/C	F	34.20	30.80	38.3	0.33	4.80
	M	33.60	29.90	35.90	0.33	4.83
BC/C	F	45.00***	39.50	48.70	0.55	6.00
	M	41.40***	38.10	46.30	0.38	4.50
RC/C	F	16.00***	13.70	17.90	0.22	6.73
	M	20.70***	15.00	26.50	0.64	15.10
RR/C	F	38.90***	35.60	41.70	0.29	3.60
	M	43.30***	37.10	48.20	0.64	7.24
RL/C	F	23.60	20.90	25.30	0.23	4.83
	M	23.00	20.80	26.40	0.32	6.73
LC/C	F	21.00	16.20	25.90	0.50	11.60
	M	19.90	13.30	23.20	0.49	12.00
SRC/C	F	31.20	27.60	35.20	0.39	6.11
	M	31.30	27.10	35.20	0.40	6.23
SRR/C	F	47.00***	42.40	50.30	0.44	4.61
	M	43.60***	38.30	48.30	0.47	5.23
SO/C	F	35.80***	33.20	38.10	0.26	3.53
	M	32.20***	29.40	36.90	0.39	5.90
IL/C	F	5.58*	2.13	8.13	0.28	24.70
	M	6.43*	4.11	9.64	0.31	23.50
% of the mouth width						
IL/SO	F	15.50***	9.54	22.10	0.75	23.70
	M	20.00***	14.00	28.70	0.91	22.40

Differences between the values within the feature are significant: ***P<0.001, **P<0.01, *P<0.05

The snout in male fish occupies a larger share of the head (P <0.001) than in females. The snout of female fish occupies from 34.3 to 39.50% of the head length, and in males from 36.60 to 46.50%, respectively.

There is no significant difference between female and male hybrids in the ratio of the maximum height of the head to its length. A significant difference in favor of female fish (P<0.05) was found in relation to the minimum height of head to its length.

The ratio behind eye area length (P <0.001); eye diameter (P<0.01); the head width

(P<0.001), the mouth (P<0.001) and the snout at the cartilaginous arch (P<0.001) to the head length were significantly higher in female fish; and in males, respectively, the length from the beginning of the snout to the roots of the barbels (P<0.001); from the end of the snout to the mouth arch (P<0.001); the width of the lower lip break (P<0.05) (Table 7; Figure 2). The ratio of the lower lip break to the mouth length in male fish is also significantly higher (P<0.001).

The morphometric indices of the hybrid are shown in Table 8.

Table. 8. Morphometric indices in a seven-year-old hybrid (Ab x Ag)

Indices	Sex	X	Min	Max	±Sx	CV
CFF	F	0.91	0.84	1.13	0.01	7.90
	M	0.93	0.81	1.33	0.02	12.50
IC	F	14.30*	12.50	15.60	0.14	4.65
	M	13.70*	11.60	15.90	0.23	8.08
ICR	F	6.39	5.43	7.06	0.08	6.00
	M	6.18	5.00	8.12	0.13	10.30
IHB	F	7.03**	6.14	7.40	0.06	4.02
	M	6.64**	11.30	7.73	0.09	6.60
IBB	F	12.50	11.90	13.70	0.11	4.40
	M	12.70	11.30	13.90	0.15	5.63
ILH	F	22.50	20.10	24.40	0.18	4.02
	M	22.90	20.60	25.60	0.20	4.31
IH	F	44.80	41.70	49.90	0.39	4.23
	M	45.10	40.20	51.10	0.48	5.24

Differences between the values within the feature are significant: ***P<0.001, **P<0.01, *P<0.05

Exterior indices are taken as a basis for conducting selection work with fish. High-backed and hardness index are especially important. They characterize producers and are directly related to productivity indicators. Khabzhokov et al. (2018) found that the hardness index reflects very well the characteristics of each individual in body weight, length, height, body thickness, gonadal development and obesity in selection work with carp. We did not find significant differences in CFF and ICR fatness indices between female and male fish but in female fish the IC values were significantly higher (P<0.05). The IC index shows the girth of the body, with the more voluminous abdominal area usually associated with more massive gonads in females. The values of the high-backed index (P<0.01) are higher in female fish (Figure 2). According to the other indices, the differences between the two sexes are not significant. The variability of features in fish is also related to the fish age and the rearing conditions. A great phenotypic variability is characteristic of Siberian sturgeon (Ruban, 2019). In our study of the hybrid, most of the calculated indices varied low (<10%). Higher, to average variation values were found in the CFF and ICR index for male fish. Both indices are related to fish fattening. The analysis results of the meristic features in the hybrids of different sex are presented in Table 9.

Table. 9. Meristic features of seven-year-old hybrid (Ab x Ag)

Features	Sex	X	Min	Max	±Sx	CV
SD	F	13.10***	10	16	0.26	9.67
	M	11.70***	9	14	0.23	9.70
SL1	F	35.40*	29	41	0.62	8.58
	M	33.40*	27	40	0.68	10.00
SL2	F	35.2*	27	39	0.52	7.20
	M	33.60*	27	39	0.72	10.50
SV1	F	9.88	8	8	0.23	11.40
	M	9.60	7	13	0.26	13.40
SV2	F	9.96**	8	12	0.23	11.40
	M	9.32**	7	11	0.23	12.30
D	F	38.40*	28	45	0.75	9.60
	M	36.10*	31	44	0.68	9.19
A	F	21.00*	13	26	0.70	16.30
	M	18.90*	15	24	0.45	11.80

Differences between the values within the feature are significant: ***P<0.001, **P<0.01, *P<0.05

Meristic features are important in sturgeon taxonomy (Sergeev, 2020). The author finds in his research for a Russian sturgeon SD 12.5 (10-17); SL 35.03 (26-48); SV 9.6 (7-12).

Romanov & Skirin (2011) found a high level of morphological variability in the number of bony scutes in a study of different sturgeon species and hybrids meristic parameters, with a particularly large amplitude found in the lateral ones. In the study of the authors of a complex hybrid of Siberian and Russian sturgeon (Ag x Ab) x (Ag x Ab) the number of bone shields was as follows - SL 40.46 ± 0.33 (33-47); SV 9.4 ± 0.08 (7-12); SD 13.46 ± 0.17 (11-16).

Szczepkowska et al. (2011) in the hybrid of Siberian and Green sturgeon found meristic features as follows: SD 9.16 ± 0.82; SL 33.05 ± 2.09; SV 8.69 ± 0.86; D 35.67 ± 2.59; A 22.92 ± 1.91, the established values for the number of bony scutes were less than the Siberian sturgeon, and the number of rays of D and A were almost the same. The authors found that there is an age variability on meristic features in this hybrid.

Most morphometric studies do not indicate the sex of the tested fish. There is no significant difference between fish of different sexes of the ventral scutes number on the left side in our study, and on the right side female fish have a larger number (P≤0.01), and their number varies from 8 to 12. The number of dorsal bony scutes in female fish is larger (P≤0.001), ranging from 10 to 16. The indicator varies from 9 to 14 in male fish. The difference in favor of female fish and the number of lateral scutes on the left and right is significant (P<0.05).

Female fish have a significantly higher (P≤0.05) number of rays in the dorsal and anal fin. The analysis generally shows a higher variation in the number of anal fin rays and in the number of ventral shields. The obtained results in our study on the characteristics of morphometric features of the Siberian and Russian sturgeon hybrid can be useful not only for aquaculture, but also when working with natural populations. The issues of "genetic pollution" are especially relevant for sturgeons in the wild. Development of sturgeon farming is one of the tools aimed at reducing the anthropogenic pressure on endangered natural populations, at the same time sturgeon aquaculture carries potential risks. Chebanov & Galich (2013) emphasize that a damage to fragile natural sturgeon populations can occur in case of fish introduction from aquaculture farms into the environment. Friedrich (2018) notes that the ability of sturgeons to hybridize and to produce fertile offspring is one of the threats to natural populations when non-native sturgeon species enters their range. Cases of natural reproduction of Siberian sturgeon have already been reported in the Danube, as well as the presence of hybrid forms between it and the local Sterlet (Ludwig et al., 2009). In connection with the above, it is important to have databases on the morphometric characteristics of different interspecific sturgeon hybrids.

CONCLUSIONS

The comparative characteristic of female and male individuals of a Siberian and Russian sturgeon hybrid (F1 Ab x Ag) at the age of seven show that there are differences in morphometric characteristics between the two sexes. Female hybrids have a bigger high backed index and have a higher degree of fatness, expressed by the IC index. In female fish, the antiventral and pectoventral distance is greater. The head of the female hybrids, compared to the male, is wider, higher in the area above the eye and has a relatively larger space behind the eye. Female fish have a relatively larger eye diameter; relatively wider mouth and wider snout at the cartilaginous arch; higher dorsal and anal fin and longer pectoral and abdominal one. Male hybrids have a higher body relative to the absolute length of the body, and a higher caudal stalk. Their anal fin is longer. The head of male fish compared to females has a more massive and longer snout; greater distance from the snout end end to the mouth and greater width of the lower lip break. The ratio of the mouth break to its length of male fish is higher.

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