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COMPARATIVE MORPHOMETRIC ANALYSIS OF RUSSIAN STURGEON (*ACIPENSER GUELDENSTAEDTII*) MALE AND FEMALE INDIVIDUALS AT THE AGE OF SEVEN YEARS

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Abstract

Seven-year-old male (n = 25) and female (n = 25) Russian sturgeons (Acipenser gueldenstaedtii), grown under the same conditions on a super-intensive cage farm, 36 plastic and 7 meristic traits are studied and 7 morphometric indices are calculated. Female fish had significantly (P <0.001) better fattening than males, their body was more compact (P <0.001) and thicker (P <0.01). In females, the ratio of antiventral distance, back thickness and body girth to the total body length is higher. In male fish, the ratios of the head lengths, the caudal stalk, the ventral fin, the anal fin height and the ventro-anal distance to the total body length are relatively larger. In female fish, the height and length of the space behind the eye are greater, they have a wider mouth, a larger eye and a wider snout. In males, the long-headed index is higher (P <0.05), the snout and the distance from its end to the mouth are longer, the lower lip interruption is larger. Female fish have significantly fewer ventral bone scutes the left (P <0.05) and the right (P <0.01) sides of the body.

Key words*: aquaculture, morphometric features, sturgeon.*

INTRODUCTION

The situation with natural Sturgeon populations raises serious concerns (Sandu et al., 2013, etc.). Vasileva (2015) emphasizes that a complex approach is needed in the conditions of constant reduction of natural Sturgeon stocks, including increasing the scale of natural and artificial reproduction, formation of productive herds in controlled conditions and Sturgeon aquaculture development. A number of authors note the importance of creating *in vivo, ex sit*u genetic collections of Sturgeon (Morev, 1999; Friedrich, 2018, etc.). Existing sturgeon *ex-situ* live gene banks are used for Sturgeon rehabilitation programs (Halasi-Kovacs, 2019).

Initially, Sturgeon conservation programs included mainly artificial reproduction of special sturgeon hatcheries. At the same time, the work of the latter is increasingly difficult due to the lack of necessary sexually mature individuals from natural populations (Ruban et al., 2015; Salmanov et al., 2016). Sturgeon aquaculture plays an important role in reducing the anthropogenic pressure on natural populations, as a subsector providing desirable delicacies for humans, as well as an important element of endangered species rescue programs (Nikolova, 2019; Chandra and Fopp-Bayat, 2021).

The goals of commercial Sturgeon aquaculture and activities related only to *ex situ* concervation differ in nature (Reinartz et al., 2016), but available Sturgeon species aquaculture herds can also be a source of valuable genotypes for restocking programs.

Sturgeon aquaculture is developing at a good rate, with developed technologies for breeding, rearing, feeding, etc. At the same time, appropriate zootechnical approaches for breeding are still to be introduced everywhere in Sturgeon breeding. It is necessary to establish the phenotypic values of biological characteristics of populations and herds at the beginning of each selection activity. Different methods are used to characterize fish, one of the most widely used being morphometric analysis (Pavlov, 2012; Svirsky and Skirin, 2005, etc.). Morphometric parameters and morphophysiological indices have been studied in different species, breeds and populations (Morev, 1999; Khosrow and Amirkolaie, 2010; Treer et al., 2000, etc.); in fish of different sexes and from separate ecosystems (Coban et al., 2011; Jawad et al., 2017; Khristenko & Kotovska, 2017; Vélez-Arellano et al., 2017).

Russian sturgeon is one of the most important species for Sturgeon aquaculture in a number of countries around the world (Kim et al., 2019; Nikolova, 2019; Sergeev, 2020). When farmed on industrial farms, the fish are under unusual conditions. In this regard, the regularities of development in the conditions of real specific industrial technologies are of interest (Nikolova et al., 2018).

We set ourselves a goal to make a comparative morphometric characteristic of Russian sturgeon of different sexes on the same age grown on an industrial cage farm located in South-Eastern Bulgaria.

MATERIALS AND METHODS

The study was carried out with Russian sturgeon (*Acipenser gueldenstaedtii*) male and female individuals at the age of seven years 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 done with commercial granulated sturgeon feed (Table 1). Twenty five Russian sturgeon fish of different sexes were randomly selected for morphometric analyzes at the end of the vegetation period (in November). The mean body weight of females was 5000.1 ± 140 g and that of males -4000.5 ± 100 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.).

The studied indicators and codes for their designation are presented in Table 2.

A measurement scheme proposed by Krilova & Sokolov (1981) specifically for sturgeon and their hybrids was used (Figure 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%		

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

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 body heights.

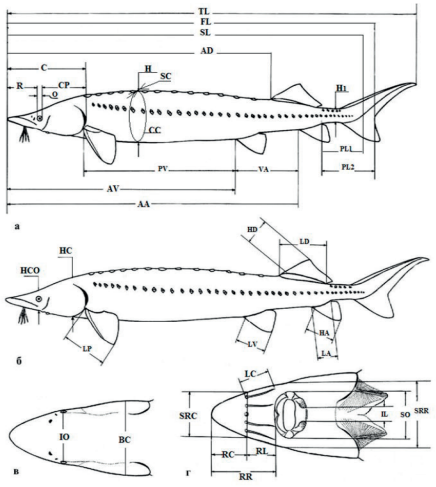

Figure 1. Sturgeon fish measurements scheme (Krylova and Sokolov, 1981, Svirski and Skirin 2005)

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

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], %

RESULTS AND DISCUSSIONS

Metric features of the body in seven-year-old Russian sturgeons of different sexes are shown in Table 4.

Total length (TL) at the age of seven years ranged from 93 to 106 cm in females, and 90-107 cm in males. In the natural area of Russian sturgeon (Caspian Sea) in six-summer-old fish the total length (TL) varies in the range of 70-80 cm, and with age there is a big difference in linear parameters between the fish who live in the sea (which are smaller), and migrated to freshwater (males with TL - 124 - 126, and females - 141-146 cm) (Gritsenko et al., 2006). In another study of Russian sturgeon from the Caspian region, the fish had a TL of 1220.53 ± 14.31 mm (Birstein et al., 2005).

Table 4. Metric features of Russian sturgeon body at the age of seven years, cm

Features	Sex	X	Min.	Max.	± Sx	CV
TL	F	99.20	93.00	106.00	0.71	3.26
	M	97.50	90.00	107.00	0.84	3.96
FL	F	86.20	81.30	97.40	0.78	4.15
	M	84.80	79.00	93.00	0.68	3.65
SL	F	80.70	77.20	85.40	0.53	3.03
	M	77.00	74.00	87.10	0.65	3.74
AD	F	62.10	58.80	66.20	0.48	3.56
	M	60.30	56.10	66.1	0.53	4.00
AV	F	53.90	50.50	57.30	0.46	3.94
	M	50.90	46.6	55.00	0.42	3.78
AA	F	67.20	63.60	71.00	0.52	3.52
	M	65.30	59.10	71.00	0.55	3.86
SC	F	9.85	8.50	10.70	0.12	5.35
	M	9.20	8.20	10.30	0.12	5.74
H	F	12.30	11.00	13.60	0.14	5.06
	M	12.00	10.7	13.70	0.15	5.92
H1	F	3.59	3.25	4.22	0.06	7.07
	M	3.56	3.10	3.94	0.04	5.35
PL1	F	8.39	6.90	9.45	0.14	7.64
	M	9.66	8.25	11.80	0.18	8.40
PL2	F	13.7	11.80	14.70	0.17	5.66
	M	15.1	12.70	17.20	0.23	6.86
LD	F	10.00	8.75	10.80	0.12	5.69
	M	10.10	8.65	12.1	0.22	9.82
HD	F	9.18	7.20	11.10	0.22	10.80
	M	9.36	6.80	12.10	0.30	14.80
LA	F	5.54	4.05	6.90	0.15	12.10
	M	5.70	4.20	11.1	0.29	23.60
HA	F	9.03	7.10	10.50	0.21	10.6
	M	10.00	8.17	11.40	0.21	9.58
LP	F	11.70	10.40	13.10	0.16	6.44
	M	11.60	8.45	14.50	0.37	14.6
LV	F	7.67	7.10	9.10	0.17	10.20
	M	8.34	6.12	10.10	0.27	15.0
PV	F	36.50	32.60	40.00	0.42	5.30
	M	33.30	30.40	39.50	0.47	6.54
VA	F	13.90	11.10	15.80	0.25	8.37
	M	15.00	11.50	20.50	0.43	13.10
CC	F	37.30	34.10	40.00	0.42	5.12
	M	33.80	30.20	37.00	0.37	5.02

In Podushka's (1988) study of Russian sturgeon from Don river TL varied from 108 to 210 cm, with an average length of 161.3 ± 1.22 cm in female fish and 130.9 ± 1.11 cm in males.

A study of morphological variability allows to assess the rate of reaction in a particular species, its adaptive capacity (Romanov and Skirin, 2011). This is especially important for farmed fish.

The measured body lengths in both sexes have a slight variation (<10%) (Table 4). The same goes for the minimum and maximum heights;

body width and girth. Higher levels of variation were found with respect to fin sizes. The variation ranged from low (in the length of the dorsal and pectoral fins) to medium (<25%), with the highest values found in the length of the male Russian sturgeons anal fin. The variation in ventro-anal distance of male fish, is relatively higher (over 1.5 times).

Metric features of the fish head of both sexes are shown in Table 5. The metric features of the head are an important part of the morphometric analysis in sturgeons. Salmanov et al. (2016) note that in sturgeons, the indicators characterizing the size of head parts should be considered as species-specific differences. It is important for each study to be performed with fish at known age. Svirski and Skirin (2005) point out that the metric features of the head can change significantly in the process of ontogenesis, and it is these features that show allometry with an increase in the size and age of the fish. Svirsky (1968) and Ruban (1999) in a study of Amur and Siberian sturgeons found that head indices differed significantly in young and mature individuals.

Table 5. Metric features of Russian sturgeon head at the age of seven years, cm

Features	Sex	X	Min.	Max.	± Sx	CV
C	F	16.50	15.60	17.80	0.12	3.27
	M	16.80	15.50	17.90	0.16	4.25
R	F	5.25	4.70	6.25	0.09	7.71
	M	6.40	4.71	7.80	0.15	10.9
HC	F	8.78	7.80	9.80	0.15	8.03
	M	8.56	7.50	13.30	0.25	13.6
HCO	F	5.68	5.23	6.70	0.07	5.86
	M	5.35	4.75	5.85	0.06	5.47
CP	F	10.30	9.70	11.10	0.10	4.53
	M	9.50	8.80	10.30	0.09	4.22
O	F	1.60	1.20	2.10	0.05	15.60
	M	5.35	1.20	2.38	0.06	5.47
IO	F	6.07	5.71	6.45	0.04	3.07
	M	6.26	5.80	6.82	0.06	4.35
BC	F	7.75	7.22	8.30	0.06	3.64
	M	7.89	7.35	8.53	0.07	3.97
RC	F	1.52	1.20	1.90	0.04	12.60
	M	2.62	1.46	3.58	0.10	17.60
RR	F	5.51	4.50	6.30	0.09	7.49
	M	6.87	4.97	7.95	0.16	11.0
RL	F	3.90	3.20	4.80	0.09	10.70
	M	4.50	3.70	5.20	0.09	9.67
LC	F	2.83	1.95	3.20	0.07	11.20
	M	2.99	1.70	3.88	0.11	17.6
SRC	F	4.75	4.10	5.77	0.09	8.59
	M	4.87	4.45	5.85	0.07	6.76
SRR	F	8.06	7.70	8.80	0.07	4.24
	M	7.78	7.05	8.58	0.08	4.58
SO	F	5.95	5.50	6.70	0.06	4.94
	M	5.21	4.82	5.90	0.07	5.88
IL	F	1.46	0.80	2.15	0.07	21.30
	M	1.61	1.30	2.10	0.05	14.60

We have not found significant variation of both sexes in metric features of the Russian sturgeon head. The variation in eye diameter of female fish is at medium levels (15.60%).

Table 6. Individual measurements to the absolute length ratio of seven year old Russian sturgeon body, %

Features	Sex	X	Min	Max	±Sx	CV
FL/TL	F	86.88	83.05	96.44	0.57	3.00
	M	87.02	84.42	96.13	0.50	2.62
SL/TL	F	81.32	78.48	84.84	0.32	1.83
	M	82.20	79.47	89.28	0.44	2.44
AD/TL	F	62.54	59.05	65.68	0.37	2.72
	M	61.96	58.82	70.17	0.51	3.75
AV/TL	F	54.28***	51.46	58.21	0.39	3.33
	M	52.23***	49.95	58.01	0.42	3.67
AA/TL	F	67.69	64.00	72.21	0.39	2.62
	M	67.06	64.51	73.81	0.43	2.97
SC/TL	F	9.92**	9.14	10.84	0.10	4.72
	M	9.46**	8.45	10.50	0.14	6.72
H/TL	F	12.36	11.46	13.89	0.12	4.53
	M	12.28	11.45	15.11	0.19	7.04
H1/TL	F	3.62	3.17	4.18	0.05	6.27
	M	3.66	3.13	4.14	0.05	6.09
C/TL	F	16.61**	15.80	18.05	0.12	3.25
	M	17.22**	15.66	19.34	0.18	4.83
PL1/TL	F	8.45***	7.42	9.36	0.12	6.34
	M	9.92***	8.67	11.86	0.18	8.40
PL2/TL	F	13.78***	12.65	15.22	0.15	4.96
	M	15.50***	12.83	17.24	0.21	6.08
LD/TL	F	10.12	9.26	10.95	0.11	4.90
	M	10.40	9.11	11.75	0.18	8.12
HD/TL	F	9.24	7.14	10.57	0.19	9.46
	M	9.60	6.98	12.11	0.29	13.75
LA/TL	F	5.59	4.01	7.09	0.16	12.75
	M	5.88	4.24	12.33	0.34	26.81
HA/TL	F	9.10***	7.29	10.38	0.20	9.83
	M	10.30***	8.51	11.93	0.20	8.82
LP/TL	F	11.83	10.62	13.05	0.17	6.63
	M	11.94	8.58	15.00	0.39	15.04
LV/TL	F	7.73*	6.48	8.88	0.15	9.16
	M	8.56*	6.30	10.36	0.29	15.31
PV/TL	F	36.75***	33.57	40.48	0.42	5.23
	M	34.15***	31.92	40.10	0.45	6.10
VA/TL	F	13.98**	11.67	15.54	0.23	7.60
	M	15.40**	12.57	21.13	0.41	12.19
CC/TL	F	37.60***	35.30	41.01	0.32	3.85
	M	34.75***	31.44	39.23	0.41	5.40

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

In male fish, the variation in this indicator is almost three times less. In terms of barbel length, the variation is greater in male fish. The highest value of the coefficient of variation is in the indicator width of the lower lip break in female fish (21.3%), but its value is also within the average level of variation

The comparative analysis of the individual parameters ratio to the total body length (Table 6) shows that there are significant differences between Russian sturgeons of different sexes.

The ratios - AV/TL ($P<0.001$); SC/TL ($P<0.01$); PV/TL ($P<0.001$) and CC/TL ($P<0.001$) are higher in female fish; and C/TL

(P<0.01); PL1/TL (P<0.001); PL2/TL (P<0.001); HA/TL (P<0.001); LV/TL (P<0.05); VA/TL (P<0.001) are smaller.

Significant differences were found between individual sexes and in the relative values of the individual features of the head to its length (Table 7). The values in female individuals are higher at the HCO/C ratios (P<0.001); CP/C (P<0.001); O/C (P<0.05); SRR/C (P<0.001); SO/C (P<0.001); and smaller respectively at R/C (P<0.001); RC/C (P<0.001); RR/C (P<0.001) (Figure 3). The ratio of the lower lip break to the mouth width is less (P<0.001) in female Russian sturgeons.

The findings of Birstein et al. (2005) C/TL, H/TL, AD/TL, AV/TL, AA/TL, LP/TL PV/TL are higher than in our study, while the dorsal and anal fin height and length are smaller.

Table 7. Head metric features to head length ratio of seven years old Russian sturgeon, %

Features	Sex	X	Min	Max	±Sx	CV
% of the head length						
R/C	F	31.84***	28.91	37.88	0.48	6.91
	M	38.08***	29.81	42.90	0.67	8.04
HC/C	F	53.25	48.48	61.30	0.80	6.88
	M	51.20	44.13	82.35	1.71	15.29
HCO/C	F	34.51***	31.89	41.36	0.47	6.27
	M	31.96***	28.70	37.74	0.42	6.01
CP/C	F	62.73***	59.15	67.92	0.46	3.36
	M	56.74***	51.40	63.83	0.71	5.75
O/C	F	9.67*	7.41	12.80	0.31	14.72
	M	8.77*	6.73	14.69	0.35	18.47
IO/C	F	36.84	34.03	38.51	0.24	3.01
	M	37.36	35.48	39.42	0.24	2.93
BC/C	F	47.03	44.90	49.11	0.29	2.81
	M	47.08	45.41	49.12	0.27	2.64
RC/C	F	9.25***	7.46	11.31	0.24	11.97
	M	15.57***	9.01	19.69	0.54	15.89
RR/C	F	33.42***	28.85	36.19	0.50	6.85
	M	40.89***	30.68	44.41	0.78	8.72
RL/C	F	23.68***	20.37	28.48	0.51	9.95
	M	26.81***	23.33	33.21	0.51	8.80
LC/C	F	17.21	12.34	19.87	0.43	11.52
	M	17.78	10.97	22.17	0.61	15.71
SRC/C	F	28.83	24.40	34.35	0.52	8.32
	M	29.05	26.02	34.21	0.43	6.84
SRR/C	F	48.92***	45.56	53.92	0.40	3.75
	M	46.43***	43.52	49.60	0.36	3.58
SO/C	F	36.13***	32.07	39.88	0.37	4.66
	M	31.09***	27.94	34.69	0.39	5.82
IL/C	F	8.84	4.90	12.49	0.39	20.36
	M	9.63	6.88	12.96	0.33	15.68
% of the mouth width						
IL/SO	F	24.48***	13.01	34.40	1.06	19.79
	M	30.94***	21.67	37.37	0.89	13.23

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

Salmanov et al. (2016) found similar to our results in seven-year-old Persian sturgeon body propotions of indeterminate sex - AA - 67.4 ± 0.31; AV - 52.4 ± 0.25; AD - 61.2 ± 0.31% of TL. In the same study, the found head proportions were similar to those obtained for female fish in terms of R/C, CP/C, SO/C, and averaged between the two sexes in terms of RC/C and RR/C.

External profiles are used to assess the physique of animals, and in fish they are built on the basis of the ratio of each feature and the total body length. Exterior profiles are used in the characterization of individual Sturgeon species and hybrids (Morev, 1999, etc.). The author notes the importance of studying the phenotypic variability of morphological features in fish, along with biochemical genetic studies.

Graphically presented profiles of body, head and indices of Russian sturgeon of both sexes in our study are presented in Figure 2.

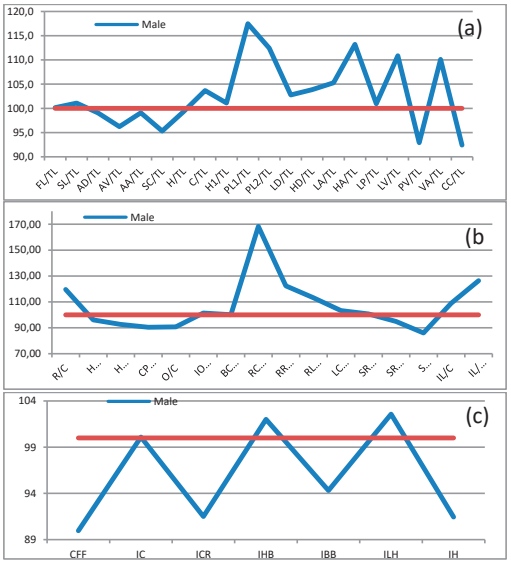

Fig. 2. Exterior profiles of body (a), head (b) and indices (c) in Russian sturgeon of different sexes

We calculated 7 exterior indices based on the measurements (Table 8).

Different coefficients of fatness are used in different scientific studies related to the exterior of fish, which is why we calculated several main indices used in fish farming - CFF, IC and ICR (Table 8). This gives a good opportunity to compare the results obtained by us with those obtained by other authors.

The Fulton's coefficient (CFF) is a classic method for determining the condition of fish by

body weight and standard body length. The coefficient is studied not only in different species, but also in different fish breeds. Thus, Cekov (1985) and Nikolova (2015), in relation to CFF, have found significant breed differences in carp. CFF remains an important index in fish research, despite its shortcomings. Kolisnyk et al. (2014) indicate that CFF shows the ability of fish to absorb available food. McPherson et al. (2011) found that there is no relationship between CFF and mesenteric fat, but there is between the level of fatty acids in muscle.

Table 8. Morphometric indices in a seven-year-old Russian sturgeon

Indices	Sex	X	Min	Max	±Sx	CV
CFF	F	0.97***	0.86	1.11	0.01	6.49
	M	0.87***	0.73	1.05	0.02	10.3
IC	F	13.8	12.80	16.20	0.16	5.38
	M	13.9	11.60	15.40	0.21	7.01
ICR	F	6.40***	5.75	7.28	0.08	5.90
	M	5.85***	5.09	6.87	0.10	8.21
IHB	F	6.59	6.11	7.08	0.06	4.29
	M	6.72	5.44	7.15	0.10	6.49
IBB	F	12.20**	11.00	13.20	0.12	4.44
	M	11.50**	10.10	12.60	0.17	6.68
ILH	F	20.40*	19.10	21.80	0.15	3.33
	M	21.00*	18.60	22.30	0.22	4.77
IH	F	46.20***	43.10	50.10	0.39	3.83
	M	42.3***	37.60	45.40	0.50	5.46

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

A number of coefficients have been developed in order to improve the accuracy of calculating the fattening of live fish, which includes more external indicators. Thus, in ICR, body height is taken into account, and in IC - body height and girth.

The data in Table. 8. show similar trends in CFF and ICR comparisons in both male and female Russian sturgeons. These indices demonstrate that female Russian sturgeons have significantly (P<0.001) better fattening than males of the same age under the same breeding conditions (Figure 2).

No significant differences were found between the sexes regarding the IC and the high back index, and the difference in body thickness (P<0.01) was in favor of female fish. The long-headed index was higher (P<0.05) in male fish and the hardness index in female fish (P<0.001).

Meristic signs in Russian sturgeon of different sex are presented in Table 9. The number of dorsal, lateral and ventral bony scutes in Sturgeons is an important taxonomic feature (Podushka, 1988), as the author cites data from Ruban and Sokolov, and Stroganov, that the number of bony scutes can be significantly influenced by environmental conditions, especially the temperature. Romanov and Skirin (2011) found that there is a high level of morphological variability in the number of bony scutes in some Sturgeon species and their hybrids, with a particularly large amplitude of variation in lateral bony scutes.

The study by Romanov and Skirin (2011) shows that in hybrids involving Russian sturgeon, the number of dorsal scutes was 13.46 - 13.86 at a limit of 11-16; the number of the lateral scutes - 40.46-42.06 at limit values 33-49 (CV 6.80-8.38%); the number of ventral scutes - 9.31-9.40 at limit values 7-12 (CV 7.84-8.83%).

Sergeev (2020) points out that there are no big differences in the number of abdominal scutes in a comparative analysis between Russian and Persian sturgeon, there are small differences in the number of dorsal, and clear differences in the number of lateral scutes. In this study, the number of dorsal scutes in Russian sturgeon was 12.5, ranging from 10 to 17; the laterals - 35.03 (from 26 to 48); the ventral ones - 9.61 (from 7 to 12). In Podushka's (1988) study of Russian sturgeon from the Don River, the mean SD number in female fish was 11.57 ± 0.11 (8-15); SL1 31.18 ± 0.31 (20-43); SL2 31.17 ± 0.27 (24-38); SV1 9.76 ± 0.10 (7-12); SV2 9.68 ± 0.09 (7-13), and in males, respectively - SD 11.56 ± 0.12 (9-15); SL1 30.18 ± 0.27 (24-39); SL2 30.31 ± 0.24 (23-38); SV1 9.61 ± 0.10 (8-12); SV2 9.60 ± 0.10 (8-13).

In our study, the number of dorsal scutes in females was from 9 to 13, and in males from 8 to 13, and no significant difference in the indicator was found in fish of different sexes. The coefficient of variation is medium (CV 10.3-10.6%), slightly exceeding the maximum level for a low degree of variation.

The number of lateral bony scutes on the left side of the fish varies from 24 to 30 in females and from 25 to 32 in males. There is a low degree of variation in the indicator (CV 7.6-8.23). A difference was found between the number of lateral scutes on the left and on the right side. Their number in female fish varies from 22 to 31 (CV 7.66%) on the right, and in

males from 25 to 34 (CV 9.08%). Female fish have significantly fewer ventral bony scutes on both the left (P<0.05) and right (P<0.01) sides. The maximum number of ventral scutes in male and female fish on both sides of the body is the same - 11. The minimum number of ventral scutes on the left side in female fish is 7, and in males 8. Eight is the minimum number of scutes on the right side in fish of both sexes. The highest coefficient of variation on the feature was obtained for the left side in female fish (CV 12.30%).

Table 9. Meristic features of seven-year-old Russian sturgeon

Features	Sex	X	Min	Max	±Sx	CV
SD	F	11.30	9	13	0.25	10.30
	M	11.20	8	13	0.26	10.60
SL1	F	27.5	24	30	0.46	7.66
	M	28.10	25	32	0.51	8.23
SL2	F	27.10	22	31	0.46	7.66
	M	28.23	25	34	0.56	9.08
SV1	F	9.14*	7	11	0.25	12.30
	M	9.73*	8	11	0.18	8.50
SV2	F	8.86**	8	11	0.19	10.00
	M	9.68**	8	11	0.20	9.23
D	F	32.20	21	39	0.90	12.80
	M	34.50	23	45	1.12	15.00
A	F	19.90	16	25	0.44	10.10
	M	19.60	16	23	0.44	10.40

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

Between the sexes of Russian sturgeon no significant differences were found in the amount of rays in the dorsal and anal fins. The amount of rays in the dorsal fin varies from 21 to 39 in female fish, and in the anal - from 16 to 25. In males, respectively, from 23 to 45 and from 16 to 23. The highest variation, within the average, in the number of the rays in the studied fins were found to be dorsal fin in male individuals.

CONCLUSIONS

Comparative characteristics of female and male Russian sturgeon at the age of seven showed that there are differences in morphometric characteristics between the two sexes. The female Russian sturgeon has significantly better fattening (P<0.001); their body is more compact (P<0.001) and thicker (P<0.01). They have a higher ratio of anti-ventral distance, back thickness and body girth to the total body length. The proportions of the head in female individuals are characterized by greater height and length of the space behind the eyes; wider mouth; larger eye and wider snout at the mouth cartilaginous arch. The number of dorsal bony scutes varies from 9 to 13; lateral on the left side - from 24 to 30, and on the right - from 22 to 31; ventral on the left - from 7 to 11, and on the right - 8-11. The number of rays in the dorsal fin is from 21 to 39, and in the anal from 16 to 25. Female fish have a significantly smaller number of ventral bony scutes compared to males from both the left (P<0.05) and the right (P<0.01) side of the body. Male fish have a larger head than females. The ratio of the head length, the caudal stalk, the ventral fin, the anal fin height, the ventro-anal distance to the total body length is greater. In males, the long-headed index is higher (P<0.05), the snout and the distance from its end to the mouth are longer, the lower lip brake is larger. The number of dorsal bony scutes varies from 8 to 13; lateral on the left side - from 25-32, and on the right from 25 to 32; ventral on both sides of the body from 8 to 11. The number of rays in the dorsal fin is from 23 to 45, and in the anal - from 16 to 23.

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