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GONADOSOMATIC INDEX OF STURGEON, BELUGA AND STELLATE STURGEON DURING THEIR LIFE PERIOD IN THE RIVERS

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ГОНАДОСОМАТИЧЕСКИЙ ИНДЕКС ОСЕТРА, БЕЛУГИ И СЕВРЮГИ В РЕЧНОЙ ПЕРИОД ЖИЗНИ

The results of the study of morphophysiological variability of sturgeon migrating to the river Volga from the Caspian Sea are presented. Gonadosomatic indices of sturgeon, beluga and stellate sturgeon for the periods 1970–1973 and 2002–2005 are compared.

Key words: sturgeon, beluga, stellate sturgeon, river Volga, gonadosomatic index, morphophysiological parameters.

Приводятся результаты исследования морфофизиологической изменчивости осетровых рыб, мигрирующих в р. Волгу из Каспийского моря. Определен гонадосоматический индекс белуги, осетра и севрюги в сравнительном виде за 1970–1973 гг. и 2002–2005 гг.

Ключевые слова: осетр, белуга, севрюга, река Волга, гонадосоматический индекс, морфофизиологические показатели.

Introduction

Knowledge of the species, population, gender, age and individual variability, morphological and physiological parameters of fish is required to assess the physiological status of individual populations in different stages of their life cycle and population response to changing environmental conditions [1–3], and to detect intrapopulation groups. Morphological studies in conjunction with the environmental conditions are of particular relevance for the sturgeon to their specific values, the upcoming use as artificial breeding sites, acclimatization and hybridization and changes in environmental conditions such relict fish due to the industrial development of developing hydrocarbons in the Caspian Sea.

Information of morphological, physiological and biochemical indices of sturgeon in European countries are quite few [1, 3, 4], but there is no comparative data.

The purpose was to study the variability of gonadosomatic index of sturgeon, beluga and stellate sturgeon in the river life period, that is, running, and then to compare the data available, since the difference in the collection of material is almost 40 years old.

Materials and methods

The main objects of the study were sturgeon fish during their life in the river Volga.

The material was collected in 1970–1973 and 2002–2005. There were chosen more than 4000 species of beluga, sturgeon and stellate sturgeon. To assess the state of the fish sex, the degree of gonad maturity, weight, length and age have been taken into account. To assess the physiological state of the fish a set of morphological parameters (the relative weight of the heart, liver, kidney, spleen, and gonads) has been examined. The results (indices of heart, liver, kidneys and gonads) were treated statistically [5, 6]. The calculation of basic statistical data was performed on personal computers.

Morphological parameters of sturgeon in the river life period

Indicators of the relative weight of the fish depend on their physiological state. In the III, III-IV, IV degrees of the gonad maturity the increase in relative weight of liver, heart, spleen, and kidneys of male and the index of female gonads is revealed.

The changes in gonadosomatic index should be especially stressed. At maturity females have 4-5 times higher index than the males does. Consequently the costs of development of the female gonads are also higher than the male ones. Obviously, in this regard, the sturgeon female with the III, III–IV, IV degrees of gonad maturity the relative weight of liver, spleen, kidney and heart is less in comparison with those of the corresponding male gonad maturity. The relative weight of the gonads, on the contrary, in females is higher than that of males. Higher indices of running in males are evidently due to their greater functional activity compared with females.

A comparative study of the relative weight of the major internal organs of the Russian sturgeon, beluga and stellate sturgeon, that is, at the entrance of the Caspian sturgeon, have revealed the existence of specific features of these parameters [1, 3, 4, 7]. Continuing this line of the research, in 2002–2005 we defined the index of the liver and gonads of fish with the III, III-IV, IV degrees of gonad maturity. All data have been statistically treated.

Morphological indicators of beluga

The most important morphological and physiological parameters of sturgeon in pre-spawning period is a gonadosomatic index, i. e. the ratio of gonad weight to body weight. Considering the gonadosomatic index in beluga females with the III, III–IV, IV degrees of gonad maturity, it can be noted that they undergo sharp seasonal variations. Thus, the gonadosomatic index of the running sturgeon females caught in the river Volga in the early 2000's is higher than that of the winter-spring migrants (tab. 1).

Table 1

Seasonal variability of morphological and physiological parameters of sturgeon in the life period in the Volga River, 2002–2005

Fish	Sex, gonad maturity II, III–IV, IV	Half-year	Number of copies, *n*	Gonadosomatic index, % *M* ± m – vibration
Beluga	♀	I	29	15.6 ± 0.2 12.6–18.0
		II	23	14.0 ± 0.18 11.0–17.0
	♂		20	3.5 ± 0.3 1.4–6.6
Sturgeon	♀	I	102	13.4 ± 0.12 10.3–16.6
		II	242	14.6 ± 0.1 11.6–22.0
	♂		55	3.8 ± 0.18 0.9–7.0
Sevruga	♀	I	421	22.8 ± 0.2 19.4–26.5
		II	212	15.6 ± 0.5 13.0–23.0
	♂		60	4.3 ± 0.3 1.2–7.3
In total			1 164	

Running beluga females at this stage of maturity have a higher gonadosomatic index than the males do. Gender differences were found both in spring and autumn. In running female gonad index peak in April is 16.5 ± 0.25%, in autumn it is somewhat reduced. The minimal gonadosomatic index of fish caught in 2002–2005 registered in June is 10.0 ± 0.18 %. If females have an average gonadosomatic index 14.0 and 15.6 %, while the males – 3.5 ± 0.03 %. Gender differences are expressed dramatically (tab. 2).

Table 2

Seasonal variability of the gonadosomatic index of sturgeon females in 2002–2005 in the Volga River, %

Time of harvest	Beluga		Sturgeon		Stellate sturgeon	
	M ± *m*	Vibration	*M* ± *m*	Vibration	*M* ± *m*	Vibration
March	16.0 ± 0.2	15.4–16.9	15.6 ± 0.13	12.7–17.6	25.0 ± 0.24	22.0–26.5
April	16.5 ± 0.25	13.0–18.0	19.6 ± 0.14	16.3–20.1	23.1 ± 0.2	20.1–26.0
May	16.2 ± 0.2	14.2–17.9	14.3 ± 0.11	11.8–16.4	23.0 ± 0.19	20.2–25.9
June	10.0 ± 0.18	8.6–12.6	12.0 ± 0.1	10.3–14.1	21.3 ± 0.18	19.4–24.0
Average March – June	15.6 ± 0.2	12.6–18.0	13.4 ± 0.12	10.3–20.1	22.8 ± 0.2	19.4–26.5
July	12.1 ± 0.14	11.0–14.	13.3 ± 0.09	11.6–16.9	19.9 ± 0.5	16.6–23.0
August	13.6 ± 0.15	11.1–16.6	16.9 ± 0.08	13.9–19.4	15.6 ± 0.46	12.2–18.9
September	14.2 ± 0.21	12.2–17.0	19.0 ± 0.15	16.0–21.1	15.2 ± 0.46	13.0–19.0
October	14.5 ± 0.22	13.3–17.0	19.5 ± 0.14	16.1–22.0	16.5 ± 0.59	13.5–21.4
Среднее June – July	14.0 ± 0.18	11.0–17.0	14.6 ± 0.1	11.6–22.0	15.6 ± 0.5	13.0–23.0

Sturgeon females caught in spring of 2002–2005, have greater amplitude of variations of individual gonadosomatic index than beluga females have in autumn. In spring the average index is 12.6–18.0 %, in autumn – 11.0–17.0 %, that indicates the heterogeneity of populations (fig 1).

Individual variations of gonadosomatic index of running beluga females are slightly wider than those of males.

Comparing gonadosomatic index of beluga females with that of sturgeon and stellate sturgeon with the III, III–IV, IV degree of gonad maturity it should be noted that the beluga females index in the first half of the year is slightly higher than that of the sturgeon, but much inferior to that of sturgeon. In the second half gonadosomatic index of beluga is lower than that of sturgeon and stellate sturgeon.

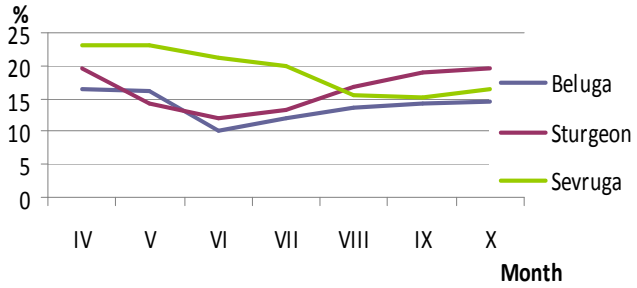

Fig. 1. Specific features of seasonal changes in the relative weight of the gonads of beluga, sturgeon and stellate sturgeon females with III, III–IV, IV degrees of gonad maturity in the river life period (2002–2005)

Beluga males have a lower gonadosomatic index than sturgeon and stellate sturgeon – 3.5 ± 0.3; 3.8 ± 0.18 and 4.3 ± 0.3, respectively.

Morphological indicators of sturgeon

Gonadosomatic index of running sturgeon caught in 2002–2005 during the river life period is undergoing some seasonal variations. The highest gonadosomatic index of females registered in April is 19.6 ± 0.14 %, in May it is reduced to 14.3 ± 0.11 %, in June the index of the gonads is minimum 12.0 ± 0.1 %. Since July the gonadosomatic index grows again and in October it has almost the same magnitude as it was observed in April – 19.5 ± 0.14 %.

The gonadosomatic index of running males is much lower than that of females – 3.8 ± 0.18 %. Thus, the sharp gender differences on the body have been fixed.

The amplitude of the individual fluctuations in sturgeon female gonads in autumn is slightly wider than that in spring. From March to June variations were 10.3–20.1 %, and from July to October – 11.6–22.0 %. The variations of the running sturgeon males were 0.9–7.0 %. It should be noted that in the catches there were individuals of different physiological conditions.

Average numbers of the gonadosomatic index of sturgeon females in the first half of the year are the lowest – 13.4 ± 0.12 %, in the second half – a little higher than those of beluga, but still inferior performance to sturgeon.

The gonadosomatic index of sturgeon males is rather higher than that of beluga, but inferior performance to sturgeon.

Morphological parameters of stellate sturgeon

The gonadosomatic index of running sturgeon caught in 2002–2005 undergoes dramatic seasonal changes. The highest gonadosomatic index of running stellate sturgeon females marked in spring is 22.8 ± 0.2 %, in autumn it is reduced to 15.6 ± 0.5 %. The maximum index is observed in March – 25.0 ± 0.24 %, from April to July it goes down. In August and September, the lowest figure recorded is 15.2 ± 0.46 %, in October it slightly increases. The sturgeon male gonad index was 4.3 ± 0.3 %. Such volatility of the gonadosomatic index is a typical feature and it is consistent with the data for the earlier period [1].

The amplitude of the individual fluctuations in sturgeon females in spring is 19.4–26.5 %, in autumn – 13.0–23.0 %. The index of males ranged from 1.2 to 7.3 %.

Statistical analysis of the data showed that the sturgeon female gonadosomatic index is higher than that of males.

The gonadosomatic index of stellate sturgeon is rather high. If in spring the index of beluga female is 15.6 ± 0.2 %, of sturgeon – 13.4 ± 0.12 %, then of stellate sturgeon is 22.8 ± 0.2 %. The stur-

geon male gonadosomatic index is also higher than that of beluga and stellate sturgeon males: beluga – 3.5 ± 0.3 %, sturgeon – 3.8 ± 0.18 % and stellate sturgeon – 4.3 ± 0.3 %.

The comparison of the liver and gonads of stellate sturgeon with those of other sturgeon species showed that the relative weight of the liver in sturgeon males is higher than that of other sturgeons, and females below. The relative weight of the gonadosomatic index of sturgeon, both females and males is the highest during the entire observation period (2002–2005). Sexual dimorphism is marked. In addition, during all the years of the research in the catches of stellate sturgeon spring forms dominated, while in the catches of sturgeon and beluga winter forms prevailed [1].

Comparative characteristics of beluga for different years catches

Comparing the gonadosomatic index of beluga females to the III, III–IV, IV maturity stages of catches in different years (between 1970–1973 and 2002–2005), it can be noted that the running female gonadosomatic index was at the same level (fig. 2).

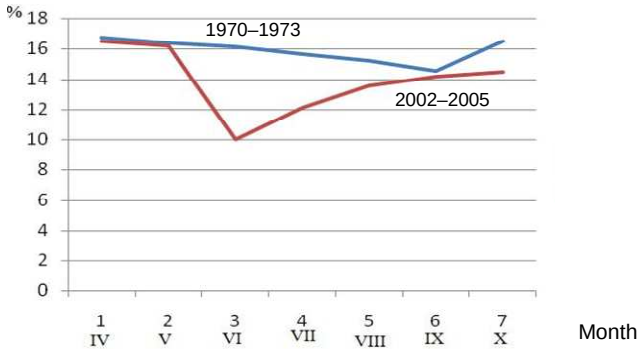

Fig. 2. Comparison of seasonal changes in the relative weight of gonads in running beluga females of different years catches during the river life period

The gonadosomatic index of beluga females in April 1970–1973 was 6.76 ± 0.64 %, and in 2002–2005 in the same month – 16.5 ± 0.25 %. In September 1970–1973 the gonadosomatic index of beluga was 14.54 ± 0.73 %, and in September 2002–2005 – 14.2 ± 0.21 %. In October beluga females caught in 1970–1973 had a higher gonadosomatic index (16.5 ± 0.05 %) than the fish caught in 2002–2005, which we relate to a decrease in the population of older species – 14.5 ± 0.22 %.

The amplitude of the variations of gonadosomatic index of beluga females in 1970–1973 is much more than in 2002–2005. For example, in October 1970–1973 variations were 8.82–28.75 %, and in 2002–2005 – only 13.0–18.0 %. It should be noted that in the population the number of older species over the years declined and currently in the river Volga there can be found individuals, spawning for the first time.

Our data obtained in 1970–1973 suggest that the gonadosomatic index of beluga females changed during the season. The maximum rate was observed in fish caught in April, May, September and October, which agrees well with recent catches (tab. 3, fig. 3).

The gonadosomatic index of beluga males with the III, III–IV, IV degrees of gonad maturity in 1970–1973 is much higher than in 2002–2005. In 1970–1973 in the first half of the year it was 5.27 ± 0.5 % and 5.13 ± 0.21 % in the second half, while in 2002–2005 at the same time – only 3.5 ± 0.3 %.

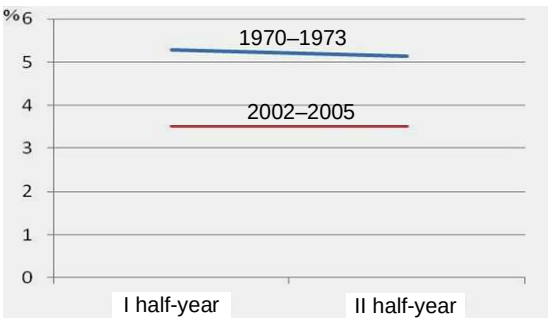

Fig. 3. Comparison of seasonal changes in the relative weight of the gonads of beluga males with the III, III–IV, IV degrees of gonad maturity in the river life period during different years

Table 3

Comparative characteristics of gonadosomatic index of sturgeon catches in different years, r. Volga, %

Months	Beluga ♀ The relative weight, *M* ± *m* Vibration		Sturgeon ♀ The relative weight, *M* ± *m* Vibration		Stellate sturgeon ♀ The relative weight, *M* ± *m* Vibration	
	1970–1973	**2002–2005**	**1970–1973**	**2002–2005**	**1970–1973**	**2002–2005**
April	16.76 ± 0.64 8.82–28.75	16.5 ± 0.25 13.0–18.0	23.0 ± 1.19 8.26–35.33	19.6 ± 0.14 16.3–20.1	23.8 ± 0.8 20.0–34.5	23.1 ± 0.2 20.1–26.0
May	–	16.2 ± 0.2 14.2–17.9	15.33 ± 1.28 6.14–25.52	14.3 ± 0.11 11.8–16.4	22.68 ± 0.32 13.2–32.5	23.0 ± 0.19 20.2–25.9
June	–	10.0 ± 0.18 8.6–12.6	13.55 ± 0.37 4.81–22.14	12.0 ± 0.1 10.3–14.1	23.32 ± 0.47 11.1–32.4	21.3 ± 0.18 19.4–24.0
July	–	12.1± 0.14 11.0–14.3	15.72 ± 0.39 9.71–23.79	13.3 ± 0.09 11.6–16.9	23.61 ± 0.6 11.1–30.9	19.9 ± 0.5 16.6–23.0
August	–	13.6 ± 0.15 11.1–16.6	17.86 ± 0.36 10.74–25.12	16.9 ± 0.08 13.9–19.4	16.4 ± 0.27 10.8–27.94	15.6 ± 0.46 12.2–18.9
September	14.54 ± 0.72 11.32–18.32	14.2 ± 0.21 12.2–17.0	18.95 ± 0.07 14.22–23.01	19.0 ± 0.15 16.0–21.1	16.0 ± 0.1 15.0–16.2	15.2 ± 0.46 13.0–19.0
October	16.5 ± 0.5 13.94–19.16	14.5 ± 0.22 13.3–17.0	23.0 ± 2.78 11.0–39.0	19.5 ± 0.14 16.1–22.0	–	16.5 ± 0.53 13.5–21.4

The amplitude of the fluctuations of the index of the gonads of males in 1970–1973 is wider than in 2002–2005. For example, in the second half of the year in 1970–1973 variations in the gonads were 1.47–11.68 %, whereas in 2002–2005 – only 1.4–6.6 %.

Comparative characteristics of sturgeon catches in different years

According to the results of the researches, the gonadosomatic index of sturgeon females with the III–IV degrees of gonad maturity in 2000–2005 is lower than in 1970–1973. So in April 2002–2005 it was 19.6 ± 0.14 %, and in 1970–1973 – 23.0 ± 1.19 %. In May and August figures differ only by 1 % – with a bigger emphasis to the individuals caught in 1970–1973. (fig. 4).

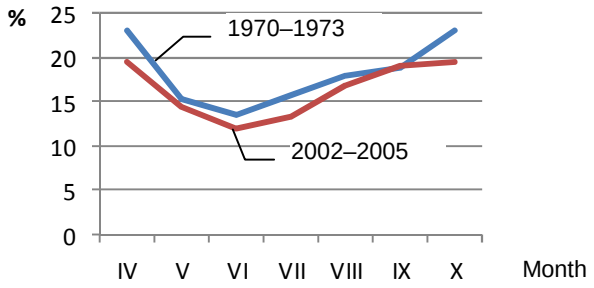

Fig. 4. Comparison of seasonal changes in the relative weight of the gonads of sturgeon females with the III, III–IV, IV degrees of gonad maturity in the river life period during different years

In September the indices are almost equal: in 1970–1973 – 18.95 ± 0.07 %, in 2002–2005 – 19.0 ± 0.15 %, and in October, they are almost the same as in April – 23.0 ± 2.78 % and 19.5 ± 0.14 %, respectively.

The amplitude of the gonadosomatic index variations of sturgeon females in 1970–1973 is much more than in 2002–2005: in April 2002–2005 – only 16.3–20.1 % and in 1970–1973 – 8.26–35.33 %. In October 2002–2005 variations of gonadosomatic index of sturgeon females were only 16.1–22.0 %, but individuals caught in 1970–1973 – 11.0–39.0 %.

Indicators of gonadosomatic index of sturgeon males in 1970–1973 are also very contrasting against the indicators of 2002–2005. In the first half of the year sturgeon male gonadosomatic index was 5.79 ± 0.21 %, and in 2002–2005 – 3.8 ± 0.18 %. In the second half-year 1970–1973 the rates are lower (4.36 ± 0.07 %), than in the first half-year, and lower relative to that of 2002–2005 – 3.8 ± 0.18 % (fig. 5).

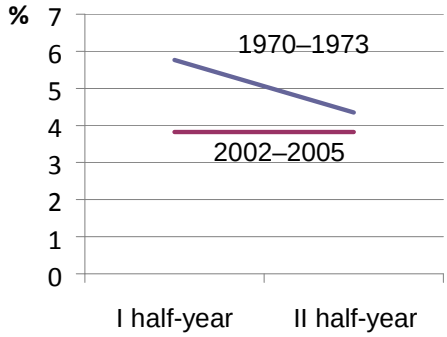

Fig. 5. Comparison of seasonal changes in the relative weight
of the gonads of sturgeon males with the III, III–IV, IV degrees of gonad maturity
in the river life period during different years catches

The amplitude of the gonadosomatic index variations of sturgeon males caught in 2002–2005 accounted 0.97.0 %, but the species caught in 1970–1973 – 1.13–10.61 %.

Comparative characteristics of stellate sturgeon catches in different years

The greatest relative weight of gonadosomatic index was observed in stellate sturgeon females in 1970–1973. So in April 2000–2005 it was 23.1 ± 0.2 %, and in 1970–1973 – 23.8 ± 0.8 %, in October the index of fish caught in 2002–2005 was 15.2 ± 0.46 %, in 1970–1973 – 16.0 ± 0.1 %.

The gonadosomatic index values of stellate sturgeon, caught in 2002–2005, yield indices of 1970–1973, and only in April, these values were about the same level – 22.68 ± 0.32 % and 23.0 ± 0.19 % (fig. 6).

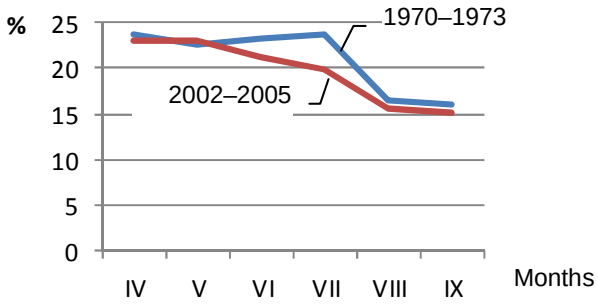

Fig. 6. Comparison of seasonal changes in the relative weight
of the gonads of stellate sturgeon females with the III, III–IV, IV degrees of gonad maturity
in the river life period during different years catches

The amplitude of the gonadosomatic index variations of stellate sturgeon females in 1970–1973 is much wider than that of the stellate sturgeon caught in 2002–2005. In July 1970–1973 variations in the gonads were 11.1–30.9 %, but in 2002–2005 – 16.6–23.0 %. The most significant changes were in the gonads of species caught in 1970–1973 in June – 11.1–32.4 %, and in 2002–2005 in October–13.5–21.4 %.

The gonadosomatic index of stellate sturgeon males changes during the season. Thus, in the first half-year in 2002–2005 the indicators of the gonadosomatic index of stellate sturgeon was only 4.3 ± 0.3, and in 1970–1973 – 7.62 ± 0.49 %, in the second half-year in 1970–1973 gonadosomatic index decreased from 7.62 to 6.03 ± 0.07 %, but it was still higher than the figure obtained in the second half-year in 2002–2005 (fig. 7).

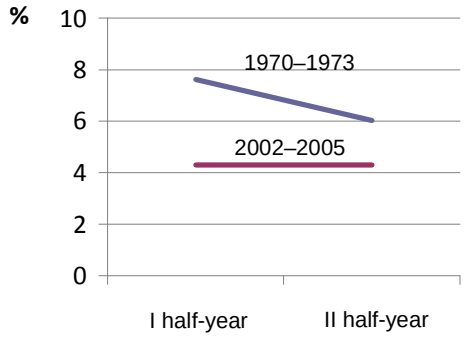

Fig. 7. Comparison of seasonal changes in the relative weight
of the gonads of stellate sturgeon males with the III, III–IV, IV degrees of gonad maturity
in the river life period during different years catches

The amplitude of the variations of the index of stellate sturgeon gonads in 1970–1973 is wider (1.25–12.67 %) than that of the species caught in 2002–2005 – 1.2–7.3 % (see tab. 3).

Conclusion

Our data for 2002–2005 show that the gonadosomatic index of beluga females varies during the season and they are in good agreement with 1970–1973 data. The fish caught in April, May, September and October 2002–2005 had the maximum rate; it is in a good agreement with previous years catch [1, 8]. It is noted that the gonadosomatic index of beluga males with the III, III–IV, IV degrees of gonad maturity in 1970–1973 is much higher than that of beluga males in 2002–2005.

The gonadosomatic index of sturgeon females with the III–IV degrees of gonad maturity in 2000–2005 is lower than that of species caught in 1970–1973. The indicators of gonadosomatic index of sturgeon males are also lower.

The greatest relative weight of gonadosomatic index was observed in stellate sturgeon females caught in 1970–1973. The indicators of gonadosomatic index of stellate sturgeon males are variable depending on time of catch.

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