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Abstract. The content of heavy metals in sterlet (*Acipenser ruthenus*) organs in the middle course of Ob river was studied. The main method of sample analysis was the atomic absorption spectrometry. There was determined the difference in concentrations of the same metal in different organs and in concentrations of different metals in the same organ, and also difference in the data about mature and immature groups. In general the pattern of heavy metals accumulation in sterlet organism is similar to that of other representatives of the family of sturgeon fishes and osteichthyes. The content of the all determined metals in the sterlet muscles in the Ob river middle course did not exceed the maximum permissible concentration accepted in Russia for fresh fish products.

1. Introduction

Sterlet *(Acipenser ruthenus* Linne, 1758) inhabits the Ob and Yenisei basins and is absent in the Baikal with its tributaries (except Angara) and Eastern Siberia rivers. Subspecies within species distribution area are not identified. The lake forms of this species are not known [1,2].

The literature about the pattern of heavy metals (HM) accumulation in the sterlet body is very scarce. There are no relevant publications about Siberian sturgeon *(Acipenser baeri* Brandt, 1869). At the same time, the detection of patterns of heavy metal accumulation and distribution in fish organisms is very relevant both theoretically (based on number of biochemical and physiological features of Acipenseriformes [3,4], including the character of reaction to water pollution [5,6]) and practically, due to the high value of Acipenseriformes as objects of fishery and aquaculture [7,8]. The purpose of this work is the analysis of data about the content of several HM in the sterlet body in the middle course of Ob river.

2. Materials and methods

The sterlet was caught in the Ob in October 2013 near the village Novonikolskoye (1689 km according to sailing direction 1987) and in June 2015 near the village Melnikovo (Shegarka) (950 km according to sailing direction 1987). In 2013 the sample consisted of 35 mature individuals at the age of 5-11 years with length 350-470 mm. In 2015 the sample was represented by a group of 30 immature

individuals at the age of 2-4 years with length 215-300 mm, and a group of 30 mature individuals with length from 360 to 440 mm at the age of 5-10 years. The content of Co, Cd, Cu, Fe, Mn, Ni, Hg, Pb, Zn was determined in the muscles (taken from the middle part of the body in the dorsoventral area), liver, kidneys, spleen, ovary, vertebrae (from the middle part of the spine), gills and air-bladder. The sample analysis was carried out in the laboratory of isotope-geochemical methods in the Institute of Geology and Mineralogy of the Siberian Branch of the RAS on the atomic absorption spectrophotometer Solaar-M6 from Thermo Electron (USA) with using flame and electrothermal atomization. Mercury was determined by the "cool vapor" method on the MAS-50D device from Bacharach (USA). In all cases, the metals concentration was determined in the crude mass. The reliability of differences of the arithmetic means was estimated by the t-test on the basis of the normal distribution of variational series, the representativeness error is 10% from the arithmetic mean, and the probability level is > 0.999 [9].

3. Results and discussion

The results of the evaluation of the HM content in sterlet are shown in the Table 1. As expected, the concentrations of metals in organs of fishes from two compared groups are very variable. For example, mercury content in muscles of mature individuals sampled in 2013 is 2.2 times higher and in muscles of immature individuals sampled in 2015 is 1.7 times higher than in muscles of mature sterlet sampled in 2015. However, the arithmetic values of mercury concentration in liver of two compared groups are close to each other, and mature fish sampled in 2015 have significantly higher mercury concentrations. Fishes sampled in 2013 have much higher concentration of all evaluated metals in liver than mature and immature individuals sampled in 2015 (except Ni for mature and Mn and Ni for immature). The difference in the HM content of other organs of compared groups is represented in the table 1. It should be noted that with high probability these differences are related to the different physiological condition of studied fishes and the heterogeneity of the chemical composition of their habitat [10]. Also it ought to be remarked that the concentrations of all evaluated metals in muscles were significantly lower than maximum permissible concentration (MPC) accepted in Russia for fresh fish products [11]. Only the Fe content was from 50 to 93% MPC in all three groups. This might be related to high background content of Fe in the Ob river [12].

Table 1. Heavy metal content in organs of sterlet of the Middle Ob.

Body fish	Elements, μg/g crude mass samples[a]								
	Co	Cd	Cu	Fe	Mn	Ni	Hg	Pb	Zn
MPC[b] in Russia	0.5	0.2	10	30	10	0.5	0.5	1.0	40
Muscle	<0,05	0.007	0.60	15	0.66	0.07	0.067	0.04	3.7
	0.012	<0,005	0.57	17	0.83	<0.3	0.030	0.05	6.0
	0.012	<0,005	0.44	28	0.79	<0.3	0.050	0.08	4.2
Liver	0.161	0.611	17	566	1.2	0.74	0.150	0.86	38
	0.082	0.124	3.4	133	2.0	<0.3	0.051	0.16	27
	0.072	0.083	2.7	147	4.9	<0.3	0.037	0.12	28
Spleen	<0,05	0.062	1.7	230	1.4	0.32	0.271	0.34	26
	0.094	0.161	4.3	165	2.4	<0.3	0.041	0.64	16
	0.092	0.034	0.92	98	12	<0.3	0.032	0.24	14
Buds	0.105	0.174	2.3	164	1.3	0.21	0.029	0.07	20
	0.093	0.152	1.8	178	2.7	<0.3	0.024	0.05	19

	0.122	0.089	1.5	257	24	<0.3	0.029	0.07	25
Ovary	0.035	0.073	0.78	42	0.86	0.12	0.021	0.15	12
	0.049	0.011	1.2	30	1,5	<0.3	0.012	0.05	28
	0.050	0.062	1.0	121	6.1	<0.3	0.027	0.26	11
Swim bladder	0.012	0.027	0.65	32	0.55	0.19	0.164	0.05	7.0
	0.047	0.015	0.74	35	2.0	<0.3	0.019	0.15	7.0
	0.133	0.024	1.6	112	8.0	<0.3	0.008	0.36	15
Gills	0.078	0.030	1.2	174	4.7	0.17	0.022	0.24	17
	0.053	0.016	0.90	92	3.0	<0.3	0.021	0.12	17
	0.057	0.009	0.96	74	3.3	<0.3	0.018	0.11	16
Vertebrae	<0,05	0.009	0.75	41	3.3	0.12	0.041	0.12	14
	0.037	0.010	0.61	45	1.3	<0.3	0.013	0.02	6.7
	0.035	0.016	0.71	47	1.8	<0.3	0.023	0.06	7.1

[a] Top row - samp1es of 2013, middle row - mature individua1s, 2015, bottom row - group of immature individuals, 2015.
[b] MPC - maximum permitted concentration.

The ranking analysis (table 2) showed that biophilic elements (Fe, Zn, Mn and Cu) have the highest concentrations in all analyzed organs, and at the end of the lines there are different combinations of Pb, Co, Cd, Hg, which are classified as highly toxic.

It is important to note that determined pattern of HM distribution in sterlet body is similar to that in other Sturgeon species, in marine [13] and freshwater species [14-16]. We have already shown this in the study of heavy metals in organs of Siberian sturgeon, sterlet and Osteichthyes (muksun, peled, pike) at Ob low course [17]. Similar resu1ts have been obtained by the mu1tiyear study of HM in the body of Sturgeon spp. (beluga, russian sturgeon, starred sturgeon and sterlet) in the Volga de1ta and North Caspian [18, 19] and sterlet in the White river [20].

Table 2. Heavy metals ranking in sterlet bodies in the Middle Ob [a]

Fish organ	Series ranking e1ements
Musc1e	Pe > Zn > Mn > Cu > Ni = Hg > Pb > Co > Cd
	Pe > Zn > Mn > Cu > Ni > Pb > Hg > Co > Cd
	Pe > Zn > Mn > Cu > Ni > Pb > Hg > Co > Cd
Liver	Fe > Zn > Cu > Mn > Pb > Ni > Cd > Co > Hg
	Fe > Zn > Cu > Mn > Pb > Ni > Cd > Co > Hg
	Fe > Zn > Mn > Cu > Pb > Ni > Cd > Co > Hg
Sp1een	Fe > Zn > Cu > Mn > Pb > Ni > Hg > Cd > Co
	Fe > Zn > Cu > Mn > Pb > Ni > Cd > Co > Hg
	Fe > Zn > Mn > Cu > Pb > Ni > Co > Hg > Cd
Buds	Pe > Zn > Mn > Cu > Pb = Ni > Hg > Co > Cd
	Pe > Zn > Mn > Cu > Ni > Cd > Co > Pb > Hg
	Pe > Mn > Zn > Cu > Pb = Ni > Hg > Co > Cd
Ovary	Fe > Zn > Mn > Cu > Pb > Ni > Cd > Co > Hg
	Fe > Zn > Mn > Cu > Ni > Pb > Co > Cd > Hg
	Fe > Zn > Mn > Cu > Ni = Pb > Cd > Co > Hg
Air-bladder	Fe > Zn > Cu > Mn > Ni > Hg > Pb > Cd > Co

	Fe > Zn > Mn > Cu > Ni > Pb > Co > Hg > Cd
	Fe > Zn > Mn > Cu > Pb > Ni > Co > Cd > Hg
Gills	Fe > Zn > Mn > Cu > Pb > Ni > Co > Cd > Hg
	Fe > Zn > Mn > Cu > Ni > Pb > Co > Hg > Cd
	Fe > Zn > Mn > Cu > Ni > Pb > Co > Hg > Cd
Vertebrae	Fe > Zn > Mn > Cu > Ni = Pb > Hg = Co > Cd
	Fe > Zn > Mn > Cu > Ni > Co > Pb = Hg = Cd
	Fe > Zn > Mn > Cu > Ni > Co > Pb > Hg > Cd

[a] Ranges follow the principle of reducing the concentrations of elements. Top row - samp1es of 2013, middle row - mature individua1s, 2015, bottom row - group of immature individuals, 2015.

4. Conclusion

The results of our work demonstrate the complex process of heavy metal accumulation in the sterlet body at the middle Ob. Most of evaluated metals have the highest concentrations in liver, kidneys and spleen and the lowest concentrations in muscles. All analyzed organs have the highest concentrations of biophilic elements (Fe, Zn, Mn, Cu) and the lowest concentrations of elements, which belong to highly toxic (Pb, Co, Cd and Hg). In general the determined pattern of heavy metal accumulation in sterlet body is similar to that in other Sturgeon species and Osteichthyes. The content of all defined heavy metals in organs of sterlet of middle Ob does not exceed MPC accepted in Russia for fresh fish products.

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