SC/68C/E/13

Sub-committees/working group name: E

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TOXICOLOGY AND OTHER RESEARCHES OF GRAY WHALES IN THE MECHIGMENSKY BAY (WESTERN BERING SEA, RUSSIA), 2013-2020.

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In the Mechigmensky Bay (Western Bering Sea, Russia) contamination levels of marine mammal tissue and organ samples were investigated by Russian scientists. Organs and tissues of Gray whales (*Eschrichtius robustus)* were necropsied after aboriginal whaling and landing by Chukotka Natives (Table) in 2008-2020.

Table – Heavy metals' concentration in organs and tissue samples of Gray whales (mg/kg mass), landed in Mechigmensky Bay (Western Bering Sea), 2008-2020

		2008[i]	2010[ii]	2015[i]	2016[i]	2017	2019	2020	MPL[iii]
Hg	mean ± SD	0.006±0.006	0.063±0.080	0.030±0.014	0.034±0.022	0.027±0.041	0.188±0.038	0.051±0.010	0.5
	range	0.001-0.022	0.007-0.120	0.014-0.048	0.007-0.087	0.000-0.189	No data	0.029-0.060	
	N of samples	14	2	5	19	37	10	15	
As	mean ± SD	1.178±0.810	0.255±0.186	3.000±1.042	0.262±0.311	0.334±0.424	0.006±0.003	0.021±0.009	5.0
	range	0.170-2.760	0.020-0.600	1.800-4.000	0.030-1.310	0.010-1.860	No data	0.010-0.033	
	N of samples	14	13	5	19	37	10	15	
Cd	mean ± SD	0.055±0.088	0.287±0.232	0.054±0.098	0.041±0.046	0.053±0.075	0.031±0.012	0.029±0.005	0.2
	range	0.005-0.317	0.007-0.700	0.005-0.230	0.003-0.155	0.001-0.289	No data	0.017-0.036	
	N of samples	14	14	5	19	37	10	15	
Pb	mean ± SD	1.011±1.404	0.204±0.116	0.206±0.111	0.099±0.098	0.027±0.026	0.24±0.09	0.035±0.011	1.0
	range	0.070-4.200	0.053-0.450	0.100-0.390	0.011-0.344	0.000-0.160	No data	0.005-0.059	
	N of samples	14	14	5	19	37	1	15	
Radioactivity, Bk/kg mass									
Cs^{137}	mean ± SD						3.05	5.971±2.160	130.0
	range						No data	3.9-10.2	
	N of samples						1	7	
Sr^{90}	mean ± SD							4.586±1.366	100.0
	range							3.4-7.5	
	N of samples							7	

[i] Kovekovdova et al., 2017
[ii] Tsygankov, 2015
[iii] Maximum permissible levels

Necropsy samples for heavy metals analysis included muscle, kidney, liver, blubber by 200-300 g (7.0-10.5 ounce) and blood 50-100 ml (1.7-3.4 fl.ounceUS). All samples were froze at -24ºC (-11.2F) and delivered to Laboratory of ApplEcology, TINRO-Center (Vladivostok), to

Veterinary Centers of Petropavlovsk-Kamchatsky and Anadyr (Russia). The preparation of tissue and organ samples for measuring was performed by acidic mineralization method using nitric acid following GOST 26929-94 [1].

In 2008-2020 measuring the concentrations of cadmium, arsenic and lead was determined with the atomic absorption spectrophotometer «Shimadzu» Aa-6800. The atomizer was a graphite cuvette, and background corrector was the deuterium lamp. The mercury concentrations in the samples were determined using a flameless atomic absorption method with the direct mercury analyzer DMA-80 MILESTONE with standard errors less than 7-10%. As standard samples we used State Standard Metal Solutions Samples (GSORM).

Pb and Hg had the lowest concentration levels in the tested animal tissues and organs in the Mechigmensky Bay (Table). The highest concentrations of As and Cd were detected in animals kidneys irrespectively to sex and age of animals.

The levels of As and Hg were significantly higher in the liver of animals. This is due to the fact that the regulation of elements content in the body is not so much limiting their content in muscles, as by between-organs redistribution of elements. Therefore heavy metals concentrated by the depositing and filtering organs in levels, dozens times higher than in other tissues and organs, regardless of animal sex, age and species.

Chukotka Natives consume intestines and meat of whales and walruses. The RSSEHR - Russian State Sanitary, Epidemiological and Hygienic Requirements [2] are controlling and limiting the level of toxic elements of As, Cd, Hg etc. in the marine mammals' tissues and organs.

Concentrations of As, Cd, Hg, Pb and radioactivity levels never exceeded the MPL in the studied muscle and blubber samples of Gray whales from Mechigmensky Bay in 2008-2020.

The Cd concentration exceeded the MPL only twice at 58.5% in liver of "stinky" gray whale male in 2008 and at 15% of permitted level in 2015 in edible female's liver. In 2010 there were 6 times from 7 exceeding the MPL in liver of Gray whales, but they used different testing equipment and methods [3].

The lead concentration exceeded the MPL three times in "stinky" whales organs and only at 2008: 1-2/ at 4.2 times in liver and 2.4 times in kidney of male; 3/ at 3.8 times in also inedible male's kidney. The multiple excess concentrations of cadmium and lead in liver and kidney might be one of the reasons of "stinky" gray whales phenomena, which we try to study more precisely. Our investigation shown that most valuable products, i.e. meet and blubber, of all studied animals and even of "stinky" whales are about edible as to toxic (As, Cd, Hg, Pb) elements.

Number of Gray whales in Mechigmensky bay was 14.8 per day in 2020, and a multiannual level firstly from 1999 showed a tiny elevation within 36 years period of coastal counts. Distribution of whales in the bay is changing annually from E to W and from coastal line (3-5 km) farther to the sea (9-12 km) and back.

In 2020 in the Severtsov Institute the serum-positivity to three pathogens (*Toxoplasma gondii, Trichinella* sp. and *Candida* sp.) was determined for serum of 21 gray whales and 4 Pacific walruses, which were harvested in Chukotka at 2018-2019. The determination was carried out by enzyme-linked immune-sorbent assay, testing the presence of antibodies to pathogens by the «cut-off» method. Two gray whales found positive to *Toxoplasma gondii*; one gray whale and two walruses were positive to *Candida* sp. Both species were negative to *Trichinella* sp.

In 2021 in the Severtsov Institute the serum-positivity to three other pathogens (Morbillivirus, herpes virus, *Mycoplasma* sp.) was determined for serum of 12 gray whales harvested in 2020. All twelve samples were serum-negative to all three pathogens. Analyzing the data from previous years we found that all 33 tested samples were serum-negative to herpes simplex virus 1/2. Serum prevalence to Mycoplasma sp. and Morbillivirus was 3.3% (one whale from 33 was positive). Gray whales in Chukotka waters have low serum prevalence to six tested pathogens in 2018-2020, and the highest (14.3%) positivity level they had to *Toxoplasma gondii*.

Also this year in the Biology Institute of Karelian Research Centre, an analysis of fatty acids from 13 gray whales was carried out by gas-liquid chromatography. For the first time in Russia, data were obtained on the vertical stratification of fatty acids of common lipids from harvested Gray whales, and the specific features of the spectrum of fatty acids in different layers

of fat were revealed (Figure). Sex and age-related differences in fatty acid profiles have been established, and differences between “stinky” and normal whales have been identified.

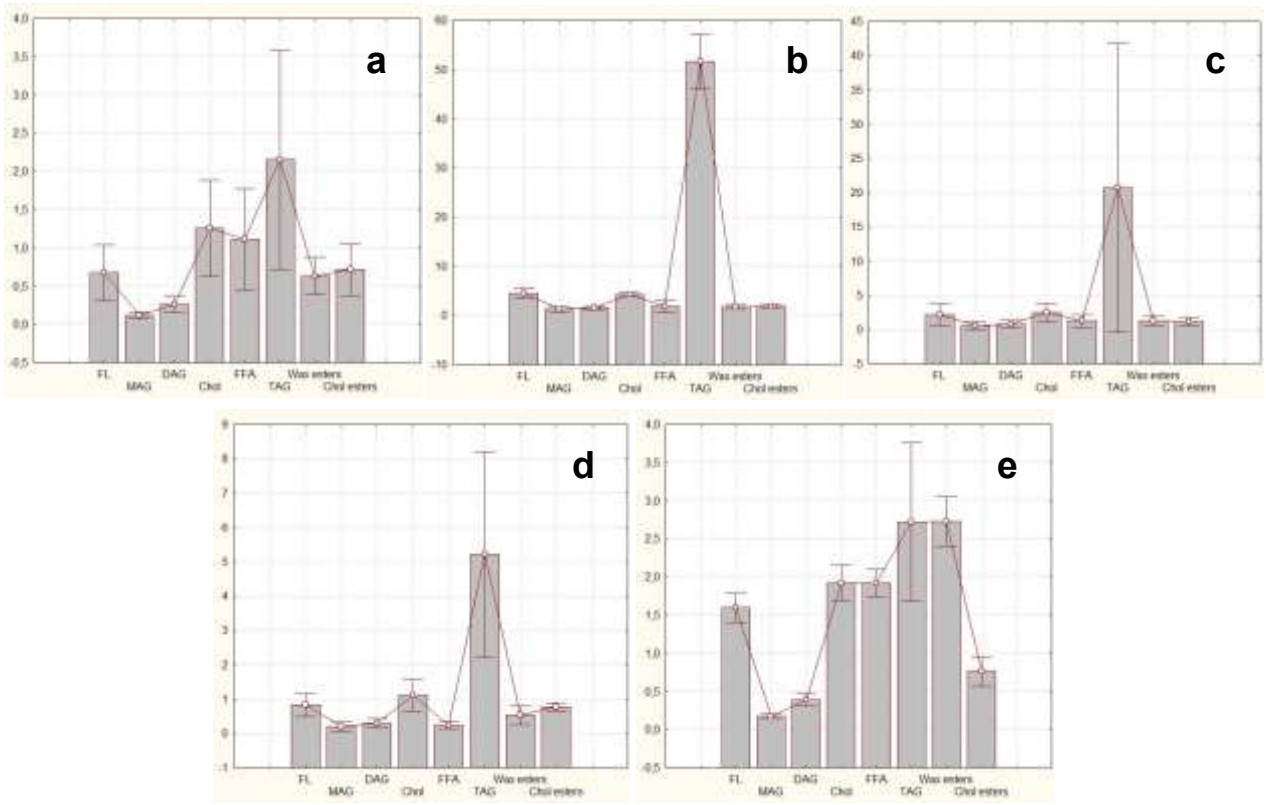

Figure – Average ± 0.95 SD value for lipid classes of skin (**a**), upper fat layer (**b**), lower fat layer (**c**), meat (**d**) and liver (**e**) of gray whales in Mechigmensky bay

The absence of skinny Gray whales during coastal counts and harvest monitoring, their good body conditions and stabile prey content in whale stomachs, as well as other researches in 2013-2020 indirectly indicate that the existing aboriginal Gray whales hunting has no negative impact to its population and feeding conditions in Chukotka waters, and thus can be implemented in the future in the same amount.

Scientific expeditions and heavy metals analysis of Gray whale samples were supported by the Chukotka Government in 2015-2020. The authors are grateful to Chukotka Governor Roman Kopin for personal interest and support of scientific studies of Chukotka whales and willing to help solving any problems with subsistence whaling by Chukotka Natives. Authors are thankful for support from regional Administrations of Chukotsky, Providensky and Iultinsky Districts of Chukotka Autonomous Okrug. Also we could not achieve any of our goals without support from TSO Lorino, personally Alexey Ottoj and Vladimir Piny, and all Chukotka experienced whalers.

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