UDC 597:614.779:546.49

M.M. Tyaptirgyanov, V.M. Tyaptirgyanova

Ecologic and Hygienic Assessment of Mercury Accumulation in Organs and Tissues of River Fish of Yakutia

ABSTRACT

The analysis according to results of heavy metals accumulation with mercury in fish organs and tissues in freshwater basins of Yakutia was performed. Fishes are bioindicators of basin pollution and a key link of the toxic element coming to human with food chain. The analysis of the data obtained showed 1 to 3 time increase of MPC against the standard in predatory fish - pike and perch, in non-predatory - crucian (carp), roach and dace in the industrial areas of diamond-and gold mining. And these fish species are mostly edible by people.

Keywords: ecosystem, heavy metals, mercury, toxic element, age groups

Pisces is the bioindicators of muddiness of reservoirs and important link of receipt on the food chain of toxic element in the organism of man. In the food ration of the population of Yakutia the consumption of fish products is on the fourth place after meat and milk products, bread and bakegoods. This circumstance has given occasion to the study of the most widespread fish of the freshwater systems.

Heavy metals (HM), including mercury, getting into reservoirs, contact with the buffer system of water, then alter into low soluble hydroxides, carbonates, sulfides and phosphates and form organ metallic complexes, adsorbing with sediments and accumulating in fish of the fresh reservoirs of Yakutia [15-21]. HM absorption by an organism, their transporting, co-operating with by intracellular bio structures and clearance from an organism are considered a difficult active process closely associated with general metabolism, therefore the amount of absorbed metal turns to be a factor, characterizing a state of organism on the whole, affecting biochemical processes and physiological functions of water organisms of Yakutia [13, 14].

It is well known that the common amount of metals absorbed by the organism in various ways depends on the concentration of this element in the environment and exposure time. It is specific for each organism to be able to accumulate different metals, including Pb, Hg and Cd, it being determined by its metabolism characteristics. Such point of view is based, mainly, on the results of the numerous works, obtained by comparing of metal content in tissues of different types of animals dwelling in regions with a different hydro chemical mode [4, 5, 10, 12, 23-25].

Complication and variety of the population structure testify to its stability and viability. The fish population dwelling in the studied reservoirs of Yakutia are characterized by higher simplification of their structure. The populations are presented by a small number of age-related groups and a minimum number of spawning generations. Factors such as life reduction, prevailing amount of junior age-related fish groups, decrease in growth rate and reduction of mid-size species, early pubescence, its maturity in extremely small sizes or its blocking in enhancing growth, stretched period of puberty are noted. In the conditions of chronic subtoxic influence of heavy metals there is a shift to life cycle strategy of white-fish: transition to the short monocycle.

For the analysis predatory fish (pike, perch) were studied as HM are accumulated by trophic chain, and imprecatory (roach, European carp, chir, dace), with benthos and water-plant organisms in their nutrition known as HM accumulators. The characteristics of clinical and path anatomical symptoms of fish intoxication was conducted during the first hour after fish capturing [1, 11, 24].

The results of the researches testify to the considerable accumulation to mercury in organs and tissues of both herbivorous and predatory fish.

As follows from the obtained data, the distribution of mercury in the organism depends on its species, age and season (Tab. 1-5).

As for crucian carps from the lake Ebe of the Vilyui district and the river Indigirka the mercury content at both small and large individuals is estimated within the limits of MPL (MPL for unpredatory freshwater fish 0,3 mgs/of kg of raw mass) (Tab. 2, 4).

In the muscular tissue of the crucian carp there is an insignificant decline of mercury concentrations in the winter period, that it is possibly related to deceleration of exchange processes due to temperature fall and oxygen insufficiency in the lakes of the region. Therefore in the winter period the golden crucian carp caught in the lakes of both districts does not present the special toxicological danger for food intake by the population [2].

The concentration of mercury is distributed in the body of the crucian carp unevenly in a following sequence: muscles > liver > brachiates > bowels > bones, that is explained by higher content of protein in the muscles of functional groups (- SH, =NH^2, - COOH, - OH) Mercury possesses high likeness [6].

In the organism of typical representative of predatory fishes - perch - from the rivers Vilyui and Indigirka the level of mercury is different and considerably higher by comparison to other types of fish, that it is related to features of its eating habit (MPL 0,6 mgs/of kg).

For the smaller individuals of perch, caught from the Vilyui below the settlement Syuldyukar (table. 2), in the muscular tissue the content of mercury in summer in 0,105 mgs/of kg lower than in winter.

For the large individuals of perch in the age from 5+ 7+ to from the Vilyui in the summer period mercury in the muscles exceeds MPL for the predatory freshwater fish in 3 times, that is dangerous for the population.

The content of mercury in different organs and tissues of perch of the Vilyui is the same as well as for the crucian carp of the Vilyui district : muscles > liver > brachiates > bowels > bones. In the muscular tissue of perches Mercury is contained in amounts exceeding maximal possible levels.

In summer for the smaller individuals of perch from the Indigirka (100 kilometers higher from the settlement Chokurdakh) in the muscular tissue the content of Mercury is practically in 2 times less than in winter. At the same time for adult individuals in the muscular fabric in summer it is estimated in 0,641 higher than the winter period. These indexes exceed maximal possible levels for predatory freshwater fish from 2 to 3 times (Table 4).

So the high content of mercury concentrations in the organism of fish in summer is possibly explained by strong technogenic influence of gold extraction industry, as the fossil mining is conducted only in summer, i.e. in this period a great amount of wash waters is thrown down into the river from industrial devices. In the icy period no works are conducted and accordingly the discharge from technological chain of the gold mining is minimized in the whole river ecosystem.

From imprecatory fish a roach in the Vilyui and a dace in the Indigirka were investigated. Eating habits of these two types are approximately similar, their food ration mainly consists of water vegetation and shallow invertebrates.

In the muscular tissue of roach individuals from the Vilyui under age 2+ the content of mercury is less than on 0,137 mgs/of kg in the summer period, as for roach individuals in age 6+ 8+ the concentration of Mercury in muscles and liver exceeds MPL in 2-3 times. In the winter period for the smaller roach individuals the Mercury content in muscles was on 0,218 mgs/of kg less than at large ones.

In the roach unlike the perch no sharp distinctions in the mercury content are revealed depending on a season. It can be explained by that large perches in summer eat mainly fish, and invertebrate organisms in winter. And the large roach individuals do not have such difference in food intake during a year. The relatively identical content of Mercury for the roach small and

large individuals can be explained by mainly plant eating habits during a year and by postnatal ontogenesis [3, 4, 8, 9].

The distribution of mercury in organs and tissues of the roach is analogical, as well as for other fish, not including a slightly higher content of Mercury in liver, than in muscles. Such distribution, presumably, is characteristic for imprecatory fish of freshwater reservoirs.

A dace caught in the Indigirka (table. 4), the content of Mercury also depended on a season and age of fish. In muscular tissue for smaller individuals 2+ in summer the concentration of Mercury is higher than in winter on 0,122 mgs/of kg, for large individuals in age from 4+ 6+ it is higher in 0,157 mgs/of kg and approximately in 2,5 time exceeds values MAC for imprecatory fish of freshwater reservoirs.

In the Chroma river the content Mercury in muscles and liver of a pike is 6+ to 4+ higher in 1,5 times in summer than in winter (Table 3). The table of Mercury content in muscles and liver of chir in age 6+ exceeds MAC in 1,3-1,7 times.

In the Kolyma (Srednekolymskiy district) a perch in age from 4+ 6 + has exceeding MAC on Mercury up to 3,1 times in muscles, 2,25 times in a liver and in 1,5 times in brachiates in summer period (Table. 5). In a winter period there is some decline of MAC of Mercury to 1,4 in muscles and 1,2 in a liver. This divergence in some case is explained by the lack of washing season in winter season and there is no amalgamation.

Unlike them, the Mercury content in muscles and organs at fish dwelling in the Амga river is considered of a lower rate and does not exceed values MAC (table. 1). Presently physiological and morphological researches of fish have a large research and practice value, because they are needed for the estimation of influence of habitat conditions on the organism of fish. As a rule, such organs of fish as brachiates, liver, buds mostly react on alterations of the habitat. The spectrum of alterations in the structure of these organs is wide enough [7].

From the medical and ecological point of view the biological activity and toxicants are considered to be the important characteristic of heavy metals.

Fish and fish products are the important source of mineral substances in food intake of the population. But at the same time it should be noted capability of fish to accumulate some microelements (heavy metals) not always is useful.

Disposing information about content of heavy metals at fish it is possible to forecast their influence on the human organism.

LITERATURE:

1. Arshanitsa N.M. Foresters L.A. [Patologo-morfologicheskij analiz sostojanija ryb v polevyh i jeksperimental'nyh toksikologicheskih issledovanijah Pathological and morphological analysis of the status of fish in the field and experimental toxicology studies] Metody ihtiotoksikologicheskih issledovanij [Methods of ichthyologic research]. L.: GosNIORKh SPO Promrybvod, 1987.- P. 7-9.

2. Bolshakova K.A. Nyukkanov A.N. Perevertaeva T.F. Toksikokinetika rtuti v organizme zherebjat i ryb Viljujskogo rajona Respubliki Saha (Jakutija) [Toxicokinetics of mercury in fish and foals Vilyui region of the Republic of Sakha (Yakutia)] Perspektivnye napravlenija integrirovanija jekologicheskih, jepidemiologicheskih i jepizootologicheskih problem v respublike dlja sovershenstvovanija veterinarnogo obsluzhivanija: mater. Pespubl. nauchn.-proizvodstv. konf. [Perspective directions of integrating ecological, epidemiological and epizootic problems in the country to improve veterinary care: Mater. Repub. sci.-pract. conf]. - Yakutsk, 1994. - P. 65-70.

3. Vetrov V.A. Kuznetsova A.I. Mikrojelementy v prirodnyh sredah regiona ozera Bajkal [Microelements in natural environments in the region of Lake Baikal]. - Novosibirsk, 1997. - P. 234.

4. Dyrheeva N.S. Pronin N.M. [Metal content (Mn, Fe, Zn, Cu, Cd, Pb) in the bodies of fish with different types of food (Chivyrkulsky Bay Lake. Baikal)] Sovremennye problemy gidrobiologii Sibiri: mater. Vserosc. nauchno-praktich. konf. [Modern problems of Hydrobiology Siberia: mater. All-Russian theoretical and practical Conference]. -Tomsk, 2001. - P. 114-115.

5. Zemkov G.V. Zhuravleva G.F. Fedorova N.N. Moldova A.A. Morfofunkcional'nye aspekty projavlenija toksikoza u ryb [Morphological and functional aspects of the manifestations of toxicity in fish] Jeksperimental'nye i nauchnye nabljudenija [Experimental and scientific observation]. - Astrakhan AGMA 2003. - P. 182.

6. Kocharyan A.G. Morkovkina I.K. Safronova K.I. Povedenie rtuti v vodohranilishhah i ozerah [Behavior of mercury in reservoirs and lakes] Povedenie rtuti i drugih tjazhelyh metallov v jekosistemah [Behavior of mercury and other heavy metals in ecosystems]. - Novosibirsk. - 1989, Part 3. - P. 88-127.

7. Kruchkov V.N. Abdurakhmanov T.M. Fedorova N.N. Morfologija organov i tkanej vodnyh zhivotnyh [The morphology of organs and tissues of aquatic animals]. - Moscow: Nauka, 2004. P.144.

8. Leonova G.A. Biogeohimicheskaja indikacija – perspektivnyj metod izuchenija antropogennoj transformacii vodnyh jekosistem [Biogeochemical indication - a promising method for the study of anthropogenic transformation of aquatic ecosystems] Sovremennye problemy gidrobiologii Sibiri: mater. Vserosc. nauchno-praktich. konf. [Modern problems of Hydrobiology Siberia: mater. All-Russian theoretical and practical Conference]. - Tomsk, 2001, P. 124-125.

9. Leonova G.A. Anoshin G.N. Sheveleva N.G. Jekologicheskaja jekspertiza sostojanija vodnyh jekosistem bassejna r.Ob' metodom biogeohimicheskoj indikacii [Environmental assessment of aquatic ecosystems by the Ob river basin biogeochemical indication] Sovremennye problemy gidrobiologii Sibiri: mater. Vserosc. nauchno-praktich. konf. [Modern problems of Hydrobiology Siberia: mater. All-Russian theoretical and practical Conference]. – Tomsk. – 2001. P. 126-127.

10. Leonova G.A. Anoshin G.N. Sheveleva N.G. Jekologicheskaja jekspertiza sostojanija vodnyh jekosistem bassejna r.Ob' metodom biogeohimicheskoj indikacii [Environmental assessment of aquatic ecosystems by the Ob river basin biogeochemical indication] Sovremennye problemy gidrobiologii Sibiri: mater. Vserosc. nauchno-praktich. konf. [Modern problems of Hydrobiology Siberia: mater All-Russian theoretical and practical Conference]. – Tomsk.- 2001. - P. 126-127.

11. Lukin A.A. Moiseenko T.I. Metod patomorfologicheskoj ocenki sostojanija organizma lososevyh i sigovyh ryb [Method of assessment of pathologic organism salmon and whitefish] Antropogennoe vozdejstvie na prirodu Severa i ego jekologicheskih posledstvij [Anthropogenic impact on the nature of the North and its environmental impact]. Apatity: KSC RAN. - 1999. - P. 205-212.

12. Matkovskyi A.K. K metodike ocenki ushherba ot gibeli kormovoj bazy ryb pri zagrjaznenii vodoemov [Method to assess damage from death when forage fish ponds Pollution] Sovremennye problemy gidrobiologii Sibiri: mater. Vserosc. nauchno-praktich. konf. [Modern problems of Hydrobiology Siberia: mater. All-Russian theoretical and practical Conference]. - Tomsk. – 2001. - P. 129-130.

13. Nyukkanov A.N. Nakoplenie rtuti v rybe iz vodoemov Momskogo rajona Jakutii [Accumulation of mercury in fish from reservoirs Moma Yakutian] Sbornik materialov II respublikanskoj nauchno-prakticheskoj konferencii «Budushhee jakutskogo sela»[Collection of

materials II Republican scientific-practical conference "The Future of the Yakut village"]. - Yakutsk. - 2000. - P.174-180.

14. Nyukkanov A.N. Vysshie vodnye rastenija kak bioindikatory sredy obitanija ryb Indigirki [Higher aquatic plants as bioindicators of fish habitat Indigirka] Veterinary Medicine, 2003, № 3, p.23.

15. Nyukkanov A.N. Kontaminirovannost' reki Viljuj rtut'ju, svincom i kadmiem [Of contamination of rivers Vilyuy mercury, lead and cadmium] Sb. materialov mezhdunarodnoj nauchno-prakticheskoj konferencii «Pit'evaja i stochnye vody: Problemy ochistki i ispol'zovanija» [Collection of materials International scientific-practical conference "Drinking and Wastewater Problems purification and use"]. – Penza. - 1997. - P. 43-44.

16. Nyukkanov A.N. Vlijanie tradicionnyh sposobov kulinarnoj obrabotki ryby v Momskom uluse na uroven' rtuti v gotovyh ryboproduktov [The influence of traditional ways of cooking fish in Moma ulus on mercury levels in fish products ready] Sbornik materialov NPK posvjashhennoj Godu Arktiki: Tez. dokl. [Collection of materials scientific-practical. conf. for the Year of the Arctic: Proc. of reports]. - Yakutsk. - 1998. - P. 20-21.

17. Nyukkanov A.N. Jekotoksikologija belkovyh produktov pitanija v Jakutii [Ecotoxicology protein food in Yakutia] Novye jenterosorbenty i farmakologicheski aktivnye veshhestva i ih primenenie v veterinarii i zhivotnovodstve: mater. mezhdunarodnoj nauchno-praktich. konf., posvjashhennoj vos'midesjatiletiju Zasluzhennogo dejatelja nauki RF, doktora veterinarnyh nauk, professora M.I. Rabinovicha, 26-27 ijunja 2002 g. [New chelators and pharmacologically active substances and their application in veterinary medicine and animal husbandry: Mater. International scientific-practical. conf. dedicated eightieth Honored Scientist of the Russian Federation, Doctor of Veterinary Sciences, Professor M.I. Rabinovich, June 26-27, 2002]. - Troitsk. - 2002. P. 79-80.

18. Nyukkanov A.N. Bolshakova K.A. Raspredelenie rtuti v presnovodnyh jekosistemah bassejna Indigirki [Distribution of mercury in freshwater ecosystems pool Indigirka] Sbornik materialov NPK posvjashhennoj Godu obrazovanija: tez.dokl. [Collection of materials scientific-practical. conf. for the Year of Education: Tez.dokl.]. – Yakutsk. – 1977. - P. 82.

19. Nyukkanov A.N. Bolshakova K.A. Problemy bezopasnosti belkovyh produktov pitanija v Respublike Saha (Jakutija) [Security problems protein food in the Republic of Sakha (Yakutia)] Sbornik materialov NPK «Regional'nye problemy sel'skohozjajstvennogo proizvodstva Respubliki Saha (Jakutija)»: tez. dokl. [Collected materials scientific-practical.

conf. "Regional problems of agricultural production of the Sakha Republic (Yakutia)": Proc. of reports]. - Yakutsk. - 2001, - P.78-79.

20. Nyukkanov A.N. Bolshakova K.A. Raspredelenie rtuti v presnovodnyh jekosistemah bassejna Indigirki [Distribution of mercury in freshwater ecosystems pool Indigirka] Sbornik materialov NPK posvjashhennoj Godu Obrazovanija: tez.dokl. [Collection of materials scientific-practical. conf. for the Year of Education: tez.dokl.]. – Yakutsk. – 1997. P. 82.

21. Nyukkanov A.N. Bolshakova K.A. Problemy bezopasnosti belkovyh produktov pitanija v Respublike Saha (Jakutija) [Security problems protein food in the Republic of Sakha (Yakutia)] Sbornik materialov NPK «Regional'nye problemy sel'skohozjajstvennogo proizvodstva Respubliki Saha (Jakutija)»: Tez. dokl. [Collected materials scientific-practical. conf. "Regional problems of agricultural production of the Sakha Republic (Yakutia)": Proc. of reports].- Yakutsk. - 2001. - P. 78-79.

22. Pavlov D. S. Savvaitova K.A. Gryzdeva M.A. [et.al.]. Raznoobrazie ryb Tajmyra [Diversity of fishes in the Taymyr region].- Moscow: Nauka.- 1999. P. 207.

23. Popov P.A. Sostojanie i metodicheskie aspekty ocenki jekologicheskogo statusa vodoemov Sibiri metodami ihtioindikacii [State and methodological aspects of the evaluation of the ecological status of water bodies Siberia methods ihtioindikatsii] Problemy gidrobiologii Sibiri [Problems of Hydrobiology Siberia].- Tomsk: Glider, 2005.- P. 202-207.

24. Reshetnikov Y.S. Popov O.A. Kashulin N.A. [et al.]. Ocenka blagopoluchija rybnoj chasti vodnogo soobshhestva po rezul'tatam morfo-patologicheskogo analiza ryb [Assessment of the welfare of the fishing community water on the results of morphological and pathological analysis of fish].- 1999, V. 119, vol. 2. - P.165-177.

25. Selyukov A.G. Morfofunkcional'nyj status ryb Ob'-Irtyshskogo bassejna v sovremennyh uslovijah [Morfofunktcionalnyj status fish Ob-Irtysh basin in modern conditions]. - Tyumen: Tyumen state. University. – 2007. P.184.

Authors:

Matvey Matveevich Tyaptirgyanov – cand. biol. sc., associate professor of BGF NEFU named after M.K.Ammosov

Victoria Matveevna Tyaptirgyanova – cand. med. sc., deputy chief physician FBI "Center of Hygiene and Epidemiology in the Sakha Republic (Yakutia)», vtyap@mail.ru

Table 1

Accumulation and distribution of mercury in the organs and tissues of freshwater fish Amgian district

period of research	age fish	muscles	liver	intestines	gills	bones
Luce (*Esox lucius*)						
summer	to 2+	0,126±0,089	0,145±0,102	0,084±0,059	0,031±0,022	0,035±0,025
	from 4+ to 6+	0,200±0,141	0,218±0,155	0,190±0,134	0,048±0,034	0,041±0,029
winter	to 2+	0,091±0,064	0,119±0,084	0,052±0,037	0,074±0,052	0,042±0,030
	from 4+ to 6+	0,103±0,073	0,190±0,134	0,047±0,033	0,097±0,068	0,054±0,038
Roach (*Rutilus rutilus*)						
summer	to 2+	0,131±0,093	0,141±0,100	0,076±0,054	0,026±0,018	0,069±0,049
	from 4+ to 6+	0,202±0,143	0,216±0,152	0,190±0,134	0,203±0,143	0,160±0,113
winter	to 2+	0,061±0,043	0,057±0,040	0,041±0,029	0,034±0,024	0,076±0,054
	from 4+ to 6+	0,156±0,110	0,189±0,134	0,047±0,033	0,168±0,119	0,133±0,094
Perch (*Perca fluviatilis*)						
summer	to 2+	0,051±0,036	0,064±0,045	0,043±0,030	0,039±0,028	0,036±0,025
	from 4+ to 6+	0,120±0,085	0,109±0,077	0,075±0,053	0,087±0,061	0,056±0,039
winter	to 2+	0,042±0,030	0,041±0,029	0,029±0,020	0,021±0,015	0,020±0,014
	from 4+ to 6+	0,098±0,066	0,077±0,054	0,041±0,029	0,054±0,038	0,043±0,030

Table 2

Accumulation and distribution of mercury in the organs and tissues of freshwater fish Vilyui district

period of research	age fish	muscles	liver	intestines	gills	bones
Crucian carp (*Carassius carassius*)						
Summer	to 2+	0,191±0,135	0,149±0,105	0,077±0,054	0,109±0,077	0,051±0,036
	from 4+ to 6+	0,210±0,148	0,154±0,109	0,137±0,097	0,160±0,113	0,049±0,035
Winter	to 2+	0,141±0,100	0,138±0,097	0,074±0,052	0,096±0,068	0,073±0,052
	from 4+ to 6+	0,201±0,142	0,143±0,135	0,129±0,091	0,182±0,129	0,093±0,066
Roach (*Rutilus rutilus*)						
Summer	to 2+	0,584±0,413	0,342±0,242	0,121±0,085	0,315±0,223	0,133±0,094
	from 6+ to 8+	0,721±0,509	0,982±0,694	0,409±0,289	0,201±0,142	0,153±0,108
Winter	to 2+	0,494±0,349	0,283±0,200	0,132±0,093	0,292±0,206	0,091±0,064
	from 6+ to 8+	0,712±0,503	0,395±0,279	0,216±0,153	0,237±0,167	0,137±0,097
Perch (*Perca fluviatilis*)						
Summer	to 2+	0,832±0,588	0,109±0,077	0,061±0,043	0,111±0,078	0,054±0,038
	from 5+ to 7+	1,621±0,145	0,210±0,148	0,127±0,090	0,148±0,105	0,062±0,044
Winter	to 2+	0,937±0,662	0,093±0,066	0,056±0,040	0,231±0,163	0,049±0,035
	from 5+ to 7+	1,820±1,290	0,678±0,479	0,349±0,247	0,439±0,031	0,167±0,118

Table 3

Accumulation and distribution of mercury in the organs
and tissues of pike and broad whitefish Basin Chrome
(Allaikhovsky district, August - October 2006, n = 10 specimens)

period of research	age fish	muscles	liver	intestines	gills	bones
Luce (*Esox lucius*)						
Summer	to 2+	0,311±0,220	0,209±0,148	0,096±0,068	0,179±0,126	0,091±0,064
	from 4+ to 6+	0,931±0,658	0,774±0,547	0,157±0,111	0,533±0,377	0,141±0,100
Winter	to 2+	0,293±0,207	0,388±0,274	0,144±0,102	0,267±0,189	0,107±0,076
	from 4+ to 6+	0,829±0,586	0,962±0,680	0,348±0,246	0,514±0,363	0,192±0,136
Chir (*Coregonus nasus*)						
Summer	to 2+	0,194±0,137	0,142±0,100	0,098±0,069	0,145±0,102	0,073±0,052
	from 6+ to 8+	0,421±0,297	0,382±0,270	0,149±0,105	0,201±0,142	0,153±0,108
Winter	to 2+	0,224±0,158	0,183±0,129	0,112±0,079	0,112±0,079	0,061±0,043
	from 6+ to 8+	0,512±0,362	0,475±0,336	0,116±0,082	0,237±0,167	0,137±0,097

Table 4

Accumulation and distribution of mercury in the organs and tissues of freshwater fish Allaikhovskiy district

period of research	age fish	muscles	liver	intestines	gills	bones
Crucian carp (*Carassius carassius)*						
Summer	to 2+	0,159±0,112	0,115±0,081	0,081±0,057	0,135±0,095	0,062±0,044
	from 4+ to 6+	0,176±0,124	0,156±0,110	0,162±0,114	0,170±0,120	0,135±0,095
Winter	to 2+	0,110±0,078	0,097±0,69	0,079±0,056	0,129±0,091	0,057±0,040
	from 4+ to 6+	0,151±0,107	0,147±0,104	0,159±0,112	0,156±0,110	0,127±0,090
Dace (*Leuciscus leuciscus*)						
Summer	to 2+	0,311±0,220	0,175±0,124	0,101±0,071	0,146±0,103	0,062±0,044
	from 6+ to 8+	0,762±0,538	0,692±0,487	0,139±0,098	0,506±0,358	0,120±0,085
Winter	to 2+	0,189±0,134	0,321±0,227	0,165±0,081	0,274±0,194	0,153±0,108
	from 6+ to 8+	0,605±0,428	0,590±0,417	0,221±0,156	0,490±0,346	0,167±0,114
Perch (*Perca fluviatilis*)						
Summer	to 2+	0,857±0,606	0,420±0,297	0,386±0,273	0,497±0,351	0,289±0,204
	from 4+ to 6+	1,877±1,326	1,375±0,972	0,621±0,439	0,734±0,519	0,499±0,353
Winter	to 2+	0,476±0,336	0,398±0,281	0,201±0,142	0,278±0,196	0,165±0,117
	from 4+ to 6+	1,236±0,873	0,732±0,517	0,330±0,233	0,520±0,367	0,220±0,155

Table 5

Accumulation and distribution of mercury in the organs and tissues of freshwater fish in the area Srednekolymsk

period research	age fish	muscles	liver	intestines	gills	bones
Dace (*Leuciscus leuciscus*)						
Summer	to 2+	0,147±0,104	0,122±0,086	0,083±0,059	0,146±0,103	0,062±0,044
	from 4+ to 6+	0, 576±0,407	0,365±0,258	0,165±0,081	0,311±0,220	0,146±0,103
Winter	to 2+	0,121±0,085	0,081±0,057	0,042±0,030	0,097±0,068	0,044±0,031
	from 4+ to 6+	0,211±0,149	0,149±0,105	0,108±0,076	0,183±0,129	0,089±0,063
Chukuchan (*Catostomus catostomus*)						
Summer	to 3+	0,413±0,292	0,161±0,114	0,101±0,071	0,209±0,148	0,083±0,059
	from 6+ to 8+	0,927±0,655	0,701±0,495	0,157±0,111	0,471±0,333	0,119±0,088
Winter	to 3+	0,286±0,202	0,287±0,203	0,127±0,090	0,311±0,220	0,097±0,068
	from 6+ to 8+	0,601±0,425	0,712±0,503	0,311±0,220	0,509±0,036	0,198±0,140
Perch (Perca fluviatilis)						
Summer	to 2+	0,932±0,656	0,401±0,283	0,516±0,365	0,521±0,368	0,311±0,220
	from 4+ to 6+	1,921±1,358	1,341±0,948	0,611±0,432	0,923±0,652	0,671±0,474
Winter	to 2+	0,576±0,407	0,311±0,220	0,276±0,195	0,311±0,220	0,211±0,149
	from 4+ to 6+	0,873±0,617	0,731±0,517	0,321±0,227	0,513±0,362	0,174±0,123