



DOI: <https://doi.org/10.23859/estr-250113>

EDN: <https://elibrary.ru/mgchgws>

UDC 546.49:574.24:599.742.4(571.62)

Short communication

**First data on mercury content in the body
of the Siberian weasel
(*Mustela sibirica manchurica* Brass, 1911)
in the south of Khabarovsk Territory**

O.S. Khomchenko 

Institute of Water and Ecological Problems, Far Eastern Branch, Russian Academy of Sciences – a separate division of the Khabarovsk Federal Research Center, Far Eastern Branch, Russian Academy of Sciences, Dikopoltsev St. 56, Khabarovsk, 680000 Russia

homchenko.ru@mail.ru

Abstract. The mercury content in the organs and tissues of the Siberian weasel from the southern districts of Khabarovsk Territory was studied for the first time. The specimens examined were individuals that died accidentally in the winter of 2023–2024 after being caught in traps on private farmsteads located adjacent to the forest. Mercury was determined by Zeeman atomic absorption spectrometry. The highest mercury concentrations were found in the kidneys (1.4 mg/kg) and fur (2.6 mg/kg) of the animals. The mercury concentrations in the tissues and organs of the Siberian weasel decreased in the following order: fur > kidneys > liver > muscle > heart > spleen > lungs. It is suggested that seasonal molting plays a significant role in clearing mercury from the body through its deposition in the fur.

Keywords: Mustelidae, mercury, organs and tissues, fur, molting, detoxification

Funding. This work was carried out within the framework of the state assignment of the Institute of Water and Ecological Problems, Far Eastern Branch, Russian Academy of Sciences (No. 126031118637-5), using the scientific equipment of the Center for Collective Use

ORCID:

O.S. Khomchenko, <https://orcid.org/0000-0003-1953-7249>

To cite this article: Khomchenko, O.S., 2026. First data on mercury content in the body of the Siberian weasel (*Mustela sibirica manchurica* Brass, 1911) in the south of Khabarovsk Territory. *Ecosystem Transformation* **9** (4), 3–13. <https://doi.org/10.23859/estr-250113>

Received: 13.01.2025

Accepted: 08.07.2025

Published online: 09.10.2026

DOI: <https://doi.org/10.23859/estr-250113>

EDN: <https://elibrary.ru/mgchgws>

УДК 546.49:574.24:599.742.4(571.62)

Краткое сообщение

Первые сведения о содержании ртути в организме колонка (*Mustela sibirica manchurica* Brass, 1911) на юге Хабаровского края

О.С. Хомченко 

Институт водных и экологических проблем ДВО РАН – обособленное подразделение
Хабаровского Федерального исследовательского центра ДВО РАН, 680000, Россия,
г. Хабаровск, ул. Дикопольцева, д. 56

homchenko.ru@mail.ru

Аннотация. Впервые изучено содержание ртути в органах и тканях колонка из южных районов Хабаровского края. Исследованию подверглись особи, случайно погибшие зимой 2023–2024 гг. в результате попадания в капканы в частных хозяйствах, расположенных на границе с лесом. Определение выполнено методом атомно-абсорбционной спектроскопии на основе эффекта Зеемана. Максимальные концентрации ртути выявлены в почках (1.4 мг/кг) и мехе (2.6 мг/кг) животных. Ряд убывания концентраций в тканях и органах колонка имеет вид: мех > почки > печень > мышцы > сердце > селезенка > легкие. Сделано предположение о значительной роли сезонной линьки в очищении организма от ртути путем ее депонирования в мехе.

Ключевые слова: куны, ртуть, органы и ткани, мех, линька, детоксикация

Финансирование. Работа выполнена в рамках государственного задания ИВЭП ДВО РАН (№ 126031118637-5) с использованием научного оборудования центра коллективного пользования.

ORCID:

О.С. Хомченко, <https://orcid.org/0000-0003-1953-7249>

Для цитирования: Хомченко, О.С., 2026. Первые сведения о содержании ртути в организме колонка (*Mustela sibirica manchurica* Brass, 1911) на юге Хабаровского края. *Трансформация экосистем* 9 (4), 3–13. <https://doi.org/10.23859/estr-250113>

Поступила в редакцию: 13.01.2025

Принята к печати: 08.07.2025

Опубликована онлайн: 09.10.2026

Introduction

Mercury is one of the most hazardous global pollutants, characterized by high reactivity and mobility in the environment. Released from minerals, rocks, coal, and oil or through volcanic activity (Nriagu and Becker, 2003), mercury undergoes a series of chemical transformations and enters numerous local biogeochemical cycles, each of which, at a certain stage, becomes part of a planet-wide cycle (Pavithra et al., 2023). Global atmospheric transport plays a major role in enriching various regions with mercury. Increasing Hg levels are increasingly being recorded in regions remote from its sources, including the Arctic (Dietz et al., 2022). In Khabarovsk Territory, the main anthropogenic sources of mercury are gold-mining operations (Krupskaya et al., 2024) and a pulp-and-board mill that is currently inactive. This plant used a chlorine-based cellulose bleaching technology, and the chlorine was produced using a mercury electrolysis unit. To date, no proper remediation has been carried out at the mill site (Tselykh et al., 2022). However, the most likely influence is transboundary transport from China, which is the world's leading emitter of mercury into the atmosphere (Qi et al., 2019).

The levels of mercury accumulation in the fauna of the Amur region remain poorly studied and concern only fish (Khomchenko, 2024; Kot, 1993; Nikitina, 2013; Senkevich et al., 2023) and farm animals (Katola et al., 2008). Studying the mercury content in the bodies of wild animals is of interest both for analyzing the effect of the existing natural background and its changes, and for examining species-specific and individual adaptive responses of organisms. The Siberian weasel (*Mustela sibirica manchurica* Brass, 1911) is a common subspecies that is widely distributed in the Amur region (westward to the Zeya River) and Primorye, and in northeastern China. It inhabits a relatively small home range year-round, prefers small birch or aspen forests and shrub thickets along the shores of lakes and rivers, and is found on the outskirts of settlements and towns. The diet of the Siberian weasel consists mainly of small voles and mice. It also includes birds, amphibians, and insects, while the proportion of other food groups is insignificant (Heptner et al., 1967; Tkachenko, 1997). In this regard, the Siberian weasel, along with the red fox *Vulpes vulpes* (L., 1758) (Kalisinska et al., 2012), may be considered a potential indicator species of environmental quality. The present study was intended to confirm or refute this assumption.

Materials and methods

Five Siberian weasel specimens were examined; they had died accidentally in December–January 2023–2024 after being caught in traps on private farmsteads on the outskirts of the settlement of Dormidontovka (Vyazemsky District, Khabarovsk Territory), located 80 km south of the city of Khabarovsk (Fig. 1). The surrounding area consists of waterlogged and tussocky plains and floodplain meadows (in places with willow thickets), interspersed with small tracts of broadleaved forest. Water bodies in the area are numerous and include two rivers (the lower reaches of the Podkhorenok River and its tributary, the Pashino River), lakes of both natural and artificial origin, and numerous ditches formed during the construction of dams. Industries traditionally regarded as sources of mercury are absent from the area.

Total mercury content was determined using an RA-915+ mercury analyzer with a PYRO-915+ pyrolysis attachment (Lumex Ltd.), which allows native samples to be analyzed without prior preparation. Calibration of the instrument and verification of measurement accuracy were performed using a certified mercury-ion standard solution (GSO 7263-96; relative uncertainty of the certified value $\pm 1.0\%$). Measurements were carried out in accordance with GOST 34427–2018¹. The measurement range for the mass fraction of mercury is 0.0025–5.0000 mg/kg. Mercury content was measured in two replicates; the arithmetic mean was taken as the measurement result, provided that the discrepancy between the replicates did not exceed the repeatability limit of the method – 17% in the range of 0.025–0.25 mg/kg and 11% in the concentration range of 0.25–5.0 mg/kg. The expanded uncertainty of the method (U) at $k = 2$ for these concentrations is 28% and 20%, respectively. The actual discrepancies between replicates across all concentration ranges were within 0.7–9.3%, with a mean of 4.3% and a median of 3.2%.

When the animal carcasses were examined, the sex, body mass, body length, tail length, and mercury content in the fur, muscle, kidneys, liver, heart, lungs, and spleen were determined. The age of the animals was not determined. Fur for analysis was taken from the dorsal part of the carcass, and muscle from the thigh. Samples were analyzed at wet weight, without prior drying.

¹ GOST 34427–2018. Food products and animal feed. Determination of mercury by Zeeman atomic absorption spectrometry.



Fig. 1. Schematic map of the Siberian weasel trapping site.

Results and discussion

Specimens Nos. 3–5 were males in somewhat reduced body condition, as indicated not only by the ratio of body weight to body size but also by the absence of fat reserves. The large female (specimen No. 2) was quite well-nourished and had fat reserves. Specimen No. 1 was a male showing signs of emaciation: body mass was greatly reduced, visceral fat was almost absent, and the muscles of the body and limbs were atrophied. However, the body condition of the animals did not affect the mercury content in their internal organs or fur. The small sample size did not allow us to determine whether the sex of the animals influences mercury accumulation in their bodies. Data on the mercury content in the organs and tissues of the Siberian weasels are presented in Table 1.

The averaged decreasing order of mercury concentration in the organs and tissues is as follows: fur > kidneys > liver > muscle > heart > spleen > lungs. Mercury concentrations in the organs varied severalfold among individuals.

Since no information could be found in the literature on the Hg content in the organs and tissues of Siberian weasels, the data obtained were compared with those previously reported for other members of the family Mustelidae: the European polecat, American mink, European pine marten, weasel, and badger (Table 2).

The mercury content in the liver, kidneys, and muscle of all the Siberian weasels examined did not exceed that in other members of the family. In specimens Nos. 1–3 it was similar to the content in the bodies of the polecat, marten, and badger; in specimens Nos. 4–5 the values approached those reported for the mink, even though its diet includes a considerable amount of fish – the main source of mercury.

To characterize the toxic effects of heavy metals on the body, their concentrations in the liver are often used as indicators. The Hg content in the liver of the Siberian weasels ranged from 0.030 to 0.903 mg/kg, which is similar to the content in the liver of arctic foxes, 0.010–1.110 mg/kg (Hallanger et al., 2019), whose diet, like that of the Siberian weasel, consists mainly of small rodents. The mercury content has been studied in murine rodents inhabiting various ecological niches in Slovenia (Petkovšek et al., 2014). It was shown that in areas subject to elevated mercury loading and having higher soil metal

Table 1. Mercury content in the organs and tissues of Siberian weasels, $X \pm U$ mg/kg; X is the arithmetic mean of the results of two parallel measurements obtained under repeatability conditions; U is the expanded uncertainty.

Sample No.	Body mass, g	Body length, cm	Tail length, cm	Sex	Mercury content in sample, mg/kg						
					Fur	Kidney	Muscles	Liver	Heart	Spleen	Lung
1	325	33	18	♂	2.603 ± 0.521	0.105 ± 0.029	0.040 ± 0.011	0.036 ± 0.010	0.030 ± 0.008	0.029 ± 0.008	0.016 ± 0.006
2	458	29	13	♀	2.031 ± 0.406	0.095 ± 0.027	0.037 ± 0.010	0.031 ± 0.009	0.023 ± 0.009	0.016 ± 0.006	0.012 ± 0.005
3	608	29	16	♂	1.801 ± 0.360	0.109 ± 0.031	0.049 ± 0.014	0.030 ± 0.008	0.040 ± 0.011	0.031 ± 0.009	0.022 ± 0.009
4	635	36	19	♂	0.331 ± 0.066	0.570 ± 0.114	0.222 ± 0.062	0.257 ± 0.051	0.152 ± 0.042	0.128 ± 0.036	0.074 ± 0.021
5	626	32	19	♂	1.641 ± 0.328	1.404 ± 0.281	0.825 ± 0.165	0.903 ± 0.181	0.610 ± 0.122	0.494 ± 0.099	0.376 ± 0.075
Среднее					1.681 ± 0.336	0.457 ± 0.091	0.235 ± 0.066	0.251 ± 0.050	0.171 ± 0.048	0.140 ± 0.039	0.100 ± 0.028

Table 2. Mercury content (mg/kg wet weight) in the muscle, fur, and organs of selected members of the family Mustelidae (based on published data).

Species	Region	Mean concentration (range)	Source
Liver			
European polecat (<i>Mustela putorius</i> L., 1758)	Finland	0.39	Lodenius et al., 2014
American mink (<i>Neovison vison</i> Schreber, 1777)	Sweden	0.72 (0.03–5.95)	Ljungvall et al., 2017
European pine marten (<i>Martes martes</i> L., 1758)	Russia, Vologda Region	0.41 (0.11–2.27)	Komov et al., 2012
Least weasel (<i>Martes nivalis</i> L., 1766)		0.13 (0.01–0.64)	
American mink		3.49 (0.57–6.49)	
European pine marten	Croatia	(0.019–0.056)	Bilandžić et al., 2012
European badger (<i>Meles meles</i> L., 1758)		(0.019-0.072)	
Kidneys			
European polecat	Finland	0.66	Lodenius et al., 2014
European pine marten	Russia, Vologda Region	0.67 (0.21–3.2)	Komov et al., 2012
Least weasel		0.27 (0.01–1.03)	
American mink		3.42 (0.58–5.52)	
European pine marten	Croatia	(0.073–0.162)	Bilandžić et al., 2012
Muscles			
European polecat	Finland	0.49	Lodenius et al., 2014
European pine marten		0.22	
European pine marten	Russia, Vologda Region	0.36 (0.10–1.44)	Komov et al., 2012
Least weasel		0.12 (0.01–0.44)	
American mink		2.37 (0.25–5.08)	
European pine marten	Croatia	(0.005–0.048)	Bilandžić et al., 2012
Fur			
European polecat	Finland	5.0	Lodenius et al., 2014
European pine marten		2.1	

concentrations relative to background sites, the Hg content in the rodents' livers was also elevated, on average by a factor of 2.3. The range of concentrations within the sample varied from background levels to values exceeding them by more than sixfold. In our study, the mercury concentrations in the corresponding organs and tissues were similar in specimens Nos. 1–3, whereas in specimen No. 4 they were 6–8 times higher. If an analogy with murine rodents is assumed, the concentrations found in specimens Nos. 1–3 could be regarded as a background level. The highest Hg concentrations were found in the organs of Siberian weasel No. 5. Compared with specimens Nos. 1–3, the excess was 25–30 times for the liver, 13–15 times for the kidneys, 16–26 times for the muscle and heart, and 16–31 times for the spleen and lungs.

The highest mercury concentrations were recorded in the animals' fur. The autumn molt of the Siberian weasel is characterized by a complete change of the pelage, which is completed by early November. At the time of the study, all individuals had a well-developed winter coat, dense and fluffy. In four of the five individuals examined, the Hg content in the fur exceeded 1.5 mg/kg, whereas in specimen No. 4 it was three times lower. Overall, such values can be considered low compared with the fur of the European polecat, where the concentration of the element was 5.0 ± 2.1 mg/kg (Lodenius et al., 2014). A critical Hg level in the fur of the river otter and mink has been proposed at 15 mg/kg, since, according to modeling results, this corresponds to a mercury content in the brain of 2.23–2.33 mg/kg dry weight, which can be taken as the maximum safe concentration (Eccles et al., 2017).

The question of whether there is any relationship between the mercury content in the fur and in the internal organs of the Siberian weasel requires further study using a larger sample. It is clear only that, for the Siberian weasel, fur cannot be used as an indicator of the risk of chronic mercury intoxication of the whole body, as has been proposed for the otter and mink (Eccles et al., 2017). Based on the data obtained, the following assumptions can be made. High mercury concentrations in the fur of the Siberian weasel may be found in individuals with both low and fairly high levels of the element in the internal organs. Molting may serve as a kind of cleansing process, during which Hg is transferred from the organs and tissues into the actively growing hair and is removed from general metabolism. Although hair growth in these animals continues year-round, its rate decreases after the molting period ends. The detoxifying role of seasonal molting was previously noted in otters in Eastern Finland (Hyvärinen et al., 2003). In an experiment in which methylmercury was added to the diet of mink, it was likewise shown that a considerable proportion of it (from 22 to 100%) accumulates in the animals' fur, and that the seasonal molt of fur-bearing animals serves as an effective mechanism of reducing the mercury content in the body (Wang et al., 2014).

Conclusion

The highest mercury concentrations in the Siberian weasel were recorded in the fur and kidneys, and somewhat lower ones in the liver and muscle tissue. The mercury content in the organs and tissues may differ by dozens of times among individuals. High Hg concentrations in the fur are not an indicator of accumulation of the element in the internal organs. The factors affecting the accumulation, redistribution, and elimination of mercury from the body of the Siberian weasel require further investigation involving additional studies and a larger sample size.

References

- Bilandžić, N., Deždek, D., Sedak, M., Đokić, M., Šimić, B. et al., 2012. Trace elements in tissues of wild carnivores and omnivores in Croatia. *Bulletin of Environmental Contamination and Toxicology* **88**, 94–99. <https://doi.org/10.1007/s00128-011-0449-y>
- Dietz, R., Wilson, S., Loseto, L.L., Dommergue, A., Xie, Z., Sonne, C., Chételat, J., 2022. Special issue on the AMAP 2021 assessment of mercury in the Arctic. *Science of the Total Environment* **843**, 157020. <https://doi.org/10.1016/j.scitotenv.2022.157020>
- Eccles, K.M., Thomas, P.J., Chan, H.M., 2017. Predictive meta-regressions relating mercury tissue concentrations of freshwater piscivorous mammals. *Environmental Toxicology and Chemistry* **36** (9), 2377–2384. <https://doi.org/10.1002/etc.3775>
- Geptner, V.G., Naumov, N.P., Yurgenson, P.B., Sludskii, A.A., Chirkova, A.F., Bannikov, A.G., 1967. Kolonok [Weasel]. In: Geptner, V.G., Naumov, N.P. (ed.), *Mlekopitayushchie Sovetskogo Soyuza*.

- T. 2, ch. 1. *Morskie korovy i hishchnye* [Mammals of the Soviet Union. V. 2, p. 1. Sea cows and predators]. Vysshaya shkola, Moscow, USSR, 700–718. (In Russian).
- Hallanger, I.G., Fuglei, E., Yoccoz, N.G., Pedersen, Å.Ø., König, M., Routti, H., 2019. Temporal trend of mercury in relation to feeding habits and food availability in arctic foxes (*Vulpes lagopus*) from Svalbard, Norway. *Science of the Total Environment* **670**, 1125–1132. <https://doi.org/10.1016/j.scitotenv.2019.03.239>
- Hyvärinen, H., Tyni, P., Nieminen, P., 2003. Effects of moult, age, and sex on the accumulation of heavy metals in the otter (*Lutra lutra*) in Finland. *Bulletin of Environmental Contamination and Toxicology* **70**, 278–284. <https://doi.org/10.1007/s00128-002-0188-1>
- Kalisinska, E., Lisowski, P., Kosik-Bogacka, D.I., 2012. Red fox *Vulpes vulpes* (L., 1758) as a bioindicator of mercury contamination in terrestrial ecosystems of North-Western Poland. *Biological Trace Element Research* **145**, 172–180. <https://doi.org/10.1007/s12011-011-9181-z>
- Khomchenko, O.S., 2024. O soderzhanii rtuti v nekotorykh vidakh ryb reki Amur [On the mercury content in some fish species of the Amur River]. *Regional'nye problemy* [Regional Problems] **27** (3), 25–27. (In Russian). <https://doi.org/10.31433/2618-9593-2024-27-3-25-27>
- Katola, V.M., Radomskaya, V.I., Radomskii, S.M., 2008. Zagryaznenie rtut'yu i soputstvuyushchimi elementami verhnego Priamur'ya [Pollution of the Upper Amur Region with mercury and associated elements]. *Ekologiya i promyshlennost' Rossii* [Ecology and Industry of Russia] **5**, 51–53. (In Russian).
- Komov, V.T., Stepina, E.S., Gremyachih, V.A., Poddubnaya, N.YA., Borisov, M.Ya., 2012. Soderzhanie rtuti v organakh mlekopitayushchih semeistva kun'ih (Mustelidae) Vologodskoi oblasti [Mercury content in the organs of mammals of the mustelid family (Mustelidae) of the Vologda region]. *Povolzhskii ekologicheskii zhurnal* [Volga Region Ecological Journal] **4**, 385–393. (In Russian).
- Kot, F.S., 1993. Ocenka urovnei soderzhaniya tyazhelykh metallov v ihtiofaune Nizhnego Amura [Assessment of heavy metal levels in the ichthyofauna of the Lower Amur]. In: Ivashov, P.V. (ed.). *Biogeohimicheskaya ekspertiza sostoyaniya okruzhayushchei sredy* [Biogeochemical assessment of the state of the environment]. Dal'nauka, Vladivostok, Russia, 100–106. (In Russian).
- Krupskaya, L.T., Leonenko, A.V., Filatova, M.Yu., 2024. Problemy rtutnogo zagryazneniya v granichakh vliyaniya likvidirovannogo gornogo predpriyatiya rossypnoi zolotodobychi v Priamur'e kak klyuchevoi faktor ustoychivogo razvitiya raiona [Problems of mercury pollution within the boundaries of influence of the liquidated placer gold mining enterprise in the Amur region as a key factor in the sustainable development of the region]. *Materialy VII regional'noi nauchno-prakticheskoi konferencii «Intellektual'naya sobstvennost' v innovatsionnom razvitii regiona»* [Proceedings of the VII regional scientific and practical conference "Intellectual property in innovative development of the region"]. Khabarovsk, Russia, 65–73. (In Russian).
- Ljungvall, K., Magnusson, U., Korvela, M., Norrby, M., Bergquist, J., Persson, S., 2017. Heavy metal concentrations in female wild mink (*Neovison vison*) in Sweden: sources of variation and associations with internal organ weights. *Environmental Toxicology and Chemistry* **36** (8), 2030–2035. <https://doi.org/10.1002/etc.3717>
- Lodenius, M., Skarén, U., Hellstedt, P., Tulisalo, E., 2014. Mercury in various tissues of three mustelid species and other trace metals in liver of European otter from Eastern Finland. *Environmental Monitoring and Assessment* **186**, 325–333. <https://doi.org/10.1007/s10661-013-3376-z>
- Nikitina, I.A., 2013. Indikatsiya ekologicheskogo sostoyaniya ekosistem vodno-bolotnykh ugodii "Bolon" po soderzhaniiyu elementov v rybakh [Indication of the ecological state of the "Bologna" wetland ecosystems based on the content of elements in fish]. *Materialy X Dal'nevostochnoi konferencii*

po zapovednomu delu [Proceedings of the X Far Eastern Conference on Nature Reserves]. Blagoveshchensk, Russia, 235–238. (In Russian).

Nriagu, J., Becker, C., 2003. Volcanic emissions of mercury to the atmosphere: global and regional inventories. *The Science of the Total Environment* 304, 3–12.

Pavithra, K.G., Rajan, P.S., Kumar, P.S., Rangasamy, G., 2023. Mercury sources, contaminations, mercury cycle, detection and treatment techniques: A review. *Chemosphere* 312, 137314. <https://doi.org/10.1016/j.chemosphere.2022.137314>

Petkovšek, S., Al S., Kopušar, N., Kryštufek, B., 2014. Small mammals as biomonitors of metal pollution: a case study in Slovenia. *Environmental Monitoring and Assessment* 186, 4261–4274. <https://doi.org/10.1007/s10661-014-3696-7>

Qi, J., Wang, Y., Liang, S., Li, Y., Li, Y. et al., 2019. Primary suppliers driving atmospheric mercury emissions through global supply chains. *One Earth* 1, 254–266. <https://doi.org/10.1016/j.oneear.2019.10.005>

Sen'kevich, O.A., Koval'skii, Yu.G., Chebargina, M.A., 2023. Monitoring fonovogo sodержaniya rtuti v biosisteme i organizme detskogo naseleniya nizhnego techeniya reki Amur [Monitoring background mercury content in the biosystem and body of the child population of the lower reaches of the Amur River]. *Vestnik Severo-Vostochnogo federal'nogo universiteta im. M.K. Ammosova. Seriya: Medicinskie nauki [Bulletin of the North-Eastern Federal University named after M.K. Ammosov. Series: Medical Sciences]* 2 (31), 31–41. (In Russian). <https://doi.org/10.25587/SVFU.2023.31.2.004>

Tkachenko, K.N., 1997. Osobennosti pitaniya sobolya i kolonka v Bol'shekhkheksirskom zapovednike [Features of the diet of sable and siberian weasel in the Bolshekhkheksirsky Reserve]. *Tezisy dokladov III Dal'nevostochnoi konferenciya po zapovednomu delu [Abstracts of the III Far Eastern Conference on Nature Reserves]*. Dal'nauka, Vladivostok, Russia, 117. (In Russian).

Tselykh, E.D., Akhtyamov, M.H., Poleschchuk, A.E., 2022. Balans mikroelementov v cepi "voda – pochva – rasteniya – zhivotnye – chelovek" v urboekosisteme g. Amurska Habarovskogo kraja v usloviyah tekhnogennogo zagryazneniya rtut'yu [Balance of microelements in the chain "water – soil – plants – animals – humans" in the urban ecosystem of the city of Amursk, Khabarovsk Krai, under conditions of man-made mercury pollution]. *Russian Journal of Ecosystem Ecology* 7 (2), 9–24. (In Russian). <https://doi.org/10.21685/2500-0578-2022-2-2>

Wang, W., Evans, R.D., Hickie, B.E., Rouvinen-Watt, K., Evans, H.E., 2014. Methylmercury accumulation and elimination in mink (*Neovison vison*) hair and blood: Results of a controlled feeding experiment using stable isotope tracers. *Environmental Toxicology and Chemistry* 33 (12), 2873–2880. <https://doi.org/10.1002/etc.2762>

Список литературы

Гептнер, В.Г., Наумов, Н.П., Юргенсон, П.Б., Слудский, А.А., Чиркова, А.Ф., Банников, А.Г., 1967. Колонок. В: Гептнер, В.Г., Наумов, Н.П. (ред.), *Млекопитающие Советского Союза. Т. 2, ч. 1. Морские коровы и хищные*. Высшая школа, Москва, СССР, 700–718.

Катола, В.М., Радомская, В.И., Радомский, С.М., 2008. Загрязнение ртутью и сопутствующими элементами верхнего Приамурья. *Экология и промышленность России* 5, 51–53.

Комов, В.Т., Степина, Е.С., Гремячих, В.А., Поддубная, Н.Я., Борисов, М.Я., 2012. Содержание ртути в органах млекопитающих семейства куных (*Mustelidae*) Вологодской области. *Поволжский экологический журнал* 4, 385–393.

- Кот, Ф.С., 1993. Оценка уровней содержания тяжелых металлов в ихтиофауне Нижнего Амура. В: Ивашов, П.В. (ред.), *Биогеохимическая экспертиза состояния окружающей среды*. Дальнаука, Владивосток, Россия, 100–106.
- Крупская, Л.Т., Леоненко, А.В., Филатова, М.Ю., 2024. Проблемы ртутного загрязнения в границах влияния ликвидированного горного предприятия россыпной золотодобычи в Приамурье как ключевой фактор устойчивого развития района. *Материалы VII региональной научно-практической конференции «Интеллектуальная собственность в инновационном развитии региона»*. Хабаровск, Россия, 65–73.
- Никитина, И.А., 2013. Индикация экологического состояния экосистем водно-болотных угодий "Болонь" по содержанию элементов в рыбах. *Материалы X Дальневосточной конференции по заповедному делу*. Благовещенск, Россия, 235–238.
- Сенькевич, О.А., Ковальский, Ю.Г., Чебаргина, М.А., 2023. Мониторинг фоновое содержание ртути в биосистеме и организме детского населения нижнего течения реки Амур. *Вестник Северо-Восточного федерального университета им. М.К. Аммосова. Серия: Медицинские науки* 2 (31), 31–41. <https://doi.org/10.25587/SVFU.2023.31.2.004>
- Ткаченко, К.Н., 1997. Особенности питания соболя и колонка в Большехехцирском заповеднике. *Тезисы докладов III Дальневосточной конференция по заповедному делу*. Дальнаука, Владивосток, Россия, 117.
- Хомченко, О.С., 2024. О содержании ртути в некоторых видах рыб реки Амур. *Региональные проблемы* 27 (3), 25–27. <https://doi.org/10.31433/2618-9593-2024-27-3-25-27>
- Целых, Е.Д., Ахтямов, М.Х., Полещук, А.Е., 2022. Баланс микроэлементов в цепи "вода – почва – растения – животные – человек" в урбоэкосистеме г. Амурска Хабаровского края в условиях техногенного загрязнения ртутью. *Russian Journal of Ecosystem Ecology* 7 (2), 9–24. <https://doi.org/10.21685/2500-0578-2022-2-2>
- Bilandžić, N., Deždek, D., Sedak, M., Đokić, M., Šimić, B. et al., 2012. Trace elements in tissues of wild carnivores and omnivores in Croatia. *Bulletin of Environmental Contamination and Toxicology* 88, 94–99. <https://doi.org/10.1007/s00128-011-0449-y>
- Dietz, R., Wilson, S., Loseto, L.L., Dommergue, A., Xie, Z., Sonne, C., Chételat, J., 2022. Special issue on the AMAP 2021 assessment of mercury in the Arctic. *Science of the Total Environment* 843, 157020. <https://doi.org/10.1016/j.scitotenv.2022.157020>
- Eccles, K.M., Thomas, P.J., Chan, H.M., 2017. Predictive meta-regressions relating mercury tissue concentrations of freshwater piscivorous mammals. *Environmental Toxicology and Chemistry* 36 (9), 2377–2384. <https://doi.org/10.1002/etc.3775>
- Hallanger, I.G., Fuglei, E., Yoccoz, N.G., Pedersen, Å.Ø., König, M., Routti, H., 2019. Temporal trend of mercury in relation to feeding habits and food availability in arctic foxes (*Vulpes lagopus*) from Svalbard, Norway. *Science of the Total Environment* 670, 1125–1132. <https://doi.org/10.1016/j.scitotenv.2019.03.239>
- Hyvärinen, H., Tyni, P., Nieminen, P., 2003. Effects of moult, age, and sex on the accumulation of heavy metals in the otter (*Lutra lutra*) in Finland. *Bulletin of Environmental Contamination and Toxicology* 70, 278–284. <https://doi.org/10.1007/s00128-002-0188-1>
- Kalisinska, E., Lisowski, P., Kosik-Bogacka, D.I., 2012. Red fox *Vulpes vulpes* (L., 1758) as a bioindicator of mercury contamination in terrestrial ecosystems of North-Western Poland. *Biological Trace Element Research* 145, 172–180. <https://doi.org/10.1007/s12011-011-9181-z>

- Ljungvall, K., Magnusson, U., Korvela, M., Norrby, M., Bergquist, J., Persson, S., 2017. Heavy metal concentrations in female wild mink (*Neovison vison*) in Sweden: sources of variation and associations with internal organ weights. *Environmental Toxicology and Chemistry* **36** (8), 2030–2035. <https://doi.org/10.1002/etc.3717>
- Lodenius, M., Skarén, U., Hellstedt, P., Tulisalo, E., 2014. Mercury in various tissues of three mustelid species and other trace metals in liver of European otter from Eastern Finland. *Environmental Monitoring and Assessment* **186**, 325–333. <https://doi.org/10.1007/s10661-013-3376-z>
- Nriagu, J., Becker, C., 2003. Volcanic emissions of mercury to the atmosphere: global and regional inventories. *The Science of the Total Environment* **304**, 3–12.
- Pavithra, K.G., Rajan, P.S., Kumar, P.S., Rangasamy, G., 2023. Mercury sources, contaminations, mercury cycle, detection and treatment techniques: A review. *Chemosphere* **312**, 137314. <https://doi.org/10.1016/j.chemosphere.2022.137314>
- Petkovšek, S., Al S., Kopušar, N., Kryštufek, B., 2014. Small mammals as biomonitors of metal pollution: a case study in Slovenia. *Environmental Monitoring and Assessment* **186**, 4261–4274. <https://doi.org/10.1007/s10661-014-3696-7>
- Qi, J., Wang, Y., Liang, S., Li, Y., Li, Y. et al., 2019. Primary suppliers driving atmospheric mercury emissions through global supply chains. *One Earth* **1**, 254–266. <https://doi.org/10.1016/j.oneear.2019.10.005>
- Wang, W., Evans, R.D., Hickie, B.E., Rouvinen-Watt, K., Evans, H.E., 2014. Methylmercury accumulation and elimination in mink (*Neovison vison*) hair and blood: Results of a controlled feeding experiment using stable isotope tracers. *Environmental Toxicology and Chemistry* **33** (12), 2873–2880. <https://doi.org/10.1002/etc.2762>