Beiträge zur
JAGD
&WILD
forschung · 34

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Is Russian game meat dangerous? A lead and cadmium case study

Schlagworte/key words: Russia, game animals, cadmium, lead, „bush meat“ quality

Introduction

About especial quality of meat of game animals („bush meat“) the emphasis in many publications is placed (Winkelmayer et al. 2004). In Russia, ecotoxicological research has been done for almost a century, although the term was introduced into practice much later and is still not widely used today. At the beginning of the 20th century, the outstanding Russian scientist and philosopher Vernadski (1940) undertook first studies and devised a progressive theory on the relationship between the chemical composition of organisms and their environment. His followers Vinogradov (1957) and Voinar (1960) studied the significance of microelements for animals and plants.

In the early 1970s, findings in wild and domestic animals living in areas with natural biogeochemical abnormalities were published (Kovalskiy 1974). Studies on the content of chemical pollutants of anthropogenic origin in wildlife were first carried out in the former USSR in the 1960s. However, at that time the results of those studies were classified as top secret. They were therefore not published in the scientific literature open to the public and not communicated by mass media. First accessible publications appeared in the 1980s (Pokarzhevsky 1985). At the same time, large-scale studies on wildlife ecotoxicology were started by the Institute of Plants and Animals Ecology in Sverdlovsk (now Yekaterinburg); however, mainly on micromammalia (Bezel 1987). First papers on pollutant levels in game animals were published in the mid – 1980s. Studies concentrated on wild ungulates in the Baltic regions (Hordejarv & Ott 1983), and later on ungulates and carnivores in Byelorussia (Deryabina 1995, 1996; Savchenko & Sidorovich 1994).

In the second half of the 1990s, research on game animal toxicology re-started due to an improved economic situation and the availability of new analytical methods. Presently, about ten Russian scientific centers are engaged in ecotoxicological studies on game animals. Among the toxic substances contaminating the environment, heavy metals are considered the most dangerous. Determination of background concentrations of these metals in the tissues of game animals is important when evaluating the questions of safety of meat of wild mammals and birds for human consumption.

The aim of our investigation was to estimate the level of lead and cadmium pollution of the game animals in some regions of Russia with use of own and reference data and comparison of the received results with data from other regions of the world.

Materials and methods

The investigations were carried out during the period 1998–2008. Research of chemical composition of moose, brown bear, hares, and game birds take place in Kirov region. Samples waterfowl was taken from Kirov, Tuva and Altai regions, samples of pheasants was taken from Astrakhan region, samples from reindeers was taken in Taimyr Peninsula. Investigations included the definition of microelements in different organs and tissues with the aim to evaluate the contamination level in such an object. Samples were collected during the autumn-winter-spring hunting period as in contaminated areas as in conditionally clean and in places where the chemical pollution was supposed to exist. Shooting and trapping methods for animal harvesting were used. Samples of muscle, liver, kidneys, lungs, heart, spleen, bones and fat were taken.

The probes was put in chemical passive pack and frozen about -20°C until the time of the determination. In the laboratory samples were dried under the temperature 60°C till the weight became consistent, then the homogenized probes were prepared with „dry“ method. The estimation of lead and cadmium concentrations is based on the method of flame atomic absorption spectrometry. The apparatus are „Spectr-5-3“ and „Saturn“. For statistical processing of results generally accepted methods of analysis (Socal & Rohlf 1995) are used.

Results and Discussion

Special specifications are developed for an estimation of degree of impurity of foodstuff in many countries, basic of which is the indicato the indicator of maximum permissible concentration (maximum concentration limit) is. Techniques of an establishment of such limiting concentration in a foodstuff, soil, water and air are in detail described in the literature (Kuzubova et al. 2000, etc.). Comparing the literary information on impurity production game meat, it is necessary to consider that admissible threshold levels can strongly vary in the different countries, and supervising bodies throughout second half of last century regularly made updating of limiting sizes, gradually softening requirements. Constant lifting of a lath of the resolved quantities of pollutants has been connected, first of all, with rising pollution of environment and all increasing difficulty of observance of hygienic norms. In Russia special maximum concentration limits are not developed for the game meat, however hygienic norms operating here for meat of agricultural animals are one of the most strict in the world on arsenic, mercury and cadmium and much more liberally on lead that in a certain measure reflects real degree of pollution by this metal of products of an animal origin in our country (Table 1).

Hygienic norms repeatedly were exposed to the serious criticism, it is quite probable that their observance does not guarantee full protection against negative influence from toxic substances. As chemical environmental contamination in many industrial and developing countries is rather great, experts of the Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives have suggested not to forbid the most polluted products to use, and to limit receipt toxic substances in an organism for a time unit. Long time experts considered the weekly use with food and water of lead of 50 mkg/kg of weight of a body of the adult person as safe threshold value (pro-

Table 1 Maximum permissible concentration of lead and cadmium (mg/kg ww) in a foodstuff of an animal origin in Russia (SAN.-EPID. PRAVILA ... 2002)

Metal	Age	Meat	Liver, heart, longue	Kidneys
Pb	Children<3 years	0,1	0,5	0,5
	Children>3 years	0,2	0,5	0,5
	Adults	0,5	0,6	1,0
Cd	Children	0,03	0,3	0,3
	Adults	0,05	0,3	1,0

visional tolerable weekly intake, PTWI) (WHO 1977). To the beginning 1990 it was found out that the adult person can use without risk for health twice less – 25 mkg of Pb/kg of weight of a body per week (that is about 250 mkg of lead on the adult man in weight of 70 kg a day) (FAO/WHO 1990). By toxicologists' estimations, in industrially developed countries to an organism of the adult person with food and water gets on the average from 48 to 574 mg of lead weekly (Cuadrado et al. 1995, Dabeka & Mckenzie 1987, Elias 1985, Falco et al. 2005, Fox 1987, Llobet et al. 2003, Moreiras et al. 1995, Rubio et al. 2004).

The basic sources of receipt of lead in diets of the person are plant products. On a share of meat and fish products 5–7 % of total of the metal getting to an organism with food and water, while on fruit, vegetables, croups (especially bean) – 50–65 % (Fox 1987) are necessary on the average.

The PTWI for Cd in adults is 7 mkg/kg body weight/week or 70 mkg/day. Estimated dietary Cd intakes vary widely in different countries. Most of such estimates show that dietary Cd intake vary between 10 and 30 mkg/day, corresponding to 17–50 % of the PTWI (Nasreddine & Parent-Massin 2002; Satarug et al. 2003). Approximately two-thirds of dietary Cd intake is derived from plant products, and animal products provide the remaining one-third of total Cd intake (Fox 1987, Satarug et al. 2002).

Because foodstuffs are the main source of human intake of heavy metals, greater efforts need to be made to reduce exposure to dietary Pb and Cd. Thus, the maximum level for Pb and Cd in a foodstuff should be set as low as reasonably achievable. From this point „additional" lead or cadmium from game meat which get to an organism of hunters and members of their families can lower „a stock of toxic durability" and even to be injurious to health.

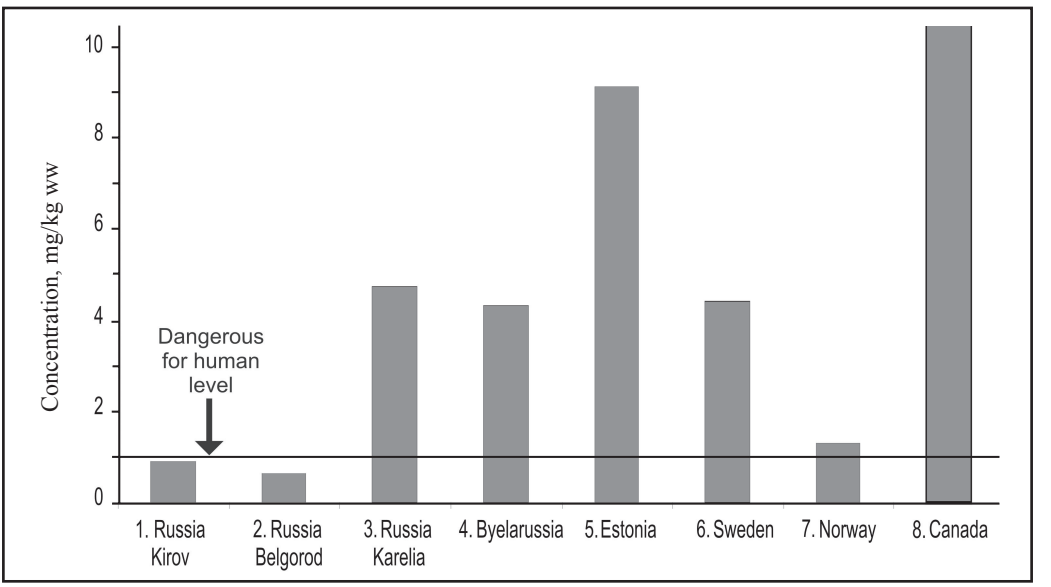
The data under the maintenance dangerous toxic agents in objects of the wild nature of Russia and other countries of the former USSR is limited. The purposes of the researches connected with definition of a chemical compound of an organism of wild animals were very different. It is paradoxical, but the estimation of quality of meat of game did not enter into problems of the overwhelming majority of them.

The **moose** (*Alces alces*) is the main hunting object on taiga zone of Russia, meat of this species makes here the basic share of „edible" production of the hunting economy. The greatest gastronomic value is represented by meat of animals extracted during the rutting season period (August–September). After animals pass on winter forages, flavouring qualities of their meat worsen that is connected with smaller nutritiousness and features of a chemical compound of branches and barks, and also deterioration of energetic balance of animals in the conditions of a cold and deep snow. Wild ungulates may be overloaded by chronic exposure to metals from natural sources of minerals and from contamination. The majority of reported average Pb concentrations in organs from wild ungulates are below 1 mg/kg ww. Hepatic and renal concentrations are similar. The highest concentrations are reported in wild boar, red deer and roe deer from Germany, in white-tailed deer from the USA, and in reindeer from Norway, Spitsbergen, and the Canadian Arctic. Meat and organs of moose from the Kirov region contained insignificant quantities of lead and cadmium basically (Table 2). Strongly polluted there were only two individuals. Lead level came nearer to average world values. Average values and cadmium limits in meat, liver and kidneys were essentially lower than in the majority of regions of Russia and the world (Pic. 1).

Meat and organs of a **reindeer** (*Rangifer tarandus*) play the important role in a food of inhabitants of the Far North, especially at the majority of the aboriginal citizens. Meat of this animal differs by especially high flavouring qualities. In seasonal migrations in some areas large scale purchases of meat are carried out. Extraction is carried out mainly on crossings through the large rivers. Production prepared thus not only is realized to local citizens, but also delivered in other regions of the country. Antlers of the wild reindeer are used as the important source of biologically active substances. The maintenance of lead at a reindeer of Taimyr has appeared slightly more low, than at an moose from the Kirov region, and cadmium – a little above (Table 3). On the reference data high Pb and Cd concentrations in reindeer may be result from their nutritional habit on the Arctic

Table 2 Concentration of lead and cadmium in meat and organs of moose from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	19	0,93	0,15	0,67	0,67	0,38	3,14
Liver	17	1,14	0,19	0,78	0,83	0,30	2,81
Kidneys	18	1,09	0,15	0,62	0,98	0,18	2,40
Lungs	8	0,81	0,13	0,37	0,83	0,36	1,30
Heart	16	0,88	0,17	0,69	0,72	0,09	2,80
Cadmium							
Meat	19	0,42	0,18	0,80	0,10	0,05	2,71
Liver	17	3,66	3,06	12,62	0,13	0,05	52,07
Kidneys	18	3,09	2,40	10,17	0,21	0,08	43,27
Lungs	8	0,87	0,69	1,95	0,12	0,09	5,69
Heart	16	0,40	0,18	0,72	0,13	0,06	2,87

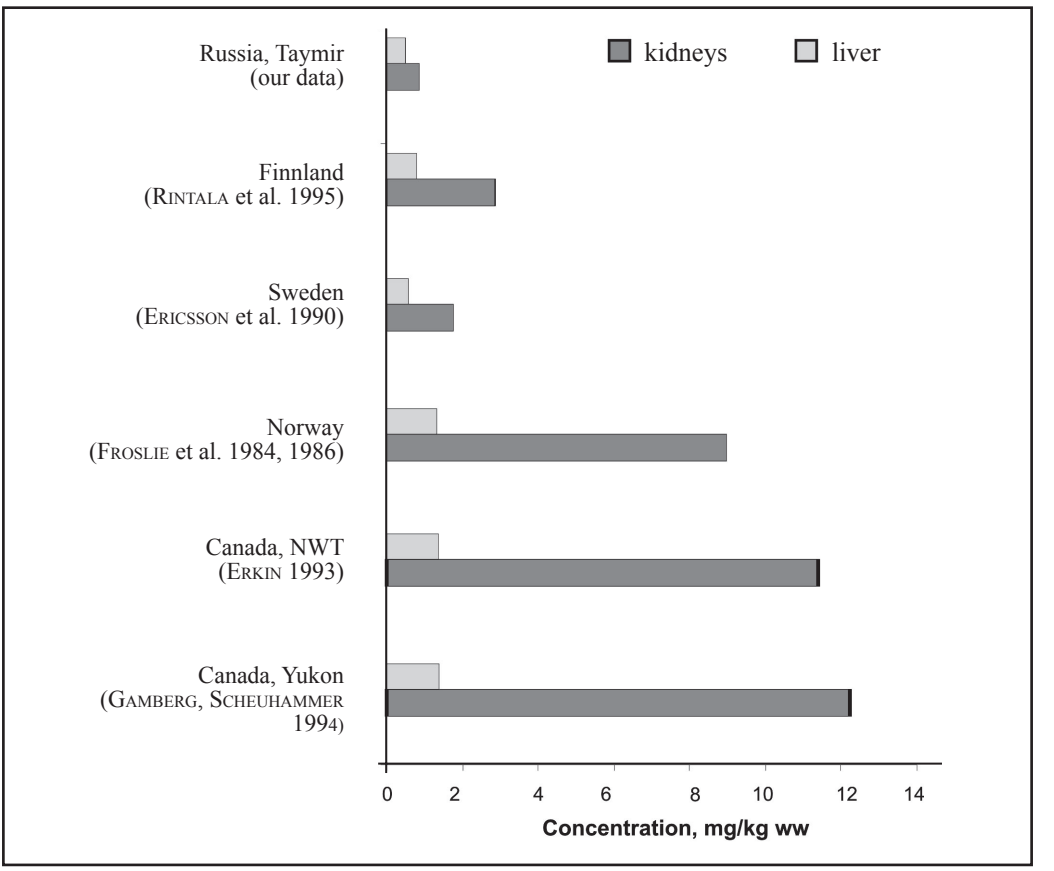


Pic. 1 Cadmium in the kidneys of moose from different regions of the world
1 - our data, 2 -Tyutikov et al. 1997, 3 - Ivanter, Medvedev 2007, 4 - Deryabina 1995, 5 - Hodrejarv, Ott 1983, 6 - Frank 1981, 7- Froslie 1986, 8 - Crete et al. 1987

plateaus, feeding primarily on lichens which accumulate large amounts of these metals. The maintenance of the basic toxic metals in bodies and tissues of reindeers from vicinities of one of the world's largest metallurgical enterprises „Norilsk nickel" has appeared rather low, essentially conceding to similar indicators for Northern Europe and Canada (Pic. 2). For example the highest Cd concentrations measured in reindeer kidneys from Finland and Sweden are 4.8 and 8.5 mg/kg ww respectively (Eriksson et al. 1990), whereas the highest value found in reindeer from a highland plateau in Central Norway was 30 mg/kg ww (Froslie et al. 1986). Concentrations in the same order or even higher have been reported in kidneys

Table 3 Concentration of lead and cadmium in meat and organs of reindeer from Central and Eastern Taimyr, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	85	0,72	0,20	1,85	0	0	11,35
Liver	33	0,33	0,10	0,59	0	0	2,71
Kidneys	21	0,86	0,51	2,36	0,01	0	10,74
Lungs	4	1,40	1,66	2,33	0,37	0	4,86
Heart	17	0,27	0,16	0,67	0,01	0	2,48
Cadmium							
Meat	85	0,36	0,08	0,76	0,09	0	4,14
Liver	33	0,74	0,06	0,36	0,65	0	1,45
Kidneys	21	4,30	0,73	3,36	3,51	0	11,65
Lungs	4	0,04	0,02	0,05	0,03	0,01	0,11
Heart	17	0,23	0,18	0,73	0,06	0,01	3,05



Pic. 2 Cadmium in the kidneys of reindeer from different regions of the world

of Canadian caribou from the Northwest Territories (Elkin 1993, Gamberg & Scheuhammer 1994). Most likely the transit individuals who have made a basis of our sample, stay in polluted zone rather short time and have not time to accumulate in an organism of dangerous quantities of toxic metals.

Few studies have examined metal concentrations in **brown bears** (*Ursus arctos*). Tissue concentrations of Cd and Pb in Kirov region (Table 4) were generally low than in Karelia (Ivanter & Medvedev 2007). Among other mammals of the Kirov region organs and tissues of a bear are to the greatest degree polluted by lead that is most likely connected with peculiarity of nutrition of this predator.

European badger (*Meles meles*) plays an important role in natural communities, since he occupies high trophic level. His importance is very clearly revealed through the trophic relations and digging activity in all parts of biotope (Gorshkov 1997). Recently the significance of the badger as the object for hunting has increased because of growing demand of natural medicines. Getting badgers occurs mainly for his useful fat, which is used to cure different injuries, tuberculosis and other diseases. Their meat is considered as by-product, but nowadays it may be used in West Siberia in a large number as well (Malkova 2003, Minakov et al. 2004). As the concentrations of elements, medical and food value of badger meat, fat and liver are very few studied, so it is issue of the day to estimate the quality of this kind of foodstuff.

Badger meat, especially ham or so-called badger ham, is also dainty in some countries (Germany, for instance) for a long time. In Russia badger meat was used during the Civil War (Yurgenson 1932) and the World War II because the lack of proteins in food. In the European part of Russia, as well as in Kirov region, there are a very few people who like badger meat now. Only 10 % badger hunters asked eat its meat.

According to found mean value of toxic metals meat of badger corresponds to sanitary-and-hygienic demands of our region (Table 5).

High Pb concentrations (8.84 mg/kg) found in one individual is probably connected with violation during taking probes, what sometimes happens. As there is relatively little ecotoxicological information for badgers so it's important to study them this way. (Sidorovich 1997) Concentrations of toxicants investigated here are not of significant importance, not very high at all. So the content of Cd in kidneys of badgers from bottomland of the river Maas in Nether-

Table 4 Concentration of lead and cadmium in meat and organs of brown bear from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	15	1,83	0,76	2,93	1,35	0,12	12,04
Liver	8	2,92	0,22	0,63	3,00	2,00	4,15
Kidneys	9	2,29	0,26	0,78	2,40	0,98	3,30
Lungs	4	1,79	0,18	0,36	1,80	1,4	2,18
Heart	11	1,31	0,21	0,71	1,31	0,31	2,50
Bones	5	4,14	0,97	2,17	3,11	2,5	7,89
Cadmium							
Meat	15	0,35	0,17	0,64	0,10	0,09	2,50
Liver	8	0,55	0,16	0,44	0,41	0,20	1,50
Kidneys	9	0,57	0,13	0,41	0,50	0,09	1,03
Lungs	4	0,16	0,02	0,05	0,16	0,12	0,21
Heart	11	0,22	0,10	0,32	0,12	0,10	1,19
Bones	5	2,10	1,26	2,83	1,08	0,31	7,12

lands polluted with industrial scrap reached the value 405 mg/kg dry weight (van den Brink & Ma 1998) and was thousand times higher (!) than mammals of Kirov region have.

According to above mentioned we may say that using the badger meat for food is not a serious danger for health of Vyatka region inhabitants, but one shouldn't eat livers and kidneys in a great amount.

Hares (*Lepus timidus & L. europaeus*) are known to reach high-density population and are very popular among hunters' trophies. In addition, hares meat is very tasty and delicatessen, so to definite the concentration of elements in this product of human use is very important, especially environmental contaminants such as heavy metals. There is no secret that these animals inhabit not only wild areas but they can live in urbanized, polluted territories, for example roads, plants and others. So their organs may contain high levels of pollutants and thus may serve the indicators of contamination. As there is relatively little ecotoxicological information for wild lagomorphs it's important to study them this way. In Kirov region we have two species of lagomorphs: mountain hare *(L. timidus),* which we can meet all over the territory, and brown hare *(L. europaeus),* which is not rare in southern and western areas.

The mean value of toxic metals in organs didn't increase maximum concentration limit (Table 6), but some individuals had exceeded concentrations of Pb and Cd in its tissues. The most „dirty" organs are livers and kidneys, where were found considerable levels of toxicants. Significant lead concentrations occurred in more than a half of individuals represented, as for cadmium – every sixth hare. Lead is transported in blood first to the soft tissues then to the bone, where its mean concentration was the biggest due to accumulation. Therefore the concentration in bone reflects long-term exposure. Only two hares were recorded with dangerous level for human use of Pb (5.70 mg/kg) and Cd (11.10 mg/kg dw) in kidneys, which is connected with the high threshold of the elements in the organ. In comparison lead content in tissues of European and mountain hares from industrialized areas of Finland ranged from 0.46 mg/kg dw in muscle to 3.54 mg/kg dw in liver. Mean Pb in liver of mountain hares at sites in Norway near nickel smelters ranged from 0.35

Table 5 Concentration of lead and cadmium in meat and organs of badger from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	6	0.44	0.13	0.31	0.37	0.12	1.03
Liver	7	1.39	1.17	0.44	1.27	0.91	2.09
Kidneys	3	0.45	0.16	0.27	0.47	0.17	0.72
Lungs	5	1.34	0.30	0.68	1.41	0.56	2.01
Heart	7	2.79	1.06	2.81	1.88	0.68	8.84
Spleen	5	0.94	0.26	0.57	1.01	0.35	1.82
Fat	3	0.62	0.42	0.72	0.24	0.16	1.45
Cadmium							
Meat	6	0.15	0.07	0.17	0.09	0.02	0.48
Liver	7	0.28	0.11	0.29	0.11	0.03	0.80
Kidneys	3	0.09	0.04	0.07	0.07	0.04	0.17
Lungs	5	0.29	0.07	0.15	0.21	0.14	0.50
Heart	7	0.14	0.03	0.07	0.13	0.06	0.23
Spleen	5	0.13	0.05	0.12	0.09	0.05	0.34
Fat	3	0.04	0.01	0.02	0.03	0.02	0.06

Table 6 Concentration of lead and cadmium in meat and organs of mountain hare from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	6	0.87	0.14	0.34	0.79	0.48	1.48
Liver	40	2.12	0.14	0.88	2.1	0.32	3.90
Kidneys	37	2.04	0.16	0.96	1.90	0.89	5.70
Lungs	11	1.38	0.18	0.61	1.44	0.35	2.20
Heart	7	1.33	0.23	0.60	1.50	0.46	2.00
Bones	6	3.66	0.42	1.04	3.63	2.48	5.40
Cadmium							
Meat	6	0.11	0.02	0.05	0.09	0.08	0.20
Liver	40	0.65	0.07	0.48	0.5	0	2.00
Kidneys	37	0.92	0.29	1.76	0.50	0.12	11.10
Lungs	11	0.29	0.09	0.32	0.13	0.01	0.98
Heart	7	0.17	0.06	0.17	0.12	0.10	0.55
Bones	6	2.17	0.45	1.10	2.15	0.90	3.48

to 0.52 mg/kg and from 0.32 to 0.67 mg/kg dw in juveniles and adults, respectively, and at a reference site was 0.15 and 1.64 mg/kg dw in juveniles and adults, respectively. (Kalas et al. 1995, 2000, Venalainen et al. 1996).

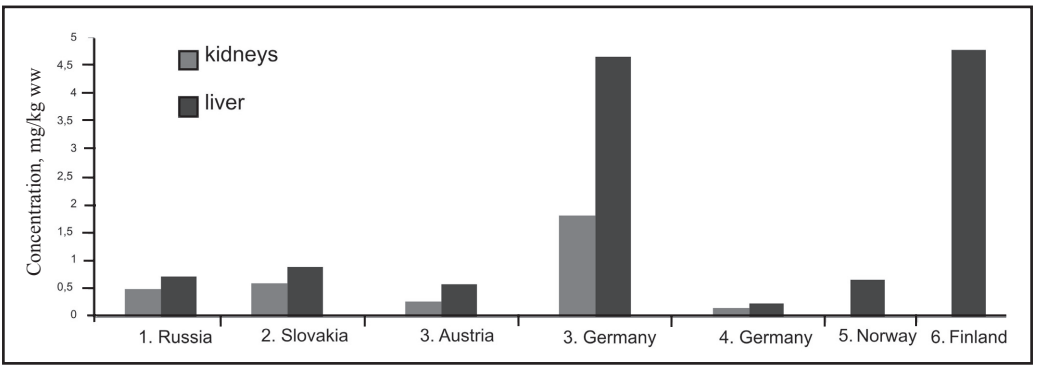
The concentration of pollutants in muscles were not exceeded maximum permissible concentration as for mountain hare as for brown hare, but the volume of investigated material is not optimistic. On the whole, in the study the contents of toxicants (Cd, Pb) in muscles and internal organs were only a bit higher our Russian MPS (10–30 %), but were significantly lower foreign ones from some industrial developed countries (Pic. 3 and 4).

In the recent past the **beaver** (*Castor fiber*) was one of the main objects of fur hunting. Today these rodents even more often obtain for the meat. The microelement structure of tissues of the beaver as a whole corresponded to the data for these animals from other regions of Russia (Table 7). Concentration of the lead and cadmium cores загрязнителей in organisms of beavers from industrial zones have appeared above, than at animals of background sites, however were in tens times below similar indicators for the polluted territories of the Western Europe (Pic. 5).

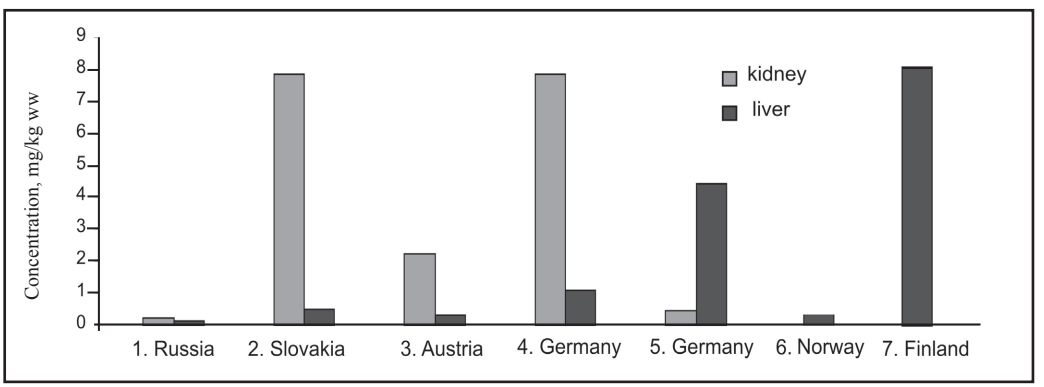
In a taiga zone of Russia **Tetraonides birds** one of the most popular and accessible objects of sports hunting. Not only shooting, but also trapping of this birds practice sparsely populated areas. In the past such trade was the important part of the income of local residents. In the Kirov region the greatest concentration of lead and cadmium have appeared for a black grouse (*Lyrurus (Tetrao) tetrix)* and minimal concentration are characteristic for a capercaillie (*Tetrao urogallus*). The hazel grouse (*Bonasa bonasia*) is intermediate (Table 8–10, Pic. 6).

The average levels of lead and cadmium in muscles of grouses birds was nearer to admissible values. Still considerable quantities of toxic metals contained in an internal and bones. So, in a liver of every third black grouse of sample (n=15) contained 0,6-11,69 mg/kg ww of lead, and the average maintenance of this metal also has exceeded maximum concentration limit and has made 1,85 mg/kg. Levels of heavy metals in organisms of hazel grouses and capercaillies from zones of technogenic influence have appeared above similar indicators for background territories.

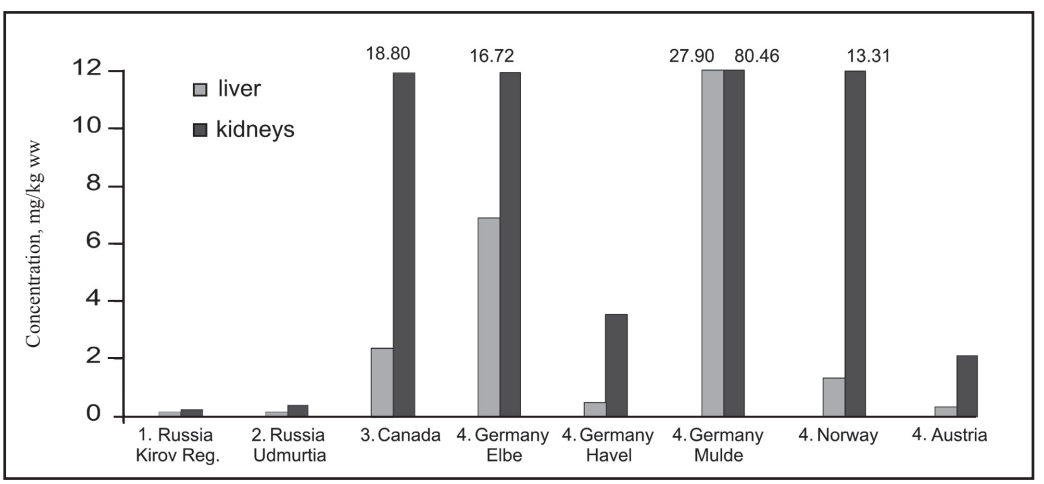
Some samples of tissues of pheasants from Astrakhan region were polluted by lead, and cadmium level has appeared lower, than at grouses



Pic. 3 Concentration of lead in kidneys and liver of mountain hares from Russia and Scandinavia and European hares from West Europe. 1 - our data, 2 - Slamecks et al. 1997, 3 - Tataruch 1984, 4 - Lutz 1985, 5 - Lindner 1989, 6 - Kalas et al. 2000



Pic. 4 Concentration of cadmium in kidneys and liver of mountain hares from Russia and Scandinavia and European hares from West Europe. 1 - our data, 2 - Slamecks et al. 1997, 3 - Tataruch 1984, 4 - Lutz 1985, 5 - Lindner 1989, 6 - Kalas et al. 1995, 7 - Venalainen et al. 1996



Pic. 5 Concentration of cadmium in kidneys and liver of beavers from European countries and Canada 1 - our data, 2 - Davletov 1999, 3 - Hillis, Parker 1993, 4 - Tataruch et al. 2005

Table 7 Concentration of lead and cadmium in meat and organs of beaver from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	20	0,87	0,06	0,28	0,89	0,26	1,40
Liver	21	2,45	0,45	2,05	2,08	0,59	10,00
Kidneys	21	1,95	0,25	1,13	2,00	0,75	4,20
Lungs	22	1,54	0,20	0,93	1,32	0,14	4,00
Heart	21	1,38	0,16	0,72	1,21	0,58	3,21
Bones	17	2,27	0,31	1,28	2,05	0,64	5,06
Cadmium							
Meat	20	0,17	0,04	0,17	0,11	0,03	0,80
Liver	21	0,50	0,09	0,41	0,35	0,01	1,35
Kidneys	21	0,62	0,14	0,65	0,40	0,01	2,70
Lungs	22	0,33	0,07	0,32	0,19	0,02	1,20
Heart	21	0,35	0,09	0,41	0,20	0,01	1,48
Bones	17	0,58	0,14	0,57	0,24	0,10	1,98

Table 8 Concentration of lead and cadmium in meat and organs of capercaillie from Kirov region, Russia (mg/kg dw)

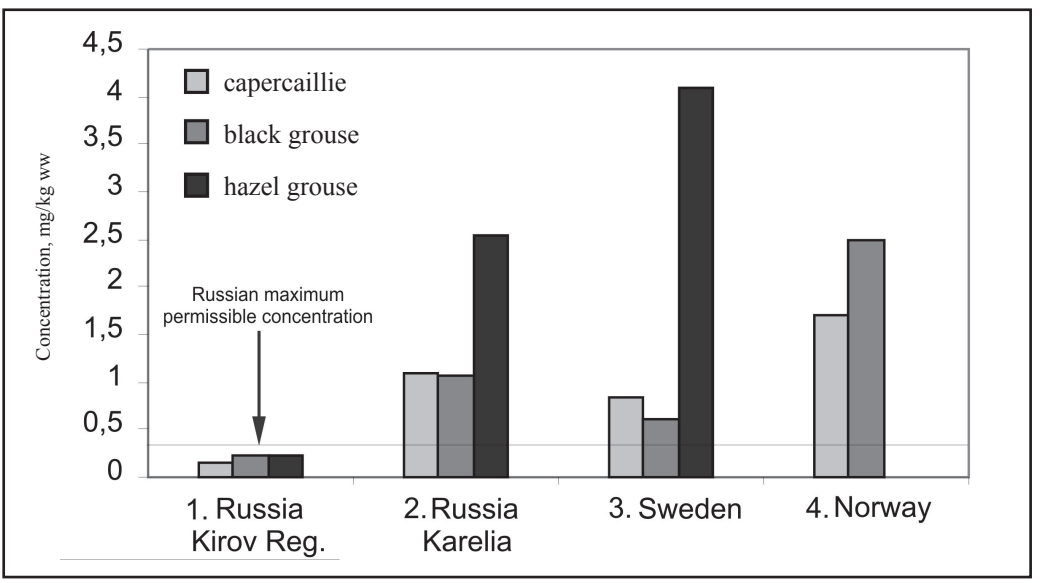
Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	21	0,94	0,06	0,31	0,87	0,50	1,80
Liver	23	1,71	0,30	1,55	1,30	0,20	6,00
Kidneys	13	1,28	0,19	0,72	1,17	0,32	2,48
Cadmium							
Meat	21	0,34	0,09	0,41	0,19	0,04	1,16
Liver	23	0,56	0,07	0,33	0,48	0,08	1,25
Kidneys	13	0,61	0,14	0,56	0,39	0,10	1,80

Table 9 Concentration of lead and cadmium in meat and organs of black grouse from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	23	1,76	0,35	1,85	1,25	0,25	8,40
Liver	25	5,62	3,31	1,75	1,30	0,11	77,93
Kidneys	20	2,74	0,53	2,84	1,97	0,88	11,80
Cadmium							
Meat	23	0,65	0,18	0,94	0,12	0,01	3,45
Liver	25	0,84	0,16	0,77	0,52	0,09	2,50
Kidneys	20	0,93	0,23	1,21	0,75	0,09	4,80

Table 10 Concentration of lead and cadmium in meat and organs of hazel grouse from Kirov region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	83	1,12	0,16	1,50	0,92	0,11	13,32
Liver	80	2,12	0,19	0,18	1,57	0,50	8,80
Kidneys	34	2,00	0,18	1,01	1,04	1,00	5,08
Cadmium							
Meat	83	0,19	0,04	0,34	0,09	0,01	2,59
Liver	80	0,82	0,09	0,88	0,72	0,09	7,03
Kidneys	34	1,02	0,13	0,91	1,00	0,09	4,50



Pic.6 Cadmium in liver of Tetraonidae from Northern Europe. 1 - our data, 2 - Ivanter, Medvedev 2007, 3 - Frank 1986, 4 - Fimreite et al. 1990

of taiga zone (Table 11). As a whole the concentration of heavy metals in an organism of pheasants corresponded to the data on other regions of Russia (Lebedeva 1999).

Waterfowl and **waders** long since are popular objects of hunting. Especially great value in a human diet have Anseriformes in places of annual concentration in seasonal migrations in a tundra and forest-steppe zone. Hunting for waterfowls during the spring and fall period, however duration of spring this hunting is rather popular is insignificant, and in the majority of densely populated areas it has more likely recreational, rather than provisional meaning. Shooting of swans is rare because Russian hunters consider murder of this bird by a evil omen, a harbinger of troubles and even death. Not suitable in food it is considered meat of loons, herons and birds of prey. At the same time the Far North aboriginal actively hunt on owls which meat is considered at them a refined delicacy.

The greatest average levels of lead among all surveyed animals is fixed in muscles, a liver and kidneys of mallard *Anas platyrhynchos* (Table 12). The raised concentration of metals are noted in samples of been geese *Anser*

Table 11 Concentration of lead and cadmium in meat and organs of pheasants from Astrakhan region, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Lead							
Meat	15	1,46	0,65	2,61	0,20	0,13	7,42
Liver	16	2,21	0,41	1,62	1,90	0,31	6,99
Kidneys	15	2,23	0,76	2,95	1,48	0,18	12,56
Lungs	15	1,28	0,65	2,52	0,51	0,18	10,20
Bones	16	1,77	0,25	1,01	1,43	0,67	4,21
Cadmium							
Meat	16	0,08	0,02	0,07	0,05	0,03	0,30
Liver	16	0,21	0,03	0,12	0,17	0,05	0,47
Kidneys	15	0,35	0,11	0,43	0,22	0,05	1,74
Lungs	16	0,11	0,01	0,06	0,09	0,05	0,29
Bones	16	0,14	0,02	0,09	0,11	0,05	0,45

Table 12 Concentration of lead and cadmium in meat and organs of mallard from Kirov and Altai regions, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Pb, Kirov region							
Meat	31	2,60	0,74	0,93	0,50	0,50	18,43
Liver	41	5,83	2,59	18,76	1,21	0,30	91,95
Kidneys	22	3,14	0,48	2,11	1,73	0,38	7,21
Pb, Altai region							
Liver	13	3,50	0,75	2,71	2,40	0,60	7,70
Cd, Kirov region							
Meat	31	0,54	0,10	0,51	0,15	0,01	2,20
Liver	41	0,86	0,12	0,62	0,50	0,01	3,00
Kidneys	22	1,40	0,22	0,95	0,77	0,10	3,40
Cd, Altai region							
Liver	13	0,26	0,12	0,44	0,06	0,03	1,68

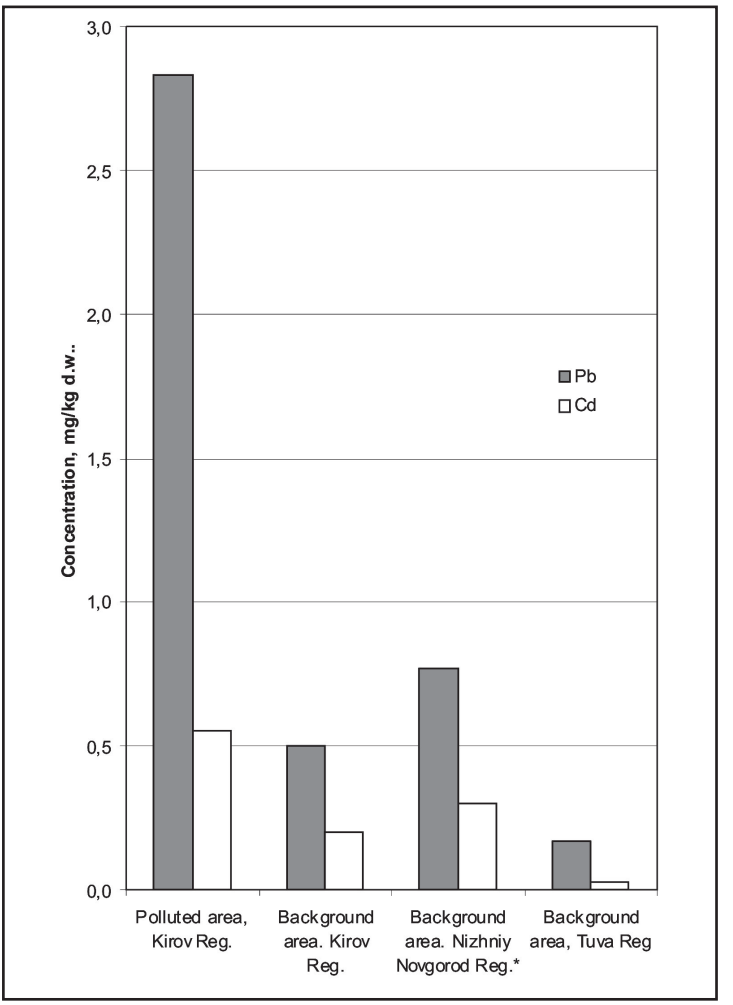
fabalis both from the Kirov region and from Altai (Table 13). At the same kind the absolute maximum of level of an element in muscles and a liver (accordingly 18.43 and 91.95 mg/kg ww) is revealed also. Occurrence „polluted“ by lead and cadmium of individuals also has appeared considerable: at mallard this indicator has exceeded 45 %, and at been geese 66 % of sample. It considerably exceeds existing ecotoxicological criteria of population plumbism in case the raised levels of lead are found out in indicator organs of individuals of sample of 5 %. At least at two mallard from the Kirov region has concentration of lead in tissues testified to acute poisoning. Geese and ducks of Altay territory had similar level of pollution. The high of toxic metals in bodies' tissues of Anseriformes, possibly, is connected with technogenic influence on habitats and especially winter sights of these birds. Considerable distinctions in the

Table 13 Concentration of lead and cadmium in meat and organs of been geese from Kirov and Altai regions, Russia (mg/kg dw)

Tissues	n	M	m	δ	Med	min	max
Pb, Kirov region							
Meat	6	1,48	0,29	0,71	1,17	0,98	2,80
Liver	6	2,64	0,19	0,47	2,67	2,11	3,21
Bones	6	4,92	0,56	1,38	5,21	2,48	6,21
Pb, Altai region							
Liver	30	3,47	0,66	3,61	2,39	0,03	14,00
Bones	5	2,73	1,93	4,33	1,32	0,18	10,42
Cd, Kirov region							
Meat	6	0,38	0,17	0,41	0,23	0,11	1,21
Liver	6	1,04	0,19	0,47	1,14	0,15	1,45
Bones	6	1,39	0,17	0,40	1,32	0,90	2,11
Cd, Altai region							
Liver	30	0,55	0,13	0,71	0,21	0,02	2,90
Bones	5	0,05	0,01	0,01	0,05	0,04	0,07

maintenance of metals at young mallard from sites with different degree of pollution (Pic. 7) are revealed. In winterings and seasonal migrations value of the reservoirs located in a zone of intensive technogenic influence is especially strongly shown. For example, the most of mallard that shot in Kirov region springtime winters in the Western Europe (The Netherlands, France, Germany, Denmark, Great Britain, Italy), at the Black Sea and Caspian coasts (Sotnikov 2000), including intensive industrial polluted areas.

The results of the determination showed that the analyzed elements presented in tissues of researched animals are similar to those in other birds and mammals, which is parenchimal organs and bones are the main storage of metals, and levels of elements are relatively low in muscles in its turn. It is revealed that the lead and cadmium maintenance in meat of wild animals usually below the threshold values representing health hazard of the human. In the Kirov region the highest concentration of toxic agents are characteristic for waterfowls, black grouses, moose and bears. Level one of the most dangerous toxic metals – cadmium in bush meat, considerably below, than in industrial regions of the world. Meat production from different areas of Russia basically has appeared better quality, than similar of industrial West European regions several times (hares, a reindeer), in tens and hundreds times (a beaver, a badger). It can be caused by the big spatial extent and smaller concentration of the industry in the surveyed regions. The lead maintenance is in an organism of wild animals of Russia at level of world values. In West and Central Europe, the introduction of unleaded gasoline and better control of industrial emissions has reduced atmospheric pollution with Pb since the late 1970s. This has been reflected in a falling trend in the Pb concentrations in wild animals. In Russia where leaded gasoline and lead shot still used Pb contamination problem is still actual. At monitoring of chemical pollution and an estimation of level of influence of toxic metals on population of wild animals it is necessary to give special attention to frequency and intensity of displays of atypical concentration of elements in organism tissues. So, the average maintenance of lead and cadmium in a liver of black grouses of the territory subject to pollution by agricultural poisons (settlement Killmez) only a few above background values, however at 12 % of individuals of sample (n=33) the indicator exceeded average values at 3–12 times. Similar

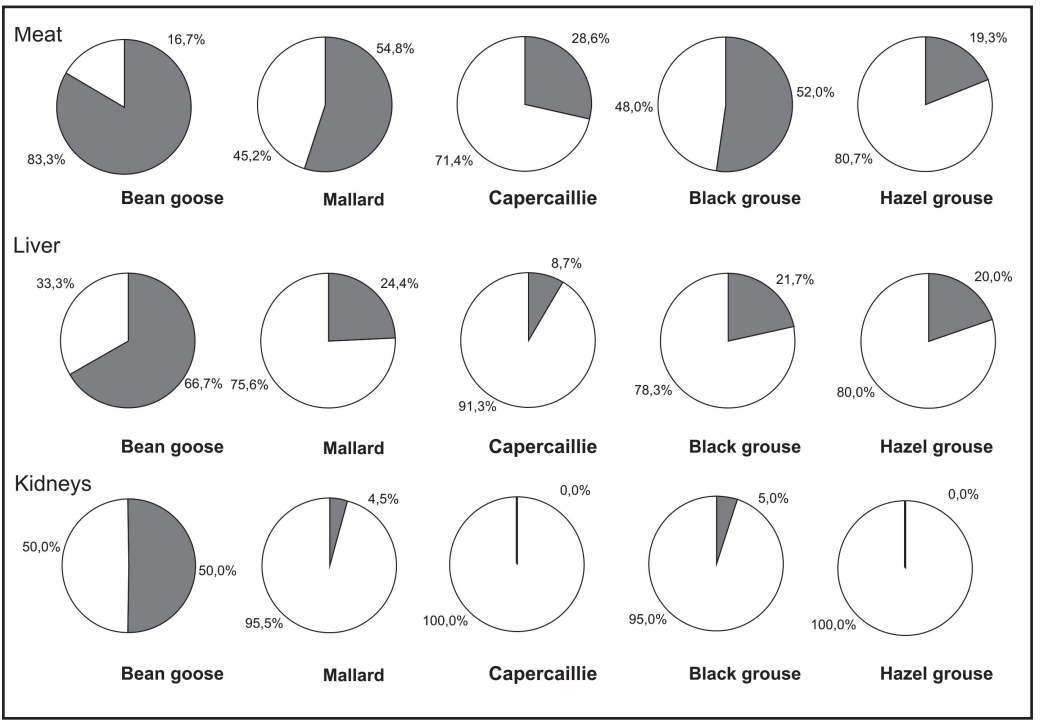


Pic. 7. Lead and cadmium in the liver of subadult mallards sampled on areas with different levels of pollution (Our data; Smirnov, 2004)*

law was marked by some researchers in places of natural geochemical anomalies. Smaller geographical distinctions as production were shown by migrating birds: to 45 percent of ducks and more than 65 percent of geese from game bag of Russian hunters also had high concentration of cadmium and lead (Pic. 8). Meat and an organs of some birds (basically mallard and been geese) represent danger to people. Meat from some mallards contained from 0.5 to 2.0 daily doses of lead recommended the FAO, and 0.9 (at separate individuals from above 5.0) daily doses of cadmium. As accumulation of these metals occurs mainly in a liver, kidneys and muscles of a stomach we do not recommend to hunters to use in food this internal. A liver and kidneys some individuals of ungulates and brown bears also contained the raised quantities of toxic metals. As a whole game meat represents danger mainly for hunters and members of their families cause the share of wild meat in a food of other inhabitants of Russia is insignificant.

Conclusions

Thus, even in ecologically safe regions hygiene of hunting production should be based not only on helminthological and infectious screening, but also with use of toxicological criteria. How-



Pic. 8 Rate of tissues of game birds of Kirov region, Russia with exceeded levels of cadmium (grey sectors)

ever for large parts of Russia, ecotoxicological data are missing.

Thus many questions related to the role of toxic substances in the population dynamics of economically significant mammals and birds and the reaction of these organisms to the chemical pollution of the environment were studied only insufficiently.

So far, no experimental studies on the influence of ecotoxicants on individual game animals and their populations were performed. Public health authorities never carried out work on pollutant levels in game meat, and the ecological consequences of using lead shot are insufficiently known.

Due to demographic problems in Russia and increase in utilitarian value of production received from the wild nature, more ecotoxicological research is needed.

Summary

On the basis of the researches spent in the European part of Russia (the east – Kirov region, the southeast – Astrakhan region), and also in Siberia (its southern part – Altai region and the Far North – Taimyr Peninsula), is spent ecotoxicological estimation of the basic objects of hunting. Quality of meat and other production from the game bagged by the Russian hunters was estimated under the maintenance of the most toxic metals – lead and cadmium. For comparison similar data across Europe, Scandinavia and the North America are involved. It is revealed that the lead maintenance in meat of wild animals usually below the threshold values representing health hazard of the person. In the Kirov region the highest concentration of toxic agents are characteristic for waterfowls, black grouses and bears. Meat production from different areas of Russia basically has appeared better quality, than similar of industrial West European regions several times (hares, a rein-

deer), in tens and hundreds times (a beaver, a badger). Smaller geographical distinctions as production were shown by migrating birds: to 45 percent of ducks and more than 65 percent of geese from game bag of Russian hunters also had high concentration of cadmium and lead. Thus, even in ecologically safe regions hygiene of hunting production should be based not only on helminthological and infectious screening, but also with use of toxicological criteria.

Zusammenfassung

Ist der Verzehr von Wildbret in Russland gefährlich? Eine Fallstudie zu Blei und Cadmium

Die Aussagen basieren auf Forschungen, die im europäischen Teil Russlands (im Osten – Kirov Gebiet, den Südosten – Astrakhan Gebiet), sowie in Sibirien (im südlichen Teil – Altai und im Hohen Norden – Taimyr), zu der öko-toxsikologischen Einschätzung der Hauptobjekte der Jagd durchgeführt wurden. Die Qualität des Fleisches und anderer Produkte vom Wild, das von den russischen Jägern erlegt wird, wurde nach dem Inhalt der giftigsten Mikroelemente – Pb und Cd – bewertet.
Für den Vergleich wurden ähnliche Ergebnisse aus Europa, Skandinavien und Nordamerika herangezogen. Der Pb-Gehalt im Wildfleisch lag gewöhnlich unter dem Schwellenwert, der die Gefahr für die Gesundheit des Menschen signalisiert. Im Gebiet Kirov können einzelne Wasservögel, Birkhähne und Bären, schwach in den toxikologischen Bereich kommen. Das Wildbret aus verschiedenen Bezirken Russlands ist von bester Qualität, im Vergleich zu industriellen westeuropäischen Regionen. Hasen, Raubtiere, Biber und Dachse sind dort bedeutend höher belastet. Kleinere geographischen Qualitätsunterschiede der Produkte haben die migrierenden Vögel: bis zu 45 % der Enten und mehr als 65 % der Gänse in den Jagdstecken der Russischen Jäger hatten hohe toxische Konzentrationen. So soll – sogar in den ökologisch günstigen Regionen – die Wildbret-Hygiene nicht nur auf helmintologisches und Infektiöses Screening, sondern auch auf Nutzung der toxikologischen Kriterien ausgerichtet werden.

Резюме

Представляет ли опасность мясо диких животных в России? Исследование на примере свинца и кадмия

На основе исследований, проведенных в европейской части России (Кировская и Астраханская области), а также в Сибири (в Алтайском крае и на Таймыре), проведена эко-токсикологичекая оценка основных объектов охоты. Качество мяса и другой продукции от дичи, добываемой российскими охотниками, оценивалось по содержанию наиболее токсичных микроэлементов – свинцу и кадмию. Для сравнения привлечены аналогичные сведения по Европе, Скандинавии и Северной Америке. Выявлено, что содержание свинца в мясе диких животных обычно ниже пороговых значений, представляющих опасность для здоровья человека. Хотя в Кировской области исключение могут составлять водоплавающие птицы, тетерева и медведи, среди которых встречаются особи, проблемные в токсикологическом отношении. Мясная продукция из разных районов России в основном оказалась лучшего качества, чем аналогичная из промышленных западноевропейских регионов в несколько раз (беляк, русак, северный олень), в десятки и сотни раз (бобр, барсук). Меньшие географические различия в качестве продукции продемонстрировали мигрирующие птицы: до 45 % уток и более 65 % гусей, добытых охотниками, также имели высокие концентрации токсикантов. Таким образом, даже в экологически благополучных регионах гигиена охотничьей продукции должна быть основана не только на гельминтологическом и инфекционном скрининге, но и с использованием токсикологических критериев.

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