



ADAPTIVE STRATEGY OF YELLOW-NECKED MOUSE AND BANK VOLE UNDER CONDITIONS OF ANTHROPOGENIC POLLUTION BY HEAVY METALS IN ECOSYSTEM OF HORNBEAM FOREST

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On the territory of Ukraine Middle Dnieper, including Kiev region, is seriously affected by technogenic pollution. Kyiv region is one of the most contaminated in Ukraine. 443 industrial plants are the sources of air pollution in Kyiv region. Among areas of region the most polluters are in Obuchiv district, amount of its industrial discharges arranges from 83000 ton per year. Among them the strongest polluter is Tripillya Thermal Power Plant (TPP) – over 21000 ton per year. It forms 84% of all discharges in atmosphere by industrial plants in Kyiv region. As the result, preserving natural ecosystems, their biodiversity and productivity is very important (Saldiva P.H.N., Bohm G.M., 2002; Flora SJS, Mittal M., Mehta A., 2008).

It is topical to clarify specific mechanisms of influence of a large plant (e.g. Thermal Power Plant) that is situated in dense populated region in the environment. Small mammals are the most convenient objects for such investigations as long as they are animals that inhabit transformed ecosystems directly near with human. Via short life cycle forest rodents have time to reflect the impact of environment on their organism. It is known that the activation of lipid peroxidation processes in cellular membranes is the reflection toxic heavy metals' impact [Sander C.S., Hong C., 2005]. Liver is most important organ of detoxication. The goal of the research is definition of basic morphological-physiological, anatomic-physiological and biochemical indicators in an organism of yellow-necked mouse and bank vole under conditions of anthropogenic pollution by heavy metals in ecosystem of hornbeam forest. Three regions with different degree of contamination were chosen for comparative analysis: Kaniv Nature Reserve (Cherkassy region, Ukraine); National Nature Park «Holosiivsky» (Kyiv, Ukraine); the district of influence Tripillya TPP (Kyiv region, Ukraine). For characterize degree of contamination of these territories was studied the content of heavy metals in the core components of the ecosystem of hornbeam forest – soil, forest laying and green phytomass of species-edificators (*Carpinus betulus* L., 1753). Researches were conducted on nature populations of yellow-necked mouse (*Apodemus flavicollis* Melchior, 1834) and bank vole (*Myodes glareolus* Schreber, 1780), on territories with different level of anthropogenic pollution. Environment of this species closely concerned with soil bedding. Therefore these species may be used as a biomonitors of man-caused pollution of environment.

The heavy metals content in upper soil stratum of 5 cm and in liver were determined by flame atomic-absorption spectrophotometer C115-M1 (SELMICHROM, Ukraine) with heavy hydrogen corrector of the background and computer complex CAS-120. The content of acid-soluble metals and their exchange fraction in soil was analyzed by extraction with acetate-ammonium buffer (pH 4.8; molarity – 1.1 mol/L) according to standard methods (Singh S.P., Ma L.Q., Harris W.G., 2001). The content of metals in the samples was estimated in mg per kg of masses of air dried recoveries. Research of content of heavy metals (Pb, Cd, Cr, Ni, Co) in soil samples displays the significant differences of selected regions under exchange fraction (table 1). Analysis of contamination of exchange fraction of heavy metals (Pb, Cd, Cr, Ni and Co) in the upper 10 cm soil layer shows that concentration of heavy metals in the impact area of Trypillya TPP is considerably higher (up to 3-8 times, $p < 0,05$) exceeds levels that were typical for the area of Kaniv Nature Reserve. Soil of National Nature Park «Holosiivsky» characterized by rather increased content of active form of investigated heavy metals especially Pb, in comparison with the similar content on territory of Kaniv Nature Reserve.

Table 1. Content of exchange fraction of heavy metals in samples of upper soil level in investigated territories

Territory of investigation	Pb		Cd		Cr		Ni		Co	
	Me	SD _{Me}	Me	SD _{Me}	Me	SD _{Me}	Me	SD _{Me}	Me	SD _{Me}
Kaniv Nature Reserve (Cherkassy region, Ukraine)	< 0,19	–	< 0,002	–	0,07	0,03	0,08	0,07	0,05	0,04
National Nature Park «Holosiiivsky» (Kyiv, Ukraine)	0,27	0,09	< 0,003	–	0,12	0,02	0,10	0,06	0,11	0,06
Region of impact of Tripillya TPP (Kyiv region, Ukraine)	0,34	0,05	0,03	0,00	0,17	0,14	0,30	0,05	0,25	0,01

Differences of soil in researched regions under content of acid-soluble fraction of heavy metals were found statistical insignificant and were corresponded to value of regional clarke typical for forest-steppe zone of Ukraine. Excess of normative indexes of boundary permissible concentrations for arable soil have not found. But the exchange fraction of heavy metals showed that its content in Kaniv Nature Reserve is the least. Increase of content of exchange fraction of heavy metals in soils at National Nature Park «Holosiiivsky» and the district of influence Tripillya TPP probably was conditioned by processes of atmospheric contaminants transportation and falling out (the presence of big city nearby with National Nature Park «Holosiiivsky» and powerful Tripillya TPP). It will be showed that in every case the exceeding of normative indexes of boundary permissible concentrations of heavy metals for arable soils was not determined. It may understand by existing environmental standards as a satisfactory ecological situation in all investigated territories.

The same results of soils pollution by heavy metals at territories adjacent to Tripillya TPP were obtained by other researchers. Estimation is showing that thanks to irregular dispersion of smoke fumes discharges of station 26,3–36,0 ton per km² of man-caused dust is falling out in South-East direction annually. Because of it soils are enriching by compounds of Cd, Pb, Cr. Thus it may be contend that region around Tripillya TPP under content of heavy metals (Pb, Cd, Cr, Ni, Co) is a man-caused contaminated territory. Territory of National Nature Park «Holosiiivsky» characterized by rather increased content of active form of investigated heavy metals especially Pb. Content of heavy metals (except Ni) in forest laying under condition of Tripillya TPP is considerably higher (up to 2-5 times, $p < 0,05$), in comparison with Kaniv Nature Reserve. Increase of the content of the investigated heavy metals in green phytomass of species-edificators (*C.betulus*) of hornbeam forest in region of impact of Tripillya TPP, in comparison with Kaniv Nature Reserve, has been determined.

Seasonal dynamics of morphological-physiological and anatomic-physiological indexes of the individuals (males and females) rodents has been revealed. It is established that for the population of the yellow-necked mouse and bank vole, which lives in the reserved territory, the decrease in the relative sizes of liver, kidneys and spleen is common. At the same time fatness increases comparatively to animals spreading under pollution conditions. The registered morphological-physiological and anatomic-physiological differences in autumn testify about presence of generalized changes in an organism of the animals as a result of processes of metabolism intensification with exhausting features.

Biochemical changes in organism are one of the most accurate indexes of direct impact of heavy metals. The products of lipid peroxidation in homogenate of bank vole's liver from natural populations were analyzed for presence of biochemical indexes' changes. Analysis of lipid peroxidation content products in voles' organism from investigated territories showed considerable differences. Increase of the concentration of diene conjugates (up to 7-10 times) and thiobarbituric acid (TBA) active compounds (up to 2-3 times) in animal's liver polluted by heavy metals have been discovered. Insignificant increasing of content of Schiff basis in liver homogenate of animals in region of impact of Tripillya TPP (in 2 times in spring and in summer, in autumn – in 3 times) was detected. Seasonal dynamics of the maintenance of lipid peroxidation has been revealed. The registered changes of biochemical indicators can be an indicator of ecological-biochemical stress in an organism of the rodents in the district of influence of Tripillya TPP.

Thus exceeding the levels of maximum permissible concentrations for soil was not detected in investigated territories but biochemical features of disturbance in organism of yellow-necked mouse and bank vole from the natural populations were observed. Conformity of chemical composition of soils to the maximum permissible concentrations was not conforms to condition of prosperity of animal organism existence of which was concerned with paedosphere. Therefore it may conclude about absolute content of heavy metals in soil is not a marker of ecological conditions of environment. The registered changes of biochemical indicators can be an indicator of ecological-biochemical stress in an organism of the bank vole in the district of influence of Tripillya TPP.

Obtained results allow concluding that higher concentration of heavy metals in soil, forest laying, in green phytomass of species-edificators (*C.betulus*) and yellow-necked mouse, bank vole of hornbeam forest, in comparison with Kaniv Nature Reserve, indicate intensive technogenic pollution in the impact area of the Tripillya TPP. Increased content of some heavy metals in the key components of the region of National Nature Park «Holosiiivsky» shows that the ecosystem is polluted. Thus, it can be argued that there is a consistent increase in harmful pollutants in key ecosystem components hornbeam groves Middle Dnieper in series: Kaniv Nature Reserve => National Nature Park «Holosiiivsky» => the district of influence Tripillya TPP.

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