Cytogenetical and haematological effects of long-term irradiation on freshwater gastropod snails in the Chernobyl accident Exclusion Zone

Elena V. Dzyubenko and Dmitri I. Gudkov

Department of Radioecology, Institute of Hydrobiology of the National Academy of Sciences of Ukraine, Geroyev Stalingrada Ave. 12, UA-04210 Kiev, Ukraine.

INTRODUCTION

The freshwater snails have great importance for the processes of radionuclide biogenic migration in aquatic ecosystems. Due to ability to accumulate practically all of radionuclides which registries in water these invertebrates can be considered as bio-indicators of radioactive contamination of aquatic ecosystems. At the same time the molluscs is one of the first group of animal that have got cell immunity during the evolution. The protective function has the cells of mantle liquid (hemolymph), which peculiar to high proliferation, heterogeneity and sensitivity to radiation impact. The main aim our studies was evaluation of cytogenetical effects level in embryo tissue of gastropod snail (*Lymnaea stagnalis* L.) as chromosome aberration rate and reaction of snails on unfavourable condition of environment as change of structure, level of differentiation, death and cytogenetical stability of hemolymph cell population.

MATERIALS AND METHODS

Our researches were carried out during 1998-2007. The water bodies of research were the flood plain reservoirs of the Pripyat River - Azbuchin Lake, Yanovsky (Pripyatsky) Crawl, Dalekoye-1 Lake, Glubokoye Lake as well as Uzh River and Pripyat River within the Chernobyl accident Exclusion Zone.

External gamma irradiation dose rate was measured by DKS-01 dosimeter and by Na-I field radiometer SRP-68-03. The estimation of the internal dose rate for snails was carried with use of dose conversion coefficients (Brown et al., 2003). The ^{137}Cs content was measured by γ-spectrometry complex: PGT IGC-25 detector (France), "Nokia LP 4900 B" analyser ("Nokia", Finland), low-volt feeding source – crate NIM BIN, amplifier NU-8210 ("Elektronicus Merokeszulekek Gyara", Hungary) and 100 mm thickness leaden protection. The ^{90}Sr content was measured on low-background NRR-610 β-radiometer ("Tesla", Czech). Minimal detectable activity was 0.04 Bq under 1000 s sample exposition. ^{238}Pu and $^{239+240}$Pu content in electrolytic samples was determined by α-spectrometric tract by NUC-8192 impulse analyser ("Elektronicus Merokeszulekek Gyara", Hungary). The ^{241}Am content was measured by x-ray-spectrometric line including x-ray detector EG&G Ortec LOAX-51370/20 CFG-SU-GMX ("EG&G Ortec", USA) and analyser "Nokia LP 4900 B". The results were measured in Bq/kg at natural humidity and the mistake of estimated radionuclide concentration fell within 15-20%.

We studied the rate of chromosome aberrations in cells of the snail's embryos. The chromosome aberration rate was measured by standard anaphase method (Pausheva, 1974). Haematological studies were carried out in mantle liquid of snails by the analysis of dead

cells, young amoebocytes and phagocytic cells quantity (Majone et al., 1987; Dzyubo and Romanova, 1992). The results of the analyses compared to the data received for snails from conditionally "clean" lakes - Vyrlitsa, Opechen', Pidbirna, Goloseevo as well as Al'ta River, located within the Kiev City area and Kiev Region.

RESULTS AND CONCLUSIONS

The absorbed dose rate for snails from research water bodies within the Chernobyl exclusion zone was registered in the range from 1.8 mGy/year to 0.4 Gy/year. The highest rate was found in snails from lakes Dalekoye-1 and Glubokoye, the lowest - from the Pripyat River and Uzh River. Molluscs from the control lakes were characterised by absorbed dose rate about 0.3 mGy/year. The lowest rate of chromosome aberration was determined in molluscs form the three control lakes - Goloseevo, Vyrlitsa and Opechen'. The rate of chromosome aberration here was about 1.1-2.0 %. About 3.3 % of aberrant cells were registered in snail's embryo from the Pripyat River. In snails of Uzh River the aberration rate was about 2.3 %. The high rate of aberration was found in snails from lakes within the dammed territory on the left-bank flood lands of the Pripyat River (Dalekoye-1 Lake and Glubokoye Lake) - 21-22 %. In the embryo tissue of snails from Yanovsky Crawl chromosome aberration rate was about 18 % and in Azbuchin Lake - about 23 % (Fig. 1).

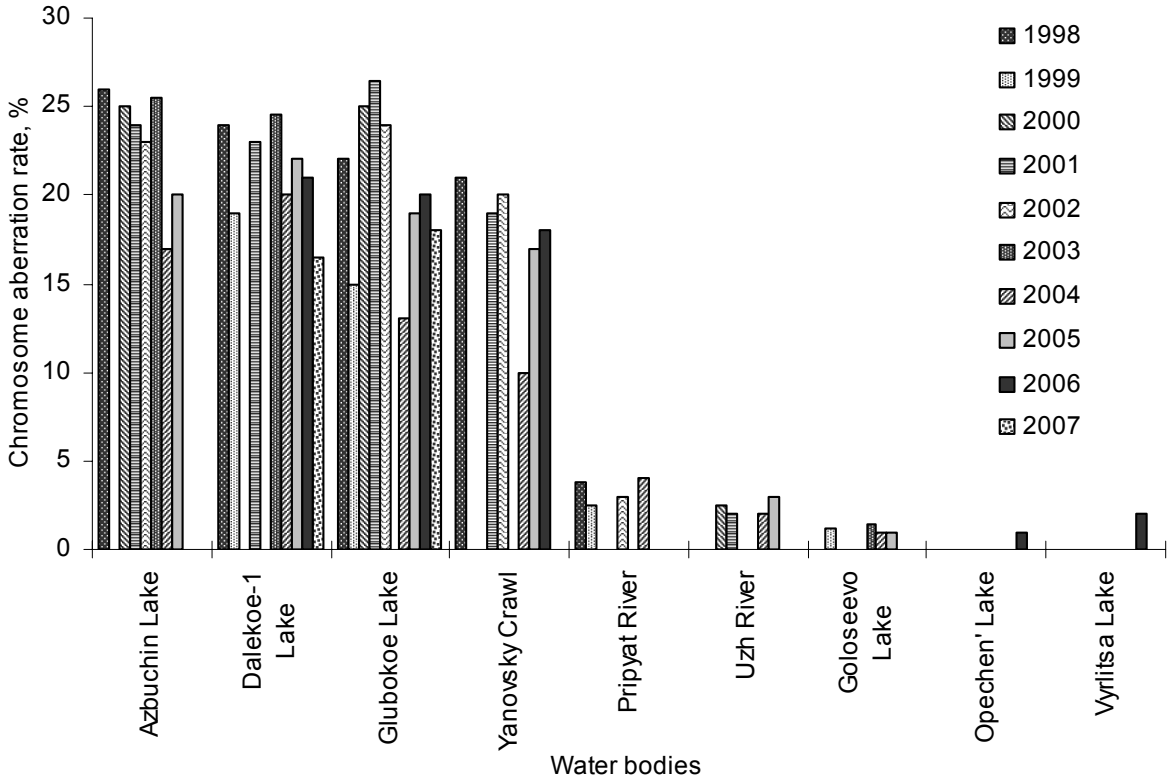

Figure 1. Chromosome aberration rate in snail embryos in water bodies within the Chernobyl accident Exclusion zone and control lakes within the Kiev City area.

The most functional and active elements of hemoliph of the snails are the granular amoebocytes, which have morphological and quantitative reaction on the physiological changes of organism. At the decrease of adsorbed dose rate coses the decrease of young amoebocytes quantity in hemoliph. The decrease of total agranulocyte quantity in cell population occurs due to decrease of amoebocytes quantity and due to increase of granulocyte quantity, which involves in phagocytic reaction. In hemoliph of snails from Dalekoye-1 Lake, Azbuchin Lake and Glubokoye Lake the quantity of dead cells averages 36.2 %, 39.2 % and 43.8 % respectively, the part of phagocytic cells averages 44.3 %, 41.2 % and 45.0 %, as well as decrease of the young amoebocytes quantity to 13.2 %, 20.1 % and 9.5 % respectively. The insignificant quantity of abnormal cells and micronuclei has been observed here as well. In conditionally "clean" water bodies the part of dead cells averages from 2.2 to 5.3 % and the quantity of phagocytic was at level 3.0-4.2 %. The quantity of young amoebocytes have increased here to 79.7-89.6 % (Fig. 2).

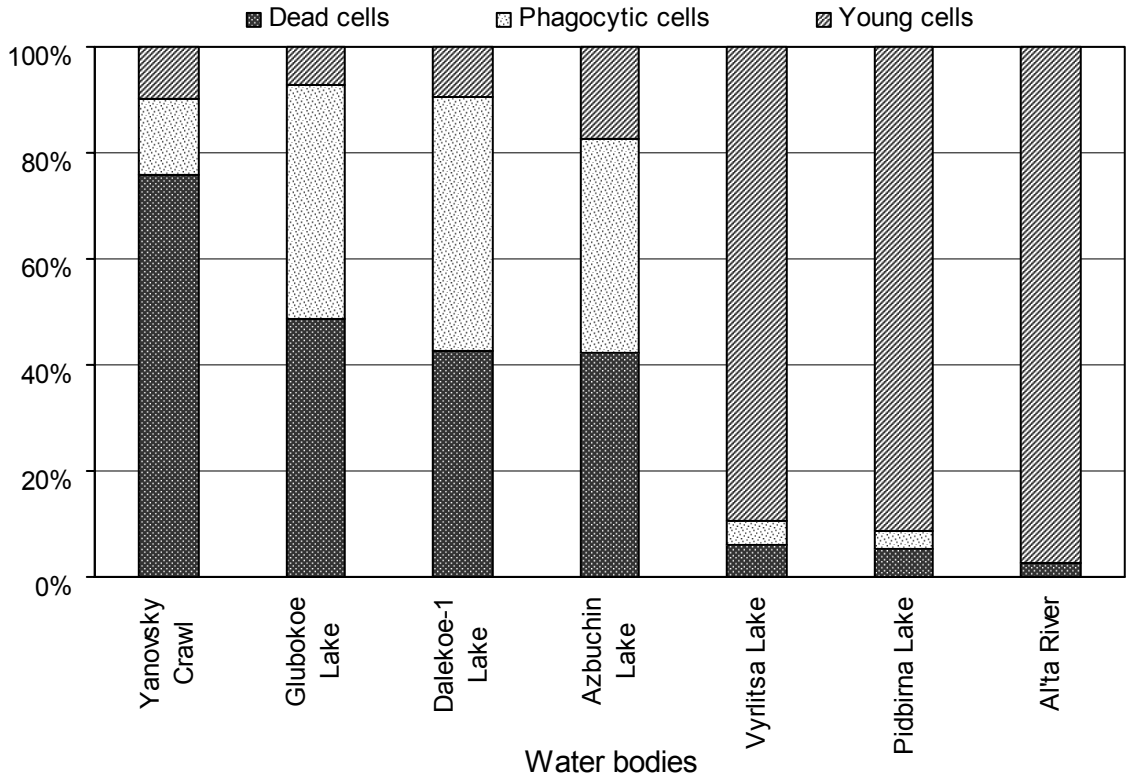

Figure 2. Ratio of different types of amoebocytes in the mantle liquid of snails in water bodies within the Chernobyl accident Exclusion zone and control lakes within the Kiev City area and Kiev Region.

Different radiation effects in hydrobionts within the Chernobyl exclusion zone have been registered in post-accident period. Some of these effects disappear shortly, while an increasing importance is expected by the remote consequences - genetic damages induced by a long-term irradiation. These remote consequences are a long-drawn realization of changes in molecules of heredity, where the initial molecular damages have a latent period without any display and can be transferred through the many generations of cells to be a reason of genome instability in future.

The long-term impact of low dose irradiation in aquatic ecosystems, especially in closed water bodies within the Chernobyl exclusion zone, is shown by the increased level of chromosome aberrations and, connected with it, reproductive death of cells.

It seems extremely important to continue investigations devoted to reconstruction of dose rate on natural populations and organization of regular cytogenetic monitoring within contaminated territories, which is necessary for forecasting and prevention of the negative remote consequences of radiation impact.

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