

THE INTEGRATED INVESTIGATION INTO THE INDIRECT EFFECTS OF THE IONIZING RADIATION AND THE DIRECT EFFECTS OF HEAVY METAL IONS ON *LYMNAEA STAGNALIS* BIOLOGICAL CHARACTERISTICS

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Issue of joint effect of the ionizing radiation and other chemical agents, particularly heavy metals, has been paid attention, because heavy metals are found in abundance in the water bodies of Ukraine. Study of synergism of the small radiation doses impact and low concentration of chemicals is of special importance. Separately they can hardly reveal their harmful effect on the organism of the aquatic animals. So in order to reveal whether radiation complicates pathological process caused by the mollusks poisoning by the heavy metals, peculiarities of reproduction under joint effect of radiation and different concentration of the heavy metal ion has been carried out.

Mollusks dominate in the bottom communities in many water bodies of Ukraine and adjoining regions. These animals are able to accumulate heavy metals and radionuclides, that's why they play a key role in biological migration of the heavy metals and radionuclides in the aquatic ecosystems. So the pond snail *Lymnaea stagnalis* Linnaeus (Gastropoda), the most common representative of hydrofauna of the Central (Zhytomyr) Polissia, was used as test-object in this study.

In study mollusks of the same size were used (average shell height 39.5 ± 1.1 mm), taken from the water body of the region suffered from the Chernobyl accident (the Loznitsa River, tributary of the Uzh River, nearby village Lubarka, the Narodichi district, Zhytomyr oblast). Animals were adapted to the laboratory conditions during two days; then they were placed into solution with the heavy metal ions of the studied concentration. As control were used mollusks of the same size from the Teteriv River kept in similar conditions.

Obtained results showed that considered concentrations of the heavy metals caused significant deviations of biological characteristics of the pond snail taken from the radioactively contaminated water body.

During 70 days of experiment control group of animals (taken from the conditionally clean water body) laid egg sets 1.5 times more than mollusks from the radioactively contaminated water body ($P < 0.05$). Pond snails from the radioactive zone, placed into solutions of Zn^{2+} , Co^{2+} , Mn^{2+} of all considered concentration, laid 1.8-2.0 times less ($P < 0.05$).

Statistically reliable differences in number of eggs were not noted only when mollusks stayed in solutions with subliminal concentration of Cd^{2+} . Minimal number of syncapsules was noted in solutions with subliminal concentration of Zn^{2+} (12 ± 1), where probably adaptation mechanisms become more active very slowly; and in solution of the chronic lethal concentration of Co^{2+} (9 ± 1), where poisoning reached its limits more quickly than in other solutions. Maximal number of syncapsules was laid in solutions of Ni^{2+} of all considered concentrations ($P < 0.05$). However it was lower than in the control group.

During the experiment mollusks from both radioactively contaminated and conditionally clean water body, placed into water without toxicants, were monitored. It was stated that during 70 days of the experiment mollusks from the Losnitsa River laid on average 50 ± 5 egg sets, that is 1.7 times less than number of syncapsules laid by the mollusks from the Teteriv River (84 ± 7 egg sets).

Length of syncapsules laid by mollusks from the radioactively contaminated zone varied insignificantly, though these syncapsules mainly were smaller than those of the control group. Similar regularity was observed in syncapsules' length laid by two animal groups kept in clean water (the Teteriv River – 33.75 ± 0.64 mm; the Loznitsa River – 32.86 ± 0.92 mm).

Abnormalities in structure of syncapsules laid by the pond snails from the radioactively contaminated zone were the same as in mollusks affected only by the heavy metal ions. However it is worth noting, that almost all teratogenic abnormalities occurred 1.5 times more often. The most frequently occurred light spiralization of band with egg capsules, monozygotic egg capsules and presence of the egg capsules out of syncapsules. Doubling of the egg capsules and presence of eggs without capsules out of syncapsule also occurred quite frequently.

Teratogenic abnormalities partly caused decrease of vitality of youth of the mollusks affected by intensive radioactive impact, in turn this affected survival rate of young pond snails in the toxic medium.

We also studied number of the egg capsules laid into syncapsules and portion of young mollusks successfully completed embryonic development and hatched. These data were compared with data obtained in experiments where mollusks from conditionally clean water body were affected by toxic impact. It is worth noting that all obtained values were lower than in control. Number of the egg capsules in a syncapsule of the mollusks from the radioactively contaminated zone kept in considered solutions reliably decreased 1.5-2.3 times ($P < 0.05$). In turn, this decreased hatching of youth.

Average number of the egg capsules in a syncapsule and portion of the hatched juvenile of the mollusks from the radioactively contaminated water body were significantly less than of the mollusks from the Teteriv River at keeping of both groups in water without toxicants. Number of the egg capsules laid by mollusks from the Loznitsa River amounted to 94.88 ± 4.7 , and by mollusks from the Teteriv River – to 106.6 ± 4.37 . Portion of the hatched juveniles of the mollusks from the Loznitsa River under such conditions was on average 1.3 times less as compared with mollusks from the Teteriv River (the Loznitsa River – $68.9 \pm 3.67\%$, the Teteriv River – $87.9 \pm 1.35\%$) ($P < 0.05$).