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ECOTOXICOLOGICAL RESPONSES OF *PLANORBARIUS CORNEUS* S. LATO ALLOSPECIES (MOLLUSCA, GASTROPODA) FROM UKRAINIAN RIVER NETWORK TO EXPOSURE OF PESTICIDES

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We studied by the laboratory tests the impact of the most widespread pesticides (insecticide "Actor", fungicide "Scooter", herbicide "Titus-C") in different concentrations (0,001–1000 mg/L) and in water on the main ecotoxicological indexes of genetic vicaristic "western" and "eastern" allospecies of great ramshorn *Planorbarius corneus* s. lato. It was established, the ranges of toxic action of these pollutants (mg/L) are the following: insecticide – < 0.01–1, fungicide – < 0.1–80, herbicide – < 40–1000 for "western" allospecies, and < 0.001–1, < 0.01–10, < 10–1000, respectively, for "eastern" allospecies. By the toxic scale for ramshorns, the studied toxicants belong to low-toxic (herbicide "Titus C"), strongly toxic (fungicide "Scooter") and highly toxic (insecticide "Actor"), and present the following order: insecticide > fungicide > herbicide. Via monitoring the behavioral features and physiological state of studied molluscs, we established the threshold, sub-lethal, chronic-lethal and acute-lethal concentrations for each of examined pollutants (mg/L). The length of latent period within the intoxication process development differed among allospecies. Under the concentrations 0,001–10 mg/L, this index was higher in "western" than in "eastern" allospecies ($p \leq 0.05$). Adaptation coefficients to three examined pesticides categories in studied molluscs were the highest under insecticide action and the lowest under herbicide action, and were registered earlier in "eastern" allospecies. Along with increasing of toxicants concentrations, the durability coefficients raised in both allospecies, but they appeared higher in "eastern" allospecies than in "western" one ($p \leq 0.05$). The lethal time decreased from lower to higher concentrations of toxicant used, but under the same concentrations it was shorter by 1–2 hours in "eastern" allospecies ($p \leq 0.05$). The absolute values of toxicity indexes were 1.6–10-fold lower for "eastern" than for "western" allospecies ($p \leq 0.05$).

Under the impact of certain concentrations of used toxicants, both allospecies developed irreversible pathological process of intoxication consisting of 5 phases: latent, stimulatory, depressive, sublethal and lethal. Under the impact of equal concentrations in all the experiments, the mortality of "eastern" allospecies was higher than that of "western" one. By a set of signs is was established, that "eastern" allospecies is much more sensitive and less adapted for pesticides impact in water environment than "western" allospecies is, thus it tends to regress under the conditions of enhanced environment pollution by studied toxicants. It can be a consequence of more arid climate in this allospecies' range on the Left-Bank of Ukraine.

Keywords: "western" and "eastern" allospecies *Planorbarius* (superspecies) *corneus* s. lato, pesticides, ecotoxicological indexes

Pesticides belong to the most widespread among artificially synthesized stable organic pollutants in the waters of Ukrainian river network [20, 28]. They are used in forestry and agriculture, particularly in stockbreeding for pathogens, parasites, pests and undesirable animals/plants defense. The main pollution sources in water ecosystems are melt, rain and ground water flow

from the areas treated by pesticides, and wind blowing during treating of different objects placed close to water bodies. Pesticides are also often applied directly into the water in the fisheries for getting rid of certain hydrobionts. These toxins having gotten into the water bodies are included in local trophic chains and cycles, being accumulated in bottom sediments, macrophytes, fishes, zoo- and phytoplankton [1, 3, 7, 36, 37]. During transfer pesticides from the water to the next trophic chain links, their content increases in dozens and hundreds times [11, 18, 30].

Into the freshwater ecosystems pesticides having gotten interact with their biotic and abiotic components. Abiotic factors may degrade or adsorb these compounds on the sediments or organic substances, while interaction with bionts includes toxins' consumption and accumulation in the organisms, which affects their populations [23, 31]. Animal hydrobionts are affected by these toxicants, and their survival depends on toxins' bioavailability (the ability of toxicants to be consumed), bioconcentration (the level of toxicants accumulation in tissues and organs), biomagnification (accumulation in the trophic chains), and stability in the given environment [26]. The toxic impact of these pollutants has many directions. They cause the changes to water physical-chemical properties, they decrease the amount of phyto- and zooplankton, that negatively influences the fishes forage basis, causing direct damage to ichthyofauna [9, 11, 12, 15, 22, 24, 26, 32, 33].

Pesticides are usually classified according to their target use. Among them, the prominent place belongs to insecticides (for insect defense), fungicides (against fungal pathogens) and herbicides (against weeds). If comparing mentioned categories, insecticides are considered as the most toxic, causing decrease in growth and hard metabolic and reproductive impairments to water insects [4, 35]. Fungicides can accumulate in water environment and concentrate in the objects of molluscs' trophic chains, causing intoxication and death to them. Herbicides having gotten into water ecosystems not only damage algae and hydrophytes, but also discolor the water, making it disgust by taste and odor, degrading its quality [17].

Under the improper use, this possess a considerable danger for long-term survival of ecosystems due to deterioration of ecological interactions between water organisms, causing biodiversity impoverishment [29]. The impact of these pesticides on hydrobionts and water ecosystems has many undesirable side effects, significantly deteriorating the ecological balance in water bodies. To establish their toxicity level for hydrobionts, the biotesting is used, based on quantitative estimations of vital indexes of water animals [10]. As test objects, those animals are usually used, which are highly sensitive to particular compounds impact, and are able to accumulate them along with to adapt to given conditions by their regular physico-biochemical processes in their organisms. Concerning the *Planorbarius corneus* (Linnaeus, 1758) sensu lato genetic allospecies, massively inhabiting the Ukrainian river network, the features of response to pesticides often used here were not yet established.

The aim of present study was: to establish the features of impact of three the most widespread pesticides group in Ukraine (insecticides, fungicides, herbicides) in different concentrations on some of the most important ecotoxicological traits of "western" and "eastern" *P. corneus* s. lato allospecies; basing on the obtained results, to estimate the suitability of used molluscs to be the bioindicators in monitoring of state of water ecosystems polluted with pesticides.

Material and Methods

There were studied 1320 exemplars of *P. corneus* s. lato in total, collected in July-August 2021, among which 650 exemplars of "western" allospecies (diameter of shell 25.56±0.24 mm) from Hnyla river (Dniester river basin) in Horodnytsia village vicinity (49°24'37.9»N 26°01'01.9»E), and 670 exemplars of "eastern" allospecies (diameter of shell 24.61±0.18 mm) from Psel river (left Dnipro river tributary) in Sumy (50°52'10.9»N 34°49'05.4»E) (see Figure).

Molluscs were collected by hands on the depths from 0.25 to 1.2 m, using the common hydrobiological methods for collecting of such water objects [34]. Allospecies were identified by their conchiological traits [13, 14].

Molluscs acclimatization to the aquarium environment was conducted following Khlebovich [19]. Its durations was 14 days with conditions: 10 L volume, 4 ind/L density, 21–22 °C temperature, 7.6–7.9 pH, 7.9–8.3 O_2 mg/L DO, with daily environment renewing. The animals were fed with water flora, taken from the sites of their collection (*Cladophora sp.*, *Myriophyllum spicatum*).

The main ecotoxicological assays were based on the Alekseev protocol [2] in the following conditions: 100 L aquarium volume, 20–23 °C temperature, 7.6–8.2 pH, 7.8–8.5 O_2 mg/L DO. Toxicants used: insecticide "Actor" (Family Garden LLC, Ukraine), fungicide "Scooter" (Family Garden LLC, Ukraine), herbicide "Titus-c" (DUNLOP Ltd, Ukraine), – in concentrations of 0,001–1000 mg/L. The solutions were prepared with aged (2 days) Zhytomyr tap water. Exposition: 48 hours, with daily renewing of toxic environments by freshly prepared. The results of monitoring were registered each 10 and 30 min, and 1, 2, 4, 6, 24, 48 hours.

The indexes of toxicants' impact on experimental molluscs were obtained via monitoring of individuals' behavior and their overall state. The attention was paid to the motion activity, feeding activity intensity, the level of deterioration of epithelial body covers, and the level of mucus secretion. The endurance coefficient was calculated by [39] of $EC=E_k/E_n$, where the E_k – time of death of all experimental animals; E_n – time of death of the first experimental animal. Adaptation coefficient was calculated by the formula [25] of $AC=E_e/E_c$, where the E_e – the mean time of all experimental animals' death, E_c – the mean time of all control group animals' death.

The results of experiments were analyzed using standard methods of basic variation statistics in software Statistica 6.0 [8].

Map showing the type localities of allospecies *P. corneus* s. lato: black triangle – «western» (Hnyla river, Horodnytsia village, Ternopil region); black diamond – «eastern» (Psel river, Sumy, Sumy region)

Results and Discussion

Pesticides are gotten into the molluscs' organisms mainly via direct percutaneous way: osmotically via body covers [35], and in much less amount from their food [31]. The ability of these toxicants to damage the water organisms depends greatly on their chemical nature, harmfulness level, which is also determined by exposure duration, dose size, and these compounds' stability in the environment [17]. Short-term impact of these pollutants on the water biota may be insignificant, while the prolonged effect may cause more sensible, even irrecoverable damage [6]. Pesticides may cause as direct, as indirect effects to the hydrobionts including molluscs. The direct effects are usually caused by the impact on the course of physiological functions, and the indirect are happened at the level of ecological interactions between species [31]. It is known [26], certain animal species can concentrate some pesticides in their tissues and organs in amounts of dozens times higher than their content in the water. In molluscs, the toxicants used by us concentrated in hepatopancreas due to the ability of these compounds to be accumulated exactly there. Further, they move in the mollusc body by its liquid internal medium (hemolymph), being distributed among different organs and tissues.

Results in the Table 1 show that threshold concentrations of used toxins, and the values of their main toxicological indexes (LC_0, LC_{50}, LC_{100}) were considerably lower for "eastern" allospecies than for "western" one ($p \leq 0.05$). It was established, the studied allospecies differ from each other by the lethality under the impact of all used pesticides (Table 2). So, under the 0.01 mg/L of insecticide, the 20 % of "eastern" allospecies individuals died by the end of experiment, while the 100 % of "western" allospecies individuals survived under the same conditions.

Table 1

The main toxicological characteristics of *P. corneus* s. lato allospecies under the exposure of pesticides (48 hours)

Indicator, mg/L	«Western» allospecies			«Eastern» allospecies		
	Insecticide	Fungicide	Herbicide	Insecticide	Fungicide	Herbicide
Threshold concentration	0.001	0.01	0.1	0.0001	0.001	0.01
LC_0	0.01	0.1	40	0.001	0.01	10
LC_{50} *	0.5	10	400	0.1	1	250
LC_{100}	1	80	1000	1	10	1000

Note: * – set graphically

Table 2

Mortality (%) of *P. corneus* s. lato allospecies under the exposure of three pesticides (48 hours)

Concentration, mg/L	«Western» allospecies			«Eastern» allospecies		
	Insecticide	Fungicide	Herbicide	Insecticide	Fungicide	Herbicide
0,0001	0	0	0	0	0	0
0,001	0	0	0	0	0	0
0,01	0	0	0	20	0	0
0,1	30	0	0	50	20	0
1,0	100	10	0	100	60	0
10	100	50	0	100	100	0
100	100	100	20	100	100	40
1000	100	100	100	100	100	100

For both *P. corneus* s. lato allospecies, we established the limits of concentrations of used toxicants from the subthreshold to maximally lethal, i.e. their toxical impact zone (Table 3). It is important for prognoses of the intoxication course speed in studied molluscs, and for establishing the level of possible reverse in them [11]. By the level of toxicity to both allospecies, the studied

toxicants form the following order: insecticide > fungicide > herbicide; moreover, the absolute values of toxicity indexes were 1.6–10-fold lower for "eastern" than for "western" allospecies.

Table 3

Rating of pesticides concentrations (mg/L) according to the effect on *P. corneus* s. lato allospecies

Pesticide	Subthreshold	Sublethal	Chronic lethal	Acutely lethal
		«Western» allospecies		
Insecticide	0.0001 and lower	0.1–0.01	1–0,5	5–2
Fungicide	0.001 and lower	1–0.1	30–5	80–40
Herbicide	0.01 and lower	10–1	80–30	150–100
		«Eastern» allospecies		
Insecticide	0.00001 and lower	0.001–0.0001	0.1–0.01	1–0.5
Fungicide	0.0001 and lower	0.01–0.001	1–0.1	10–2
Herbicide	0.001 and lower	1–0.1	50–10	100–60

The latent period duration decreased in both allospecies with the increase of toxicants' doses. The first signs of intoxication from the onset of experiment (motion activity weakening, defensive mucus layer secretion on the cover epithelium) in experimental individuals under the impact of fungicide in concentration of 0.001 mg/L emerged in 26.2 h in "western" allospecies, and in 23.1 h in "eastern" one (Table 4). This indicates the higher sensitivity of "eastern" allospecies to used toxin ($p \leq 0.05$). With increasing of the pesticides concentrations, the signs of intoxication emerged in "eastern" allospecies much earlier than in "western". So, in both allospecies, they emerged the most quickly in the insecticide solutions, and the most slowly in herbicide solutions.

Table 4

Latent period (hours) of *P. corneus* s. lato allospecies under the exposure of pesticides

Concentration, mg/L	«Western» allospecies			«Eastern» allospecies		
	Insecticide	Fungicide	Herbicide	Insecticide	Fungicide	Herbicide
	M±m	M±m	M±m	M±m	M±m	M±m
0,001	25.40±1.05	26.20±0.85	–	22.30±0.99*	23.10±1.06*	–
0,01	23.10±0.97	25,.50±1.04	26.50±1.21	20.20±0.12*	22.40±1.11*	22.10±1.09*
0,1	15.10±1.04	16.20±1.11	18.50±1.07	12.40±0.88*	13.30±1.02*	15.20±1.18*
1,0	3.50±1.07	4.10±1.05	6.30±1.34	3.20±1.04	3.50±0.98	5.10±1.20
10	1.15±0.98	1.50±0.88	2.10±0.79	1.10±1.11	1.30±0.95	3.00±1.16
100	0.20±1.12	0.25±1.01	0.35±0.98	0.20±0.85	0.20±1.05	0.35±1.08
1000	–	–	0.30±0.75	–	–	0.25±1.13

Note: * – statistically significant differences ($p \leq 0.05$) between *P. corneus* s. lato allospecies

The adaptation coefficient shows the level of adaptation of studied allospecies to impact of used pesticides. The values of this index for both allospecies appeared the highest under the insecticide impact, and the lowest under the herbicide impact, and were recorded earlier in "eastern" allospecies (Table 5). So, the "western" allospecies developed adaptation to insecticide in 40 min later than "eastern" allospecies.

Table 5

Adaptation coefficient (hours) of *P. corneus* s. lato allospecies under the exposure of pesticides

Pesticide, mg/L	«Western» allospecies	«Eastern» allospecies
Insecticide	3.50	3.10
Fungicide	2.10	1.35
Herbicide	1.20	1.10

It was established, that the value of endurance coefficient depends directly on the amplitude both physiological status indexes and toxic resistance in studied individuals. Its values for

ramshorns under the impact of pesticides were the less, the less concentration of used toxicant was (Table 6). Under the low concentrations, it often was impossible to determine its value due to mortality lower than 100 % by the end of experiment. It appeared, that "western" allospecies is better adapted to the impact of all used toxicants comparing to the "eastern" allospecies ($p \leq 0.05$).

Table 6

Endurance coefficient (hours) of *P. corneus* s. lato allospecies under the exposure (48 hours) of pesticides

Concentration, mg/L	«Western» allospecies			«Eastern» allospecies		
	Insecticide	Fungicide	Herbicide	Insecticide	Fungicide	Herbicide
	M±m	M±m	M±m	M±m	M±m	M±m
0,1	1.34±1.04	–	–	2.02±1.06*	–	–
1	1.87±1.12	2.36±1.25		2.75±0.98*	2.77±1.16	
10	2.06±1.24	2.87±1.08	–	2.81±1.07*	3.65±1.11*	–
100	2.84±1.13	3.44±1.03	–	3.68±1.21*	4.41±1.01*	–
1000	–	–	4.31±1.20	–	–	4.88±1.11

Note: * – statistically significant differences ($p \leq 0.05$) between *P. corneus* s. lato allospecies

It was established, that under impact of different concentrations of used pesticides molluscs developed the phased pathological process of intoxication. Under the threshold concentrations, these animals did not demonstrate the changes in ethology and physiology. By the end of experiment, they retained the same state as control group had. Such a response to the toxicant impact is usually considered [38] as a sign of the first and the longest intoxication phase – latent.

Under the sublethal toxicant concentrations, the experimental animals showed viability during the entire study with the first signs of ethological and physiological impairments, consisting of motion activity increasing aimed to avoiding the toxic environment. This is the result of presence of nervous connection between osphradia and columellar muscle and leg muscles complex [27]. Along with this, experimental molluscs experienced the stimulation of their feeding and reproductive activity. All the mentioned defensive reactions are the symptoms of the following intoxication phase – stimulation. It was established, that the "eastern" allospecies demonstrated such a change 1–2 h earlier and under the lower pollutants concentrations than "western" allospecies, with shows its higher sensitivity and lower toxic resistance. Besides, these individuals increasingly secreted the mucus at their epithelium, which decreased the speed and volume of toxicants' percutaneous getting into their organisms. This is one of defensive physiological reactions. However, over time the defensive mucus layer got thinner due to partial coagulation and exfoliated to the water by pieces, different by size and shape. By the end of insecticide impact experiment, the mucus covered the body surface in only 51 % individuals of "western" allospecies and 65 % of "eastern"; under the herbicide impact these indexes were 42 % and 54 %, respectively.

Under the chronically-lethal concentrations of fungicide, the mortality of "western" allospecies was 38 %, and for the "eastern" it was 46 %. The rest of experimental molluscs were oppressed. The similar situation was observed under the insecticide and herbicide impacts. One of the defensive physiological reactions in experimental animals was their bodies' swelling due to deterioration of their water balance. This was the way of toxic impact soothing via "soluting" the toxicants affecting them [5, 27].

Under the acute lethal concentrations, the ramshorns immediately tried to leave the toxic environment, emerging to the water surface tension film or creeping out by aquarium walls and placing themselves right over it. The significant portion of molluscs remained at the bottom immovable. Along with it, the reaction of prolapse was recorded in 40 % of "western" and 51 %

of "eastern" allospecies individuals. The rapid body volume increase (1.5–2 times) and decrease of columellar muscle resilience did not allow these animals to pull their bodies into the shells, thus their heads and foots hanged out of shells' aperture. According to some authors [16, 21], it was apparently the result of kidneys functioning impairment, which was caused by decrease of osmotic concentration of these animals' excreta. This leads to cellular membranes (pleonasm) destruction, which causes the destruction and death of kidney cells. Such destructions are typical for depressive and sublethal phases of intoxication process. These phases were registered earlier and were more expressed than in "eastern" allospecies than in "western". By the end of experiment (48 h), the mortality of experimental animals reached 100 %, that corresponds with the end of lethal phase of pathological process. The lethal time was established for each allospecies. Worth noting, along with increasing of concentrations of used toxicants, the lethal time and mean lethal time decreased in allospecies proportionally (Tables 7 and 8). It occurred the most quickly under the insecticide impact, and the latest under that of herbicide. The reversible of intoxication by these pollutants was quite minor in both allospecies. However, the "eastern" allospecies appeared to be much more sensitive to the toxicants impact: its lethal time and mean lethal time were registered 1–2 hour earlier than in "western" allospecies under the increasing concentrations. Under the same concentrations, the mortality of "eastern" allospecies was higher ($p \leq 0.05$). We assume it can be the consequence of their inhabiting the different nature zones: they are much tougher in "eastern" allospecies' range due to higher climate drought (the middle regions of Left-Bank Ukraine and extreme South of its Steppe zone).

Table 7

Time-to-death (hours) of *P. corneus* s. lato allospecies under the exposure of pesticides

Concentration, mg/L	«Western» allospecies			«Eastern» allospecies		
	Insecticide	Fungicide	Herbicide	Insecticide	Fungicide	Herbicide
	M±m	M±m	M±m	M±m	M±m	M±m
0,01	38.3±1.08	39.2±0.96	–	35.2±1.18*	36.4±1.14*	–
0,1	26.5±1.12	31.4±1.05	–	23.3±1.09*	27.3±1.17*	–
1,0	18.4±1.14	19.6±1.08	–	15.1±0.99*	16.2±1.11*	–
10	8.2±1.25	11.5±1.12	30.4±1.24	7.3±1.04	8.1±1.21*	27.3±1.02*
100	0.3±0.98	0.5±1.04	19.3±1.21	0.2±1.13	0.4±1.06	15.5±0.97*
1000			2.5±1.12			1.4±1.07*

Note: * – statistically significant differences ($p \leq 0.05$) between *P. corneus* s. lato allospecies

Table 8

Mean time-to-death (hours) of *P. corneus* s. lato allospecies under the exposure of pesticides

Concentration, mg/L	«Western» allospecies			«Eastern» allospecies		
	Insecticide	Fungicide	Herbicide	Insecticide	Fungicide	Herbicide
	M±m	M±m	M±m	M±m	M±m	M±m
0,1	43.0±1.27	44.0±1.21	–	40.0±1.22*	41.1±1.18*	–
1,0	23.0±1.34	27.1±1.14	–	20.1±1.28*	24.2±1.23*	–
10	14.3±1.18	18.0±1.12	–	11.3±1.21*	15.0±1.16*	–
100	4.5±1.09	5.2±1.31	48.0±1.25	3.1±1.13*	4.0±1.28	44.0±1.25*

Note: * – statistically significant differences ($p \leq 0.05$) between *P. corneus* s. lato allospecies

Thus, the limits of toxical impact zone of insecticide "Actor", fungicide "Scooter" and herbicide "Titus-c" differ by concentration ranges concerning their impact on *P. corneus* s. lato allospecies: the "eastern" allospecies was damaged under the lower concentrations and earlier in time comparing to "western" allospecies, that shows its lower toxic resistance. Its higher sensitivity and lower endurance is demonstrated by the ecotoxicological indexes: latent period duration, lethal time and mean lethal time values, coefficients of adaptation and endurance. The last two showed that the first signs of irreversible intoxication emerged earlier in "eastern" allospecies

than in "western", which indicated the higher viability of the last. With the increasing of toxical agents concentrations from threshold to acute lethal, the latent period occurrence fastened for both allospecies, and the lethal time shortened.

The obtained ecotoxicological indexes undoubtedly show the different level of sensitivity of *P. corneus* s. lato allospecies to the different pesticide groups, that were applied to them. This allows recommending both "eastern" and "western" allospecies for their applying as indicator objects in the monitoring of pollution state of water Ukraine ecosystems by used pollutants.

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ЕКОТОКСИКОЛОГІЧНІ ХАРАКТЕРИСТИКИ АЛОВИДІВ *PLANORBARIUS CORNEUS* S. LATO (MOLLUSCA, GASTROPODA) РІЧКОВОЇ МЕРЕЖІ УКРАЇНИ ЗА ВПЛИВУ ПЕСТИЦИДІВ

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Досліджено вплив низки концентрацій (0,001–1000 мг/л) найуживаніших пестицидів в Україні – інсектициду «Актор», фунгіциду «Скутер», гербіциду «Тітус-с» водного середовища на значення основних екотоксикологічних показників генетичних аловидів-вікаріантів витушки рогової *Planorbarius corneus* s. lato – «західного» і «східного». Встановлено, що межі зон токсичної дії цих полютантів (мг/л) для аловиду «західного» становлять щодо інсектициду – < 0,01–1, фунгіциду – < 0,1–80, гербіциду – < 40–1000, а для аловиду «східного» – < 0,001–1, < 0,01–10, < 10–1000 відповідно. За шкалою токсичності речовин для аловидів витушок досліджені нами токсиканти належать до категорій слабкотоксичних (гербіцид «Тітус-с»), сильнотоксичних (фунгіцид «Скутер») і високотоксичних (інсектицид «Актор») речовин і утворюють такий ряд: інсектицид > фунгіцид > гербіцид. Шляхом спостереження за особливостями поведінки і фізіологічного стану піддослідних м'якунів встановлено значення підпорогових, сублетальних, хронічнолетальних, гостролетальних концентрацій по кожному із використаних полютантів (мг/л). Тривалість латентного періоду за розвитку процесу отруєння у порівнюваних аловидів була неоднаковою. У діапазоні концентрацій від 0,001 до 10 мг/л значення цього показника у аловиду «західного» були вищими, ніж у аловиду «східного» ($p \leq 0,05$). Значення коефіцієнтів пристосування досліджуваних м'якунів до впливу використаних нами трьох категорій пестицидів є найвищими за дії на них інсектициду, а найнижчими – за дії гербіциду і відмічалися у аловиду «східного» раніше за часом. З піднесенням рівня концентрації токсикантів у обох аловидів *P. corneus* s. lato спостерігали зростання значень показників коефіцієнта витривалості, проте у аловиду «східного» вони виявилися вищими, ніж у аловиду «західного» ($p \leq 0,05$). Летальний час у піддослідних тварин зменшувався від меншої до більшої концентрації ужитих токсикантів, проте за однакових їхніх концентрацій значення цього показника у аловиду «східного» реєстрували на 1–2 год раніше, ніж у аловиду «західного» ($p \leq 0,05$). Таку ж закономірність спостерігали і щодо середнього летального часу у досліджуваних аловидів. Наголосимо, що абсолютні кількісні значення згаданих вище показників щодо аловиду «східного» були в 1,6–10 разів меншими, ніж у аловиду «західного».

За впливу застосованих концентрацій використаних токсикантів у аловидів *P. corneus* s. lato розвивався незворотний патологічний процес (отруєння), представлений п'ятьма фазами: латентною, стимуляції, депресивною, сублетальною і летальною. За дії однакових концентрацій усіх використаних у дослідах отрутохімікатів смертність у аловиду «східного» була вищою, ніж у аловиду «західного». За сукупністю отриманих результатів встановлено, що аловид «східний» виявився значно чутливішим і менш пристосованим до дії ужитих щодо нього пестицидів водного середовища, ніж аловид «західний», через що він інтенсивніше регресує в умовах посиленого забруднення навколишнього середовища цими токсикантами. Це є наслідком наявності у межах ареалу аловиду «східного» набагато посушливіших умов, а саме такими вони і є на півдні Лівобережної України порівняно з умовами, в яких перебуває аловид «західний».

Ключові слова: «західний» і «східний» аловиди *Planorbarius* (superspecies) *corneus* s. lato, пестициди, екотоксикологічні показники