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STRUCTURAL AND FAUNISTIC ORGANIZATION OF THE UDAY RIVER'S LITTORAL ZOOPLANKTON IN THE NATIONAL NATURE PARK "PYRIATYNSKIY"

Results of the investigation of the littoral zooplankton's structural and faunistic organization of the Uday river are presented. The research was conducted in the National Nature Park "Pyriatynskiy" in summer 2015. As the result of research 58 zooplankton's species were established. Their density, biomass, ecological spectrum of the community, type and way of the feeding were analyzed.

Key words: zooplankton, Uday river, National Nature Park "Pyriatynskiy", Ukraine.

Introduction. The influence of anthropogenic factor causes the significant changes and restructuring in the aquatic ecosystems. In turn, all these processes have a strong impact on the status of different taxonomical and ecological groups of hydrobionts. Thus these processes lead to the quantitative and qualitative changes in hydrobionts' communities and to the development of adaptive characteristics in different water organisms [1]. Such transformations are intense and proceed in a short time, what may lead to the considerable restructuring of the diversity of hydrobionts [2].

The special attention is attracted to the Uday river. Its valley is located in the National Park "Pyryatynsky" created in 2009. This pond was considered as one of the cleanest rivers in Ukraine a few decades ago. However, due to the active reclamation in recent time, many floodplains of tributaries that fed Uday were drained. Also, toxic substances extremely impact the ecosystem of the river. This led to a reduction in the diversity of aquatic organisms, siltation and overgrowing of the river. Therefore there is an urgent need for continuous monitoring of the Uday river to examine the state of hydrobiocenosis, which is a necessary component of the hydroecological studies.

Material and Methods

The objects of research were representatives of the three main groups of zooplankton: rotifers (class Eurotatoria), cladocerans (class Branchiopoda, order Cladocera), different age stages of copepods (class Copepoda). Also, ostracods (class Ostracoda) and larvae of bivalves (class Bivalvia) were investigated. Monogonont rotifers, copepods and crustaceans were identified to the species. For bdelloid rotifers (subclass Bdelloidea), ostracods and larvae of bivalves only the higher taxonomic groups were identified.

As the material for research was used zooplankton which was collected in late July 2015. Eight experimental stations in the intertidal zone of the Uday river were investigated (Fig. 1): outskirts of the Kroty village N $50^0$23.197' E $32^0$28.494'; Gurbentsi village N $50^0$21.314' E $32^0$28.612'; Leliaky village N $50^0$20.137' E $32^0$23.700'; Keibalivka village N $50^0$18.351' E $32^0$30.100'; Sumskiy bridge, Pyriatyn city N $50^0$13.636' E $32^0$33.324'; Masalskiy island, Pyriatyn city N $50^0$14.365' E $32^0$31.883'; Velyka Krucha village N $50^0$11.159' E $32^0$34.300'; Povstyn village N $50^0$11.183' E $32^0$40.283'. Zooplankton was studied within the overgrown habitat (in the following formations: common reed *Phragmites communis*, broadleaf cattail *Typha latifolia*, yellow water-lily *Nuphar lutea*) and within the freshwater ones. Collection of zooplankton was performed using conical nets [3]. 16 samples were collected and analyzed on the basis of generally accepted methods [3-10].

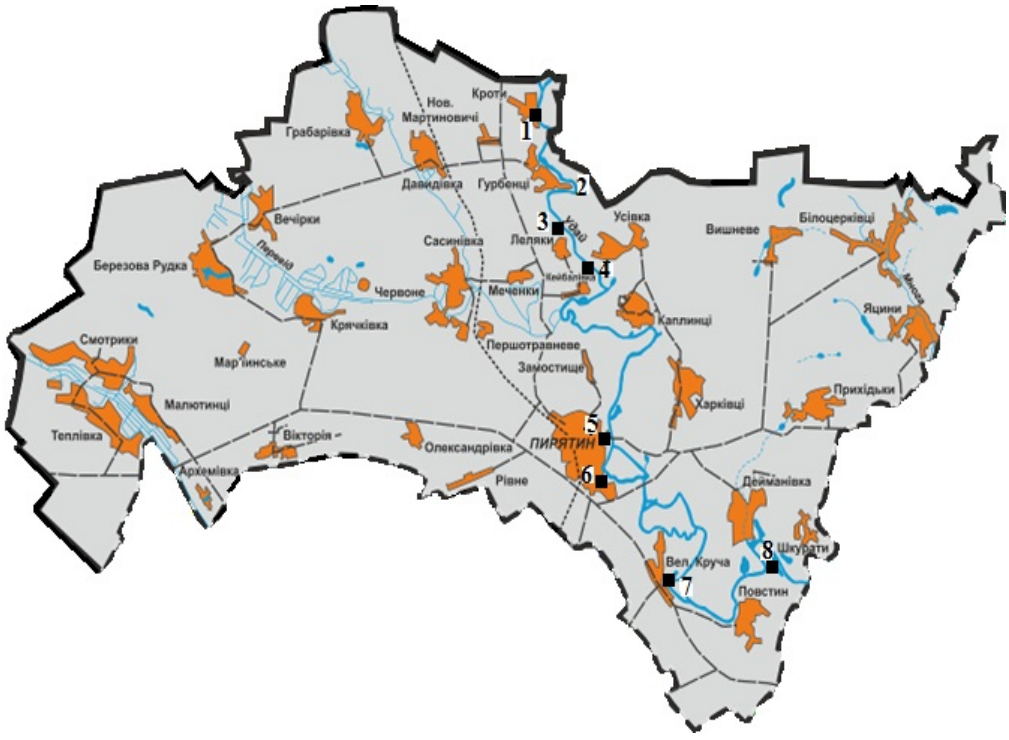

Figure 1. Stations of the littoral zooplankton sampling (Uday river, National Nature Park "Pyriatynskiy").
Marks: 1 – outskirts of the Kroty village; 2 – Gurbentsi village; 3 – Leliaky village; 4 – Keibalivka village; 5 – Sumskiy bridge, Pyriatyn city; 6 – Masalskiy island, Pyriatyn city; 7 – Velyka Krucha village; 8 – Povstyn village

Results and discussion

In the result of research, 58 zooplankton species were registered. The representatives of the rotatoria and cladocera complex were dominated.

23 species of monogonont rotifers were registered: *Anuraeopsis fissa fissa* Gosse, 1851; *Asplanchna priodonta* Gosse, 1850; *Brachionus angularis* Gosse, 1851; *Br. calyciflorus* Pallas, 1766; *Br. quadridentatus* Hermann, 1783; *Euchlanis deflexa* (Gosse, 1851); *E. dilatata* Ehrenberg, 1832; *E. lyra* Hudson, 1886; *E. triquetra* Ehrenberg, 1838; *Hexarthra mira* (Hudson, 1871); *Lecane bulla* (Gosse, 1851); *L. luna* (O.F.Müller, 1776); *L. lunaris* (Ehrenberg, 1832); *L. closterocerca* (Schmarda, 1859); *Lophocharis oxysternon* (Gosse, 1851); *Mytilina ventralis* (Ehrenberg, 1830); *Plationus patulus* (O.F.Müller, 1786); *Platyias quadricornis* (Ehrenberg, 1832); *Polyarthra dolicoptera* Idelson, 1925; *Synchaeta pectinata* Ehrenberg, 1832; *Testudinella patina* (Hermann, 1783); *Trichocerca rattus* (O.F.Müller, 1776); *Trichotria pocillum* (O.F.Müller, 1776). Also bdelloid rotifers (subclass Bdelloidea) were registered.

22 species of cladocerans were discovered: *Acroperus harpae* (Baird 1834); *Alona guttata* Sars, 1862; *A. rectangula* Sars, 1862; *Alonella nana* (Baird 1843); *Bosmina longirostris* (O.F.Müller, 1776); *Ceriodaphnia affinis* Lilljeborg, 1900; *C. pulchella* Sars, 1862; *C. quadrangula* (O.F.Müller, 1785); *Chydorus piger* Sars, 1862; *Ch. sphaericus* (O.F.Müller, 1785); *Daphnia cucullata* Sars, 1862; *D. longispina* (O.F.Müller, 1776); *Diaphanosoma brachyurum* (Lievin, 1848); *Disparalona rostrata* (Koch, 1841); *Eurycercus lamellatus* (O.F.Müller, 1776); *Graptoleberis testudinaria* (Fischer, 1848); *Lathonura rectirostris* (O.F.Müller, 1776); *Macrothrix hirsuticornis* Norman & Brady, 1867; *Pleuroxus aduncus* (Jurine, 1820); *Pseudochydorus globosus* (Baird, 1843); *Sida crystallina* (O.F.Müller, 1776); *Simocephalus vetulus* (O.F.Müller, 1776).

Copepods were represented by the 13 species: Веслоногі ракоподібні були представлені 13 видами: *Acanthocyclops americanus* (Marsh, 1893); *Cryptocyclops bicolor* (Sars, 1863); *Ectocyclops phaleratus* (Koch, 1838); *Eucyclops denticulatus* (Graeter,1903); *E. Macrurus* (Sars, 1863); *E. serrulatus* (Fischer, 1851); *Macrocyclops albidus* (Jurine, 1820); *Megacyclops viridis* (Jurine, 1820); *Mesocyclops leuckarti* (Claus, 1857); *Microcyclops varicans* (Sars, 1863); *Thermocyclops crassus* (Fischer, 1853); *Th. oithonoides* (Sars, 1863); *Eurytemora velox* (Lilljeborg, 1853).

Zooplankton species composition of different habitats and experimental stations had low similarity, as evidenced by Jaccard index (J = 4,7 – 44,5).

Littoral zooplankton was characterized by significant ecological diversity. Three environmental groups were observed in zooplankton composition: pelagic, demersal and phytophilous.

The ecological spectrum of zooplankton communities was characterized by a significant prevalence of phytophilous groups over pelagic and demersal. Pelagic representatives included 18 species (31%), demersal – 14 (24%) and phytophilous – 26 (45%). Rotifers and cladocerans dominated among the demersal group, while copepods constituted a significant percentage of pelagic and phytophilous groups (Fig. 2).

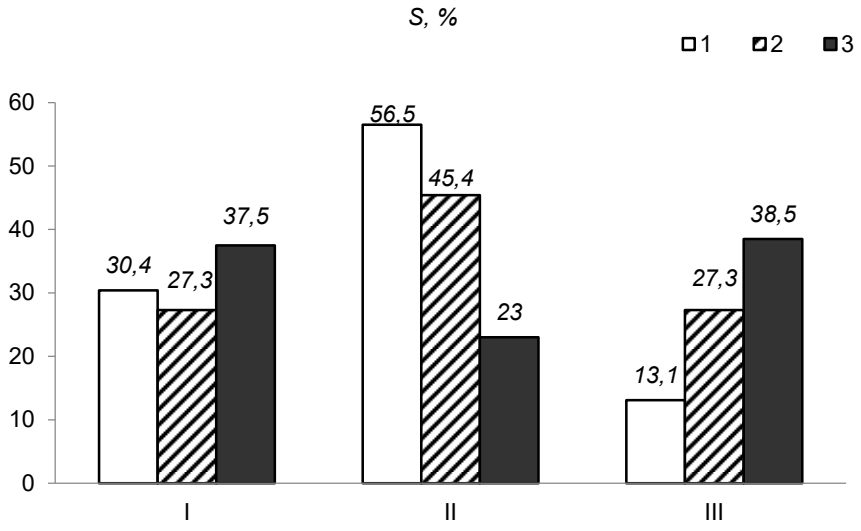

Figure 2. Environmental groups of zooplankton main communities within the district of Uday river.
Marks: I – pelagic, II – demersal, III – phytophilous; 1 – rotifers 2 – cladocerans, 3 – copepods

Zooplankton species are also distinguished by the type and method of feeding. The representatives of different zooplankton species are divided in three trophic groups depending on the type of feeding: peaceful – 44 species (75.9%), omnivorous – 6 (10.3%) and predators – 8 (13.8%). Among rotifers dominated peaceful species – 22 (95.7%) and only 1 (4.3%) omnivorous representative – *Asplanchna priodonta*. Cladocerans were a peaceful group – 22 (100%), while omnivorous copepods included 7 (53.8%) species and predators – 6 (46.2%).

By method of feeding planktonic invertebrates are divided on the following groups: verticators, suction feeders, primary and secondary filter-feeders, gatherers, active and passive hijackers, and parasites. Nine groups were noted during investigation of the Uday river: vertification – 15 species (25.9%), vertification and suction – 4 (6.9%), suction – 3 (5.2%), secondary filtration – 12 (20.7%), seizure – 8 (13.8%), gathering – 6 (10.3%), seizure and absorption – 1 (1.7%), capturing and filtering – 1 (1 7%), primary filtration – 8 (13.8%). Among rotifers dominated the representatives feeding by vertification – 15 species (65.2%),

vertification and absorption – 4 (17.4%), suction – 3 (13%), seizure and absorption – 1 (4.4%). Cladocerans were represented by 12 species (54.5%) of secondary and 8 (36.4%) of the primary filter feeders and 2 (9.1%) gatherers. Among the copepods dominated hijackers – 8 species (61.5%), gatherers – 4 (30.8%) and filtrators and hijackers – 1 (7.7%).

According to the standard classification [3], overall dencity parameters of overgrown habitats in the experimental waters were "very low" for stations Leliaki village (820 ind./m^3) and the island Masalskiy (1600 ind./m^3), "low" – Sumskiy bridge(24300 ind./m^3), Keybalivka village (26900 ind./m^3), Povstyn village (17,280 ind./m^3), Gurbentsi village (9160 ind./m^3), "below average" – Kroty village (111 600 ind./m^3) and Velyka Krucha village (54,080 ind./m^3). In the fresh waters these parameters can be described as "very low" – 200-2480 ind./m^3, except density parameters of the station Keybalivka village – "low" (11700 ind./m^3), and Kroty village – "below average" (109,260 ind./m^3).

Copepods dominated by the density within both habitats in the most of experimental stations (p≤0,05). In overgrown habitats they numbered 22,930 (± 20698,64) of total 30905 (± 25665,4) ind./m^3, while in the freshwater habitats – 14602,9 (± 24129,9) of 14297,8 (± 29842,4) ind./m^3. The only one exception was the station with freshwater habitat – Povstyn village (Fig.3), where cladocerans prevailed by the density- 120 of 200 ind./m^3. Dominant zooplankton species by the density were not noted.

Density prevalence of copepods within the most of experimental stations of the Uday river can be explained by the massive development of the larval stages of copepods, namely nauplius and metanauplius.

According to the standard classification [3] the overall parameters of the biomass of littoral zooplankton in overgrown habitat – common reed and yellow water-lily were "very low" for stations Leliaky village (0.06 g/m^3) and the island Masalsky (0.14 g/m^3), "low" – Keybalivka village (0.53 g/m^3), Povstyn village (0.58 g/m^3), Gurbentsi village (0.51 g/m^3) and "below average" – Sumskiy Bridge (1.27 g/m^3), Kroty village (4.3 g/m^3), Velyka Krucha village (2.35 g/m^3). In freshwater biotope parameters of biomass were "very low" – 0,005-0,13 g/m^3, except Kroty village – "below average" – 2.3 g/m^3 (Fig.3).

In the majority of the experimental aquatories of both habitats dominated copepods (p≤0,05). In overgrown habitats they amounted to 1,33 (± 1,11) of the total biomass of zooplankton groups 2,11 (± 1,61) g/m^3, while in the freshwater habitats – 0,3 (± 0,49) of 0,4 (± 0,64) g/m^3. Cladocerans prevailed in overgrown biotope of the Leliaky village – 0.05, Masalskiy island – 0.08, and in both habitats of the Povstyn village – 0.32; 0.005 g/m^3, and in the Gurbentsi village- 0.32; 0.02 g/m^3 (Fig.4). Cladocerans and copepods have great individual weight, therefore biomass indices were higher compared with other groups of zooplankton.

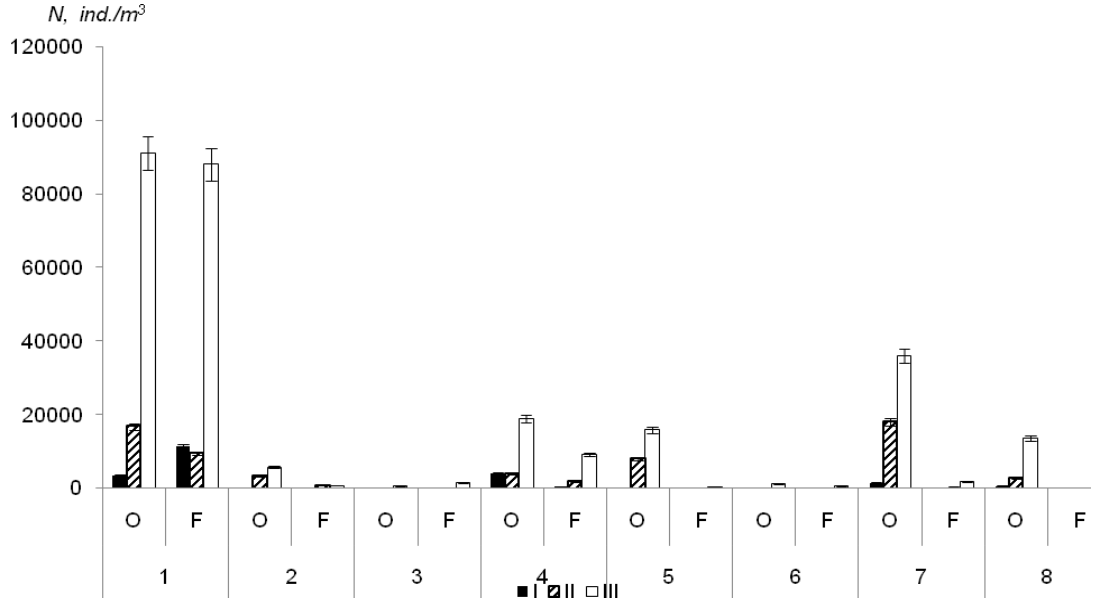

Figure 3. The ratio of the zooplankton densities of different groups in the two habitats of Uday river.
Marks: 1 – outskirts of the Kroty village; 2 – Gurbentsi village; 3 – Leliaky village; 4 – Keibalivka village; 5 – Sumskiy bridge, Pyriatyn city; 6 – Masalskiy island, Pyriatyn city; 7 – Velyka Krucha village; 8 – Povstyn village; I – rotifers, II – cladocerans, III – copepods; O – overgrown habitat, F – freshwater habitat

For overgrown habitat of the Lelyaki village the dominant by the biomass cladocerans species was distinctly identified – *Eurycercus lamellatus* – 66,6% (0,04 total of 0.06 g/m^3). Within overgrown habitat of the station Sumskiy bridge dominated representatives of copepods – *Macrocyclops albidus* – 33,1% (0,42 from 1,27 g/m^3). Also, monodominance of the copepoda *Eurycercus lamellatus* – 57,1% (0,08 from 0,14 g/m^3) was pronounced on the island Masalsky within the overgrown habitat.

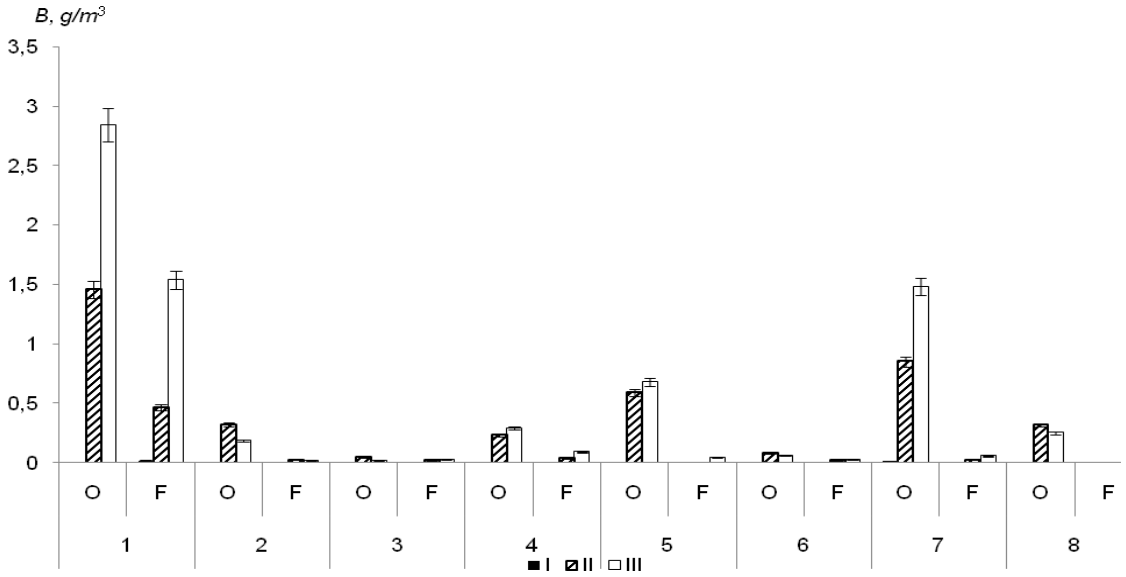

Figure 4. The ratio of the zooplankton biomass of different groups in the two habitats of Uday river.
Marks: 1 – outskirts of the Kroty village; 2 – Gurbentsi village; 3 – Leliaky village; 4 – Keibalivka village; 5 – Sumskiy bridge, Pyriatyn city; 6 – Masalskiy island, Pyriatyn city; 7 – Velyka Krucha village; 8 – Povstyn village; I – rotifers, II – cladocerans, III – copepods; O – overgrown habitat, F – freshwater habitat

In freshwater biotope of the station Velyka Krucha village dominated the copepoda – *Macrocyclops albidus* – 37,5% (0,03 from 0,08 g / m^3). In both habitats of the Povstyn village cladocerans dominated by the biomass, within the overgrown one – *Simocephalus vetulus* – 51,7% (0,3 of 0.58 g/m^3) and within the freshwater – *Daphnia cucullata* – 80% (0,004 of 0,005 g / m^3). In the Gurbyntsi village cladocera *Simocephalus vetulus* dominated in both overgrown biotope – 51% (0.26 from 0.51 g/m^3) and the freshwater – 50% (0.02 from 0.04 g/m^3). Within other investigated stations dominant complex was not determined because of the low biomass.

Ostracods had "very low" parameters [3] of the density – 20-2400 ind./m^3 and of the biomass – 0,002-0,24 g/m^3. Larvae of bivalves were not found at any station.

Conclusions

1. Within the Uday river in the Park "Pyriatynskiy" 58 species of zooplankton were recorded: rotifers – 23, cladocerans – 22, copepods – 13.

2. Zooplankton's species composition of different habitats had low similarity, as evidenced by Jaccard index (J = 4,7 – 44,5).

3. In the ecological spectrum the prevalence of the phytophilous zooplankton group was discovered – 26 species (45%) over the pelagic – 18 (31%) and bottom – 14 (24%).

4. By the type of feeding among representatives of zooplankton communities prevailed the peaceful groups – 44 (75.9%) of the 58 species.

5. By the method of feeding littoral zooplankton was assigned to 9 groups. The dominant groups were vertication – 15 species (25.9%) and secondary filtration – 12 (20.7%).

6. The parameters of density were "very low", "low" and "below average" for overgrown habitat – 820-111600 ind. / м3, and for freshwater – 200-109260 ind. /m3. Copepods dominated by the density within all research stations, except the freshwater habitat of the Povstyn village, where cladocerans dominated.

7. The biomass parameters were "very low", "low", "below average" in the overgrown biotope – 0,0596-4,30392 g/m3, and in the freshwater- 0,00538-2,02556 g/m3. The complex of cladocerans and copepods dominated.

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СТРУКТУРНО-ФАУНІСТИЧНА ОРГАНІЗАЦІЯ ЛІТОРАЛЬНОГО ЗООПЛАНКТОНУ Р. УДАЙ НПП "ПИРЯТИНСЬКИЙ"

Представлено результати дослідження структурно-функціональної організації угруповань літорального зоопланктону р. Удай в межах Національного природного парку "Пирятинський", проведені влітку 2015 року. В результаті досліджень визначено 58 видів зоопланктону та проаналізовано їх щільність, біомасу, екологічний спектр угрупування, тип і спосіб живлення.

Ключові слова: зоопланктон, р. Удай, НПП "Пирятинський", Україна.

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СТРУКТУРНО-ФАУНИСТИЧЕСКАЯ ОРГАНИЗАЦИЯ ЛИТОРАЛЬНОГО ЗООПЛАНКТОНА Р. УДАЙ НПП "ПИРЯТИНСКИЙ"

Представлены результаты исследования структурно-функциональной организации сообществ литорального зоопланктона р. Удай в районе Национального природного парка "Пирятинский", проведенные летом 2015 года. В результате исследований определено 58 видов зоопланктона и проанализировано их плотность, биомассу, экологический спектр сообщества, тип и способ питания.

Ключевые слова: зоопланктон, р. Удай, НПП "Пирятинский", Украина.

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CHANGE IN THE CONTENT OF XANTHONES AND LIGNIN IN BUCKWHEAT AND WHEAT PLANTS UNDER SALICYLIC ACID AND CADMIUM IONS

Investigated the effect of cadmium and salicylic acid on phenols content (xanthones, lignin) in plants buckwheat (Fagopyrum esculentum Moench.) and wheat (Triticum aestivum L.). It is established that the action of cadmium ions increases the content of xanthone and produces lignin. To reduce the impact of stress factors it is expedient to use salicylic acid, which normalize the amount of xanthones and lignin in plants of buckwheat and wheat. With this stress regulator, phytohormons can significantly reduce the toxic effects of cadmium ions.

Key words: Fagopyrum esculentum Moench., Triticum aestivum L., cadmium chloride, salicylic acid, lignin, xanthones.

Introduction. Plants organism are extremely sensitive to the state of the environment and actively respond to change. The influence a different anthropogenic factors are seriously damaging for all plants. Plants resistance to stressful factors are controlled by the hormonal system. In recent years attention give hormonal compounds, especially for the induction of plants resistance to different stress factors. For this compounds include salicylic acid. Salicylic acid (SA) is considered as an endogenous plant growth regulator which has been found to generate a wide range of physiological and metabolic responses in plants [10]. The important role of plant protection under the action of stressors in necessary for life restored condition, belongs to the phenolic compounds. Polyphenols – secondary metabolites of the plant organism [6,12], which protect it from oxidative stress. The synthesis of polyphenols is enhanced under stressful conditions [8,13]. It is known that polyphenols counteract oxidative stress: neutralize active forms of oxygen, support the internal environment of cells and have a positive effect for activity of antioxidant enzymes [13].

In the present work, we made an attempt to explore whether external treatment of salicylic acid could mitigate the adverse effect of Cd toxicity on buckwheat and wheat plants and also investigate changes in the phenol contents under these conditions.

Matherials and methods. Seeds of wheat (*Triticum aestivum* L. cv. Podolianka) and buckwheat (*Fagopyrum esculentum* Moench. cv. Rubra) were sterilized and divided into two groups. First group of seeds were soaked in 0.05 μM SA respectively for 5 h, another group was soaked in distilled water (control). Then both groups were allowed to germinate on moist filter paper in the dark. Two-days-old seedlings were transported in pots filled with washed and inciderated sand artificially contaminated with Cd (25 mg/kg substrate). The concentration was chosen by comparing with the literature sources [5,7]. For our research were the plants are grown without Cd ions and SA (control), also plants, wich seed are soked SA, and plants are grown with Cd. The concentration of salicylic acid (0.05 μM) were chosen experimentally, basis of our previous studies. For investigation were used 14-days-old and 21-days-old plants.

Determination of xanthons was based on the determination the main and most common glucoside – mangiferin. For investigation were used spectrofotometric assays. The results of mangiferin was expressed in % of dry weight (DW) [2,3].

Determination of lignin in stem was based on color reaction with floroglucine [4]. For investigation were used optical microscope and program Image Tool. The size was obtained using the formula A=P/0,8, де A-size of aperture (micrometers), P- size of aperture (pixels), 0,8 – the conversion factor. The conversion factor was determined by photographing a ruler and then determined the number of pixels in 1 micrometers.

Results and discussion. Plants are frequently exposed to stress factors, that greatly influence growth, development, survival, crop productivity, and species distribution. Many plants can acquire tolerance in response to this factors. In this article all attention is for secondary metabolites of the plant organism – phenolic compounds, exactly xanthones. Many plants for stressful reaction including changes in physiological and biochemical processes [3]. Information about the change of xanthones contents under influence of heavy metals doesn't find. Known that xanthones as a phenolic compounds and secondary metabolites of plant organism has a protective role under stressful condition and oxidative stress, and their synthesis increase under this conditions [8,12,13]. The most common C-glucoside – mangiferin. Mangiferin was isolated from mango (*Mangifera indica* L.), but known that it is common