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ECOLOGICAL ANALYSIS OF THE COMPOSITION AND COMMUNITY STRUCTURE OF THE GORODNICHANKA RIVER AQUATIC INVERTEBRATES (GRODNO, BELARUS)

Among watercourses most numerous and least studied bodies of water are small rivers. Small rivers in the city are an integral part of the urban landscape. In Grodno city (Belarus) the Gorodnichanka river flows through the central part of the urbanized landscape, and performs not only environmental, but also city-forming functions.

The species composition of the Gorodnichanka river aquatic invertebrates is represented by 39 taxa. It is inhabited by invertebrates, belonging to 5 ecological groups: benthos, nekton, plankton, pleuston, periphyton and 3 trophic groups: filter feeders, phytophages and zoophages with the predominance of zoophages (16 taxa). Among aquatic invertebrates environmental groups benthic organisms dominate — 16 taxa. Closer to the river mouth the level of anthropogenic load decreases, and the species composition of aquatic organisms increases. Reduction of aquatic organisms ecological groups composition is due to flow rate, gradual increase in the anthropogenic load in the city center.

The analysis of aquatic organisms species composition makes it possible to identify the following ecological complexes: psammoreophiles, litoreophiles, argilloreophiles, peloreophiles, fitoreophiles. In the Gorodnichanka peloreophiles represented by 15 taxa prevail.

To assess water quality and the ecological status of the Gorodnichanka river Mayer index has been used. Indicator groups of aquatic invertebrates in the Gorodnichanka river have been defined. On the basis of the above mentioned we can say that the watercourse under study refers to water bodies of the 3d class water quality, moderately pollutedd.

Key words: small river, hydrobionts, invertebrate animals, ecological groups, species composition, urbanized landscape, assessment of environmental quality.

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ЭКОЛОГИЧЕСКИЙ АНАЛИЗ СОСТАВА И СТРУКТУРЫ СООБЩЕСТВ ВОДНЫХ БЕСПОЗВОНОЧНЫХ РЕКИ ГОРОДНИЧАНКА (ГРОДНО, БЕЛАРУСЬ)

Малые реки среди водотоков в настоящее время являются самыми многочисленными и наименее изученными водными объектами. В городах они представляют собой, как правило, неотъемлемую часть урбанизированного ландшафта. В городе Гродно (Беларусь) река Городничанка протекает через центральную часть урболандшафта и выполняет не только экологическую, но и градообразующую функции.

Целью работы являлось выявление видового разнообразия беспозвоночных-гидробионтов реки Городничанка, а также оценка её экологического состояния. Основные исследования проведены на территории города Гродно в 2011—2013 годах, выделен центральный водоток — река Городничанка, вдоль которого от истока к устью определены 6 пробных площадок.

Результаты исследований показали, что видовой состав беспозвоночных гидробионтов реки Городничанка представлен 39 таксонами. В ней обитают беспозвоночные, относящиеся к 5 экологическим группам — бентосу, нектону, планктону, плейстону, перифитону, — и 3 трофическим группам: фильтраторам, фитофагам и зоофагам с преобладанием зоофагов (16 таксонов). Среди экологических групп водных беспозвоночных доминируют бентосные организмы — 16 таксонов. Ближе к устью реки уровень антропогенной нагрузки уменьшается, а видовой состав гидробионтов увеличивается. Уменьшение состава экологических групп гидробионтов объясняется скоростью течения, постепенным возрастанием антропогенной нагрузки в центре города.

Анализ видового состава гидробионтов позволил выделить следующие экологические комплексы: псаммореофилы, литореофилы, аргиллореофилы, пелореофилы, фитореофилы. В реке Городничанка преобладают пелореофилы, представленные 15 таксонами.

Для оценки качества воды и экологического состояния реки Городничанка использован индекс Майера. Качество воды на пробных площадках ухудшается плавно от первого участка, который находится вне жилой зоны, к участкам, располагающимся в центре города, где антропогенная нагрузка максимальная. Выявлены индикаторные группы беспозвоночных-гидробионтов в реке Городничанка, на основании которых можно отметить, что исследуемый водоток относится к водным объектам 3-го класса качества вод, умеренно грязным.

Ключевые слова: малая река, гидробионты, беспозвоночные животные, экологические группы, видовой состав, урбанизированный ландшафт, оценка качества среды.

Табл. 2. Библиогр.: 12.

Introduction. The most numerous among water bodies and watercourses of fresh water of all types is a small river. Small rivers mode is formed by specific conditions of the region and, as a rule, has its own characteristics in each basin. In addition, in the city small rivers are an integral part of the urban landscape [1]. However, in Belarus and in the neighboring countries their study received little attention compared to water bodies of all other types, particularly in urban areas [2], which increases the relevance of our work.

The river Gorodnichanka is a small river according to the standard classification, whose main geographical feature is the formation of the runnel. The national program of tourism development for 2006—2010 in the Republic of Belarus provides the river bed further reconstruction and restoring of the Gorodnichanka Valley. The expected outcome of these activities is the restoration of a natural object. In this regard, there was need for an integrated bioecological monitoring the status of a natural object within the development of recreational and tourist areas of Grodno city.

The Gorodnichanka river flows through Grodno city, falls into the Neman river on the right. The length is 4.6 km. It starts in the north-eastern outskirts of the city near Uchhozovskaja street. The valley upstream part is swampy and weak. The width of the river bed is 1.5 m. In the pipes or under bridges the river flows through the right side of the city. In the lower part of the valley the Gorodnichanka narrows to 40 m and has high and steep slopes. The width of its channel is up to 3 m. Near the confluence of the Gorodnichanka into the Neman Grodno city originated. The river Gorodnichanka is the third order element in the city ecological structure. It performs important ecological and sanitary functions of accumulation and removal of the bulk contaminants from areas surrounding Grodno, some of which are deposited in the flood plain of the river and accumulated. The zone of precipitation of pollutants flowing into the Gorodnichanka is 30% of the area.

In the Gorodnichanka river a large number of pollutants with rainwater are washed away. One of the problems for the Gorodnichanka is the state of household collectors constructed in different years. The problem of the Gorodnichanka river "environmental remediation" is one of the most important for Grodno city, not only environmental, but also urban.

The *purpose* of our work was to identify the aquatic invertebrates species diversity of the Gorodnichanka river, as well as to evaluate the ecological state of Grodno city central watercourse (the Gorodnichanka river).

Material and methods. The basic research was conducted by us in Grodno city in 2011—2013. From the source to the mouth the Gorodnichanka river along the 6 test plots (TP) was defined. The

work was performed at the Department of Zoology and Physiology of Man and Animals at Yanka Kupala Grodno State University.

TP 1 — at the beginnings of the river in front of the zoo, the flow velocity is m / s υ = 0.08 m / s, the coordinates are N 53° 41' 512", E 23° 51' 201". The bottom is muddy, silt capacity is of 10—20 cm. The depth is of 1 m. Riparian vegetation on the banks is well expressed, sometimes forming continuous thickets. There are no maelstrom and shallows there is a surface film of oil.

TP 2 — behind the zoo, before the bridge on E. Orzeszko str.: the flow velocity is m / s υ = 2 m / s, the coordinates are N 53° 41' 128", E 23° 50' 715". The bottom is sand and gravel, aquatic and semi-aquatic vegetation is practically absent. The oil film and contamination are not detected, garbage is present.

TP 3 — Lenin str., under the bridge in E. Orzeszko str.: the flow velocity is m / s υ = 0.15 m / s, the coordinates are N 53° 41' 023", E 23° 50' 396". The bottom is sandy and muddy. There is almost no aquatic and semi-aquatic vegetation. Surface oil and garbage is present.

TP 4 — E. Zhiliber city park: the flow velocity is m / s υ = 0.03 m / s, the coordinates are N 53° 41' 028", E 23° 50' 167". The water is turbid, the bottom is muddy. The water has a greenish color, there is no garbage; there is a film of oil. Aquatic vegetation is absent, coastal is weak.

TP 5 — Vilenskaja str., between the bridges in Gorky str. and Vilensky lane: the flow velocity is m / s υ = 0.46 m/s, the coordinates are N 53° 41' 005", E 23° 49' 759". The bottom is gravel and sand, theflow of the river is quick. It is characterized by presence of garbage and lack of oil film. There are many snags and large stones in the river. Aquatic vegetation is absent, waterfowl is weak.

TP 6 — the Gorodnichanka r. near the mouth, 300 m above the confluence of the Neman river: the flow velocity is m / s υ = 0.34 m / s, the coordinates are N 53° 40' 700", E 23° 49' 333". The bottom is sandy, the flow of the river is quick. Riparian vegetation on the banks is well expressed, forming sometimes continuous thickets on the river bed. It is characterized by presence of garbage and lack of the oil film.

Invertebrates collecting was performed by aqueous dip net [3]. Samples were taken from each plot at the strongest water flow, from the water surface, from the bottom together with the ground, water plants were also examined [4].

All samples in the laboratory were processed and analyzed. Plankton samples in vivo or in a fixed state were treated. Species determination and ecological groups allocation were carried out in accordance with literary sources [5—9]. The level of water pollution was determined by Mayer index [10; 11].

Results and discussion. During the study on the six test plots of the Gorodnichanka river, we collected and identified representatives of 39 invertebrates taxa. The distribution of aquatic invertebrates on test plots is presented in Table 1.

The first plot (TP 1) is the most inhabited by hydrobionts, despite the presence of the oil film and a small amount of garbage. During the study period 32 invertebrates taxa were found here. Species diversity can be explained by the low flow rate, rich aquatic and riparian vegetation, the abundance of organic and low anthropogenic load. The fast flowing river water, the rocky bottom and lack of riparian vegetation, the high banks due to construction work are characteristic for TP 2.On this site we came across 10 aquatic invertebrate taxa. TP 3 is characterized by the sandy bottom, the weak current, poor riparian and aquatic vegetation, and the presence of the oil film. Closed, undrained troughs are nearby, the processes of pollutants accumulation in those areas dominate. The invertebrates species composition is quite poor here — only 8 taxa.

The water on the TP 4 is muddy, the bottom is slime, and the water flow is practically absent. Aquatic vegetation is absent, coastal is weak. 11 taxa of aquatic invertebrates were found. The bottom of the TP 5 and TP 6 is sandy and gravel, the water flow is very fast. 9 invertebrate taxa were found (Table 1).

The analysis of the data showed that invertebrate animals which live in the Gorodnichanka belong to five ecological groups: benthos, nekton, plankton, pleuston, periphyton. Among the ecological groups of the Gorodnichanka river benthic aquatic invertebrates organisms dominate — 16 taxa (*Chironomus plumosus, Tubifex tubifex,*

T a b l e 1. — The aquatic invertebrates species composition in the test plots of the Gorodnichanka river

T а б л и ц а 1. — Видовой состав водных беспозвоночных на пробных площадках реки Городничанка

Taxa	Number of test plots (TP)					
	1	2	3	4	5	6
Pelomyxa palustris Greeff, 1874	–	–	–	+	–	–
Paramecium aurelia (Ehrenberg), 1838	+	–	–	+	–	–
Trachelius ovum Ehrenberg, 1831	+	–	–	–	–	–
Hydra oligactis Pallas, 1766	+	–	–	–	–	–
Gordius aquaticus Linnaeus 1758	+	–	–	–	–	–
Ephiphanes senta (O. F. Mueller, 1773)	+	–	–	–	–	–
Tubifex tubifex (Müller, 1774)	–	+	+	–	–	+
Aelosoma terebrarum Claparéde, 1880	–	+	–	+	–	–
Stilodrilus heringianus Vejdovský, 1862	–	+	–	–	–	–
Glossiphonia complanata (Linnaeus, 1758)	+	–	–	–	–	–
Haemopis sanguisuga (Linnaeus, 1758)	+	+	+	–	–	–
Erpobdella octoculata (Linnaeus, 1758)	+	–	+	–	+	–
Lymnaea stagnalis (Linnaeus, 1758)	+	–	–	+	–	–
Lymnaea Radix *auricularia* (Linnaeus, 1758)	+	–	–	–	–	–
Lymnaea Galba *truncatula* (Müller, 1774)	+	–	–	–	–	–
Planorbarius corneus (Linnaeus, 1758)	+	–	–	–	–	+
Planorbis planorbis (Linnaeus, 1758)	+	–	–	–	–	–
Anisus vortex (Linnaeus, 1758)	+	–	–	–	–	–
Physa fontinalis (Linnaeus, 1758)	+	–	+	–	–	–
Bithynia tentaculata (Linnaeus, 1758)	+	–	–	–	–	–
Anodonta cygnaea (Linnaeus, 1758)	+	–	–	–	–	–
Pisidium amnicum (Müller, 1774)	+	–	–	–	–	–
Sphaeriastrum (*Sphaeriastrum*) *rivicola* Bourguignat, 1854	+	–	–	–	–	–
Daphnia pulex Leydig, 1860	+	–	–	+	–	–
Asellus aquaticus (Linnaeus, 1758)	+	–	–	–	+	+
Acanthocyclops viridis (Jurine, 1820)	–	+	+	–	+	+
Argyroneta aquatic (Clerck, 1757)	+	+	–	–	+	–
Ephemeroptera fam. gen. sp.	+	+	+	+	+	+
Calopteryx splendens (Harris, 1782)	–	–	–	–	–	+
Nepa cinerea Linnaeus, 1758	+	–	–	–	–	–
Notonecta glauca Linnaeus, 1758	+	–	+	–	+	–
Dytiscus marginalis Linnaeus, 1758	+	–	–	–	–	–
Gyrinus natator (Linnaeus, 1758)	+	–	–	–	–	+
Hydrophylus piceus (Linnaeus, 1758)	–	+	–	–	+	–
Hydrochara caraboides (Linnaeus, 1758)	+	–	–	+	–	+
Chironomus plumosus (Linnaeus, 1758)	+	+		+	+	+
Simuliidae gen. sp.	+	+	+	+	+	–
Plumatella fungosa Pallas 1768	+	–	–	+	–	–
Plumatella repens (Linnaeus, 1758)	+	–	–	+	–	–
All taxa	32	10	8	11	9	9

Sphaeriastrum rivicola, Planorbis planorbis, Planorbis (Coretus) corneus, Gordius aquaticus, Pisidium amnicum, Haemopis sanguisuga, Ephemeroptera fam. gen. sp., *Herpobdella oc-toculata*, Simuliidae, *Pelomyxa palustris*, *Anodonta cygnaea, Calopteryx splendens, Anisus vortex, Glossiphonia complanata*). Nekton is represented by 5 taxa *(Hydrochara caroboides, Hydrophylus piceus, Ditiscus marginalis, Notonecta glauca, Argyroneta aquatica)*, and plankton — by 7 taxa *(Ephiphanes senta, Acanthocyclops viridis, Daphnia pulex, Stilodrilus heringianus, Aelosoma terebrarum, Paramecium aurelia, Trachelis ovum)*. The smallest group was pleuston — only 2 taxa *(Nepa cinerea, Gyrinus natator)*, probably due to the rapid current in some plots. The abundance of benthos, periphyton and plankton is explained due to the presence of organic matter, which forms the rich breeding ground.

Detailed analysis of ecological groups in each plots revealed the presence of all the groups in TP 1. It is because there are optimal conditions for the development of meiobenthos. In TP 2 and TP 3 only benthic and planktonic organisms were found, while TP 4 and TP 5 periphyton organisms were marked. The reduction of hydrobionts ecological groups composition is due to the flow rate and gradual increase in anthropogenic load on the plots in the city center. Closer to the river mouth the level of anthropogenic load decreases, the aquatic invertebrate species composition and ecological diversity increases.

Analysis of aquatic organisms species composition make it possible to identify the following ecological complexes: psammoreophiles, litoreophiles, argilloreophiles, peloreophiles, fitoreophiles. According to our data, at the Gorodnichanka river peloreophileus prevail and are represented by 15 taxa *(Herpobdella octoculata, Haemopis sanguisuga, Plumatella repens, P. fungosa, Lymnaea stagnalis, L. auricularia, Chironomus plumosus, Physa fontinalis, Pisidium amnicum, Hydrophilus piceus, Daphnia pulex, Calopteryx splendens, Tubifex tubifex, Asellus aquaticus, Ephemera vulgata)*. This indicates that the Gorodnichanka river has silted grounds. Psammoreophiles are presented by 7 taxa (*Pisidium amnicum, Anodonta cygnea, Planorbarius corneus, Ephemera vulgata, Lymnaea auricularia, Haemopis sanguisuga, Dytiscus marginalis)*. Both litoreophiles *(Plumatella repens, P. fungosa, Lymnaea stagnalis, L. auricularia, Physa fontinalis, Asellus aquaticus, Pisidium amnicum, Nepa cynerea)* and argilloreophiles *(Ephemera vulgata, Chironomus plumosus, Anodonta cygnea, Herpobdella octoculata, Haemopis sanguisuga, Nepa cynerea, Gyrinus natator, Calopteryx splendens)* include 8 taxa. Fitoreophiles are represented by 11 taxa (*Hydra oligactis, Lymnaea stagnalis, L. truncatula, Planorbarius corneus, Pisidium amnicum, Argyroneta aquatica, Dytiscus marginalis, Calopteryx splendens, Notonecta glauca, Hydrophylus piceus, Hydrochara caraboides).*

In the spring season in all plots peloreophiles group dominates. In TP 1 representatives of all ecological groups were registered, with peloreophiles prevalence. In TP 2 and TP 5 equal number of psammoreophiles, argilloreophiles, peloreophiles, fitoreophiles were registered. During summer psammoreophiles prevail. In the autumn season peloreophiles prevail. Seasonally the number of species of peloreophiles is relatively stable, and they are present in almost all of the plots that may be indicative of the state of the river bottom. During all seasons due to the congestion of the city center, in the river there occurs accumulation of silt deposits, which is the breeding ground for peloreophiles.

Trophic specialization study of the Gorodnichanka river invertebrates showed the presence of three groups: filter feeders, phytophages and zoophages (Table 2). In the hydrobionts trophic structure zoophages zoophagesprevails — 16 taxa, it is associated with high organic content. Phytophages are represented by 14 taxa due to the presence of aquatic and semi-aquatic plants. Filtrators are not numerous, but their presence indicates that there are processes of self-cleaning of the river. Analysis of each test plot showed that in all plots there are zoophages, herbivores and filter feeders. Plots with well-developed vegetation settle better, especially in TP 1, where the level of anthropogenic loads is less.

To assess the quality of the water and the ecological status of the Gorodnichanka river we

T a b l e 2. — The trophic structure of the Gorodnichanka river aquatic invertebrates

T а б л и ц а 2. — Трофическая структура водных беспозвоночных реки Городничанка

Filtrators	Zoophages	Phytophages
Daphnia pulex	*Gordius aquaticus*	*Lymnaea stagnalis*
Simuliidae gen. sp.	*Herpobdella octoculata*	*Lymnaea auricularia*
Ephiphanes senta	*Haemopis sanguisuga*	*Lymnaea truncatula*
Plumatella fungosa	*Dytiscus marginalis*	*Planorbis (Coretus) corneus*
Plumatella repens	*Nepa cinerea*	*Planorbis planorbis*
Sphaeriastrum rivicola	*Hydra oligactis*	*Bithynia tentaculata*
Pisidium amnicum	*Gyrinus natator*	*Tubifex tubifex*
Anodonta cygnaea	*Pelomyxa palustris*	*Chironomus plumosus*
—	*Acanthocyclops viridis*	*Hydrochara caraboides*
—	*Notonecta glauca*	*Paramecium aurelia*
—	*Stilodrilus heringianus*	*Trachelis ovum*
—	*Aelosoma terebrarum*	*Asellus aquaticus*
—	*Ephemeroptera*	*Physa fontinalis*
—	*Calopteryx splendens*	*Anisus vortex*
—	*Argyroneta aquatica*	—
—	*Glossiphonia complanata*	—
8	16	14

used Mayer index. Indicator groups of invertebrates were allocated in the Gorodnichanka river. Based on these results it can be stated that the Gorodnichanka river refers to water bodies of the 3d class of water quality. In the samples indicator groups of polluted water dominated — 6 groups (Lymnaeidae, Oligocheta, Asellus aquaticus, Simullidae, Chironomidae, Hirudinea). Also there were organisms of the average level of pollution — Planorbidae and Odonata larvae as well as indicators of clean water — Bivalvia and Ephemeroptera larvae. The index value is different on different plots. The highest value of the index is on TP 1, it has the lowest degree of anthropogenic load. Water quality in the test plots is worsening gradually from the first point, which is located outside the residential zone, to plots located in the centre of the city, where the anthropogenic load becomes maximum. In this part of the city there are a number of old collectors (household and rain), sewerage system, which overflows during heavy rains and causes river pollution. Deterioration of quality of the water also affects the improvement of the territory, population density, traffic intensity, which in this area is very intense. The most polluted is TP 3. But from the fifth plot the water quality is improving, human pressure is gradually decreasing.

Thus, the aquatic invertebrates species composition of the Gorodnichanka river is represented by 39 taxa. In the Gorodnichanka river live invertebrates, belonging to 5 ecological groups: benthos, nekton, plankton, pleuston, periphyton and 3 trophic groups: filter feeders, phytophages and zoophages with prevalence of zoophages. Assessment of the river status with Mayer index showed that the water in the Gorodnichanka river is moderately dirty. The problem of the Gorodnichanka river "environmental remediation" is one of the most important problems of Grodno, not only environmental, but also urban.

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Резюме

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ЭКОЛОГИЧЕСКИЙ АНАЛИЗ СОСТАВА И СТРУКТУРЫ СООБЩЕСТВ ВОДНЫХ БЕСПОЗВОНОЧНЫХ РЕКИ ГОРОДНИЧАНКА (ГРОДНО, БЕЛАРУСЬ)

Среди водотоков самыми многочисленными и наименее изученными водными объектами являются малые реки, режим которых формируется специфичными условиями регионов. Малые реки в городах являются неотъемлемой частью городского ландшафта. В городе Гродно (Беларусь) река Городничанка протекает через центральную часть урбанизированного ландшафта и выполняет не только экологическую, но и градообразующую функции.

Видовой состав беспозвоночных гидробионтов реки Городничанка представлен 39 таксонами. В ней обитают беспозвоночные, относящиеся к 5 экологическим группам — бентосу, нектону, планктону, плейстону, перифитону, — и 3 трофическим группам: фильтраторам, фитофагам и зоофагам с преобладанием зоофагов (16 таксонов). Среди

экологических групп водных беспозвоночных доминируют бентосные организмы — 16 таксонов. Ближе к устью реки уровень антропогенной нагрузки уменьшается, а видовой состав гидробионтов увеличивается. Уменьшение состава экологических групп гидробионтов объясняется скоростью течения, постепенным возрастанием антропогенной нагрузки в центре города. Анализ видового состава гидробионтов позволил выделить следующие экологические комплексы: псаммореофилы, литореофилы, аргиллореофилы, пелореофилы, фитореофилы. В реке Городничанка преобладают пелореофилы, представленные 15 таксонами.

Для оценки качества воды и экологического состояния реки Городничанка использован индекс Майера. Выявлены индикаторные группы беспозвоночных-гидробионтов в реке Городничанка, на основании которых можно отметить, что исследуемый водоток относится к водным объектам 3-го класса качества вод, умеренно грязным. Качество воды на пробных площадках ухудшается плавно от первого участка, который находится вне жилой зоны, к участкам, располагающимся в центре города, где антропогенная нагрузка максимальная. В пробах на площадках в центре города преобладали индикаторные группы загрязнённых водоёмов. Начиная с пятой площадки качество воды улучшается, антропогенная нагрузка постепенно уменьшается.