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# Species diversity of unionid mussels (Mollusca: Bivalvia: Unionidae) as a bioindicator of the state water environment of river basins of Ukraine

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**Abstract.** Species diversity and frequency index of bivalve mollusks' of unionid family are researched within river basins of Ukraine. The largest frequency index of mussels is identified in the Prypiat and Desna basins (84 and 79% respectively), then (as the indicator declines) – the Dnieper and Severskiy Donets basins (74 and 67%), the Southern Bug and Danube (47 and 46%), the Southern and Western Bug (47 and 28%), the Crimea (17%). No mollusks were found in the Azov basin at all. Most often (33%) there were found groups consisting of only three unpretentious species (*Unio pictorum*, *U. tumidus*, *Anodonta anatina*). In general, settlements from one to three species make up 70% of all researched collecting sites. Settlements formed by four species are identified only in 23% of habitats. Only 6% of settlements consisted of five aboriginal species and about 1% – of six. Locations where six species lived together were identified only in the Danube and Prypiat basins. There are no settlements of five species in the Western Bug and Desna basins at all, and there are not any even four species settlements in the Crimea. The obtained data can be used for organizing environmental activities and assessing water environment quality

## 1. Introduction

Researching bivalve mollusks of unionid family (Mollusca: Bivalvia: Unionidae) is becoming relevant around the world and Europe [1, 2]. These species are really essential for bioindication of water environment condition. Information about their dissemination can be used for decision-making regarding water resources management, for organizing environmental activities and assessing water environment quality. They can supplement existing data [3]. Unionid mussels are sensitive to anthropogenic changes of hydrocenosis and are already recommended for protection in many European countries [4-9].

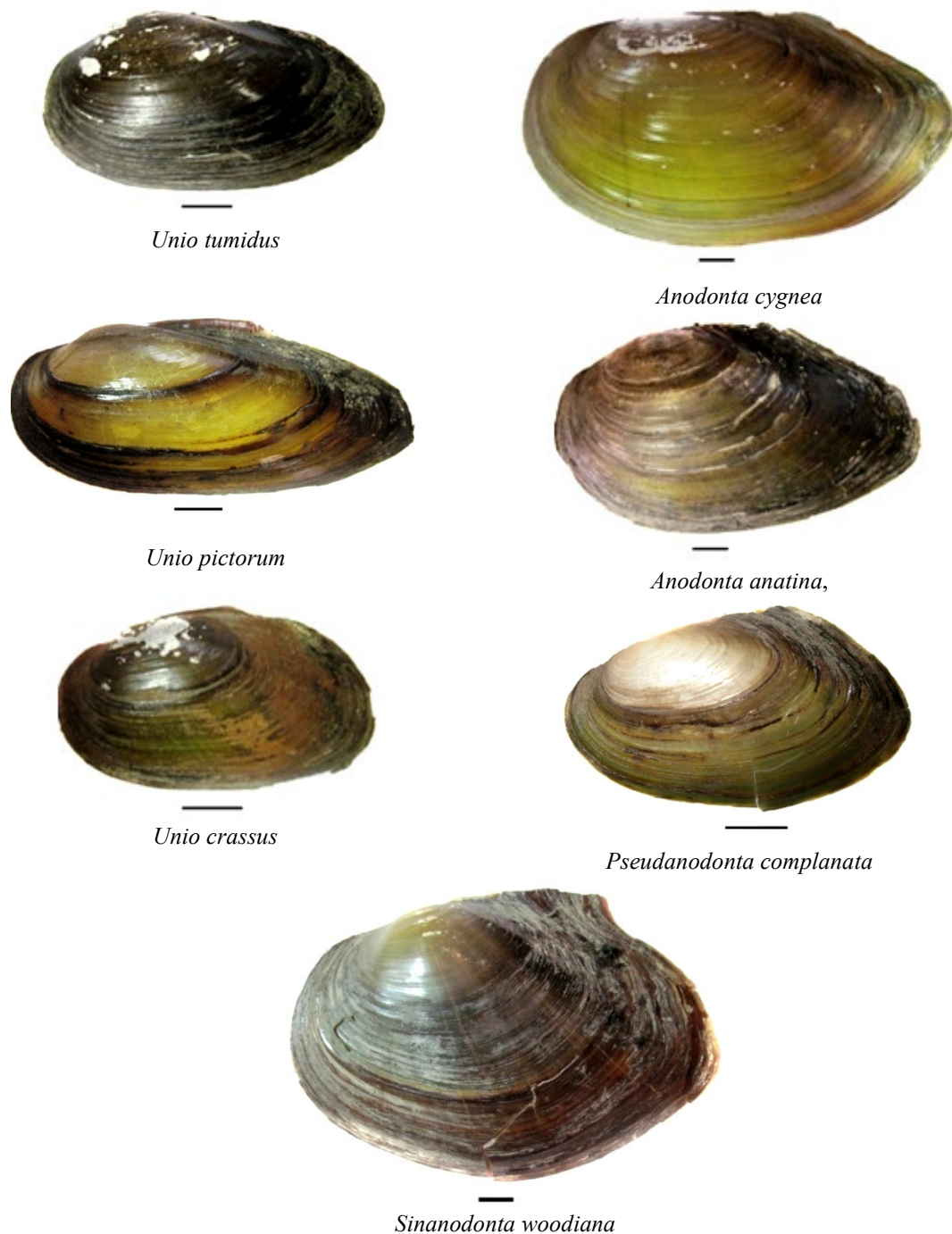
Developing methods for bioindication of water environment in accordance with the Water Framework Directive [10] in Ukraine is becoming an increasingly significant issue. Bivalve mollusks, namely unionid mussels, are important species-indicators [11, 12]. Their existence in the hydrotape serves like a proof that water quality here at least corresponds to the third class. That is why these species' frequency index in a particular river basin can serve as indicator of its ecological condition. Moreover, identifying recommended for protection habitat-demanding species, (*Unio crassus* Philipsson, 1788, *Pseudanodonta complanata* Rossmassler, 1835 and *Anodonta cygnea* Linnaeus, 1758) in collecting sites, may at least indicate the second class of water quality. The more their habitats in a certain river basin are identified, the better its ecological condition is. A significant characteristic is the number of species found in the hydrotape. Such an analysis makes it possible to assess not only general river basin condition, but also specific location of the study.



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## 2. Material and methods

As the material for the research authors have chosen their own collection of unionid mussels, carried out in 2007-2019 within all river basins of Ukraine. Information about collected material is entered into international database [13]. Common methods of material collection (manually, at depths of 0.5 – 2.5 m) and species identification were used [14]. During the study bioethics norms were observed, releasing researched species back into the reservoir after the study. Six native species (*U. pictorum* Linnaeus, 1758, *U. tumidus* Philipsson, 1788, *U. crassus*, *A. anatina* Linnaeus, 1758, *A. cygnea* and *P. complanata*) and one adventive species (*Sinanodonta woodiana* Lea, 1834) were identified (Fig. 1). The latter is an invasive species [15, 16], and we have identified it only in the Danube basin.



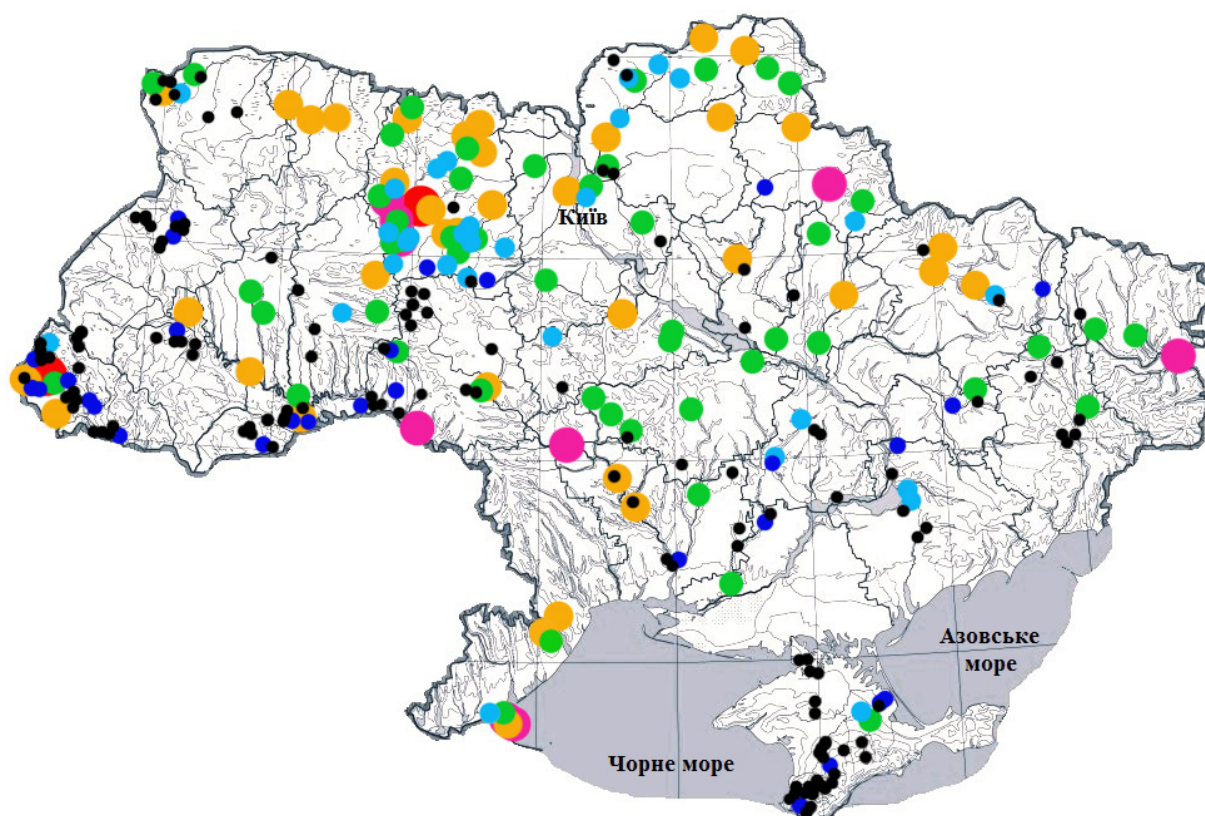
**Figure 1.** Material for the research (own authors' photos). Scale ruler 1 cm.

### 3. Research results

Until the XX century, unionid mussels were common in freshwater, they could be observed in large numbers along the entire coastline. In the regional faunal lists of the XIX – early XX centuries, at least four or even five or six species of unionid mussels' groups in each reservoir were indicated from the point of view of modern systematic approaches. And only in the foothill rivers they formed groups, represented only by foothill species *U. crassus*. It is clear that the larger species' family diversity is, the more stable it is.

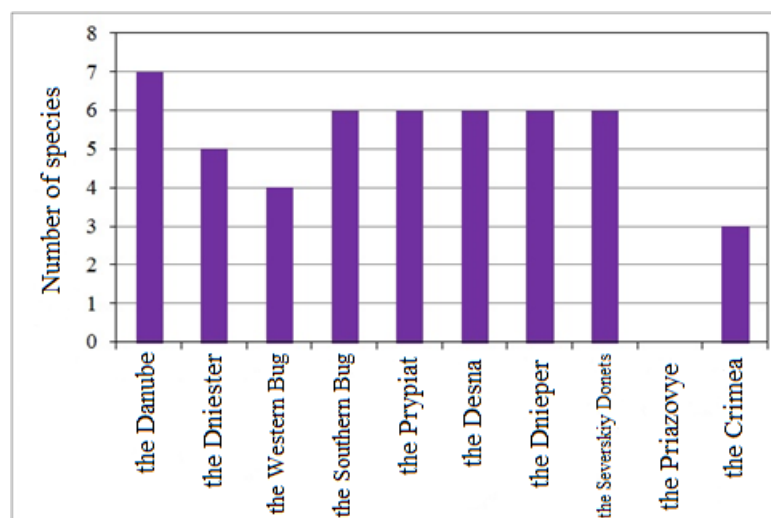
In different years (period 2007-2019) within all river basins of Ukraine, authors examined 302 habitats potentially suitable for bivalve mollusks. Unionid mussels were identified in only 54% of hydrotopes, which already indicates water quality in studied locations (Fig. 2). The situation had its differences within different river basins. The maximum number of species identified in one hydrotope was six. The obtained data are illustrated on the map of collecting sites and diagrams (Figs. 3, 4).

It is in the Danube basin where six species of mollusks (*U. pictorum*, *U. tumidus*, *U. crassus*, *A. anatina*, *P. complanata*, *S. woodiana*) were identified in one location (the Latorytsia river, Chabanivka, Zakarpattia region). It should be noted that only in the Danube basin, invasive species *S. woodiana* was identified simultaneously in seven sites. Frequency index for species, demanding water quality, indicated respectively: *U. crassus* – 22, *A. cygnea* – 2, *P. complanata* – 14%. Attention is called by relatively high indicator for *U. crassus* and too low for *A. cygnea*.

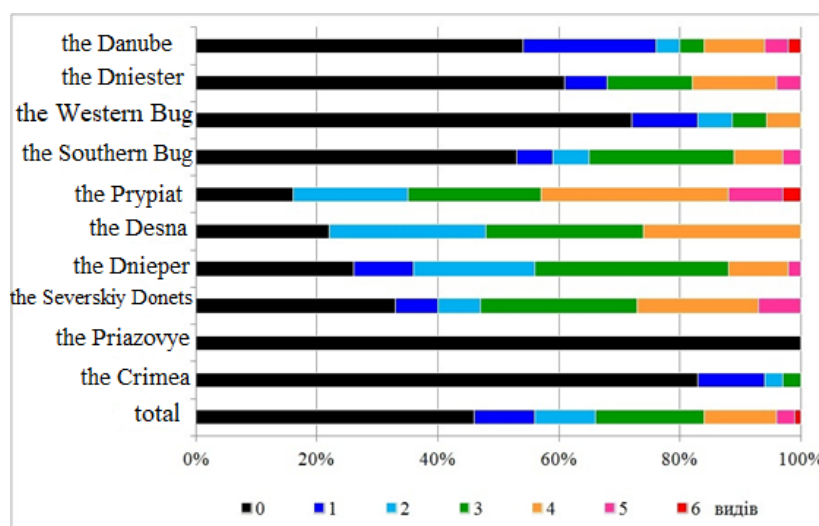


**Figure 2.** Number of aboriginal unionid mussels' species identified in collecting sites:

● - 6; ● - 5; ● - 4; ● - 3, ● - 2; ● - 1, ● - 0.



**Figure 3.** Number of unionid mussels' species identified in river basins.



**Figure 4.** The ratio of collecting sites number with different numbers of species in river basins of Ukraine.

In the Dniester basin in the collecting site of the Murafa river (near Vinnytsia region) the maximum number of mollusks species for this basin was identified, namely – five (*U. pictorum*, *U. tumidus*, *U. crassus*, *P. complanata*, *A. anatina*). In general, the prevalence of *U. crassus* in the basin was 12, *P. complanata* – 19%. Toothless *A. cygnea* wasn't identified in any collecting site, although its findings in recent years are known.

In the Western Bug basin, there are no settlements in which six and five species coexist. In general, in the Western Bug basin frequency index of malacocenoses is low. The best situation is in the lakes of Shatsk National Nature Park, where frequency index is approximately 43%. Frequency index of certain species in the Western Bug basin is one of the lowest among all river basins of Ukraine and estimates 17% for *A. cygnea*. Oxyphilic and rheophilic *P. complanata* and *U. crassus* have never been found here (although their findings are known from literature and from collection of B. Dybovsky Zoological Museum of Lviv Ivan Franko National University and Natural History State Museum of National Academy of Sciences of Ukraine). In the Southern Bug basin, five unionid mussels' species (*U. pictorum*, *U. tumidus*, *U. crassus*, *P. complanata*, *A. anatina*) were identified as a part of settlement in only one collecting site (the Southern Bug, Lupolove village, Kirovohrad region). For habitat-demanding toothless *A. cygnea*, frequency index was critically low (3%).

In Prypiat basin settlements were marked by the largest species diversity. In particular, simultaneously six unionid mussels' species (*U. pictorum*, *U. tumidus*, *U. crassus*, *P. complanata*, *A. anatina*, *A. cygnea*) were identified in one collecting site of the Tnya River (Sokoliv village, Zhytomyr Region). This is the only case from all 302 inspected sites of reservoirs and watercourses of Ukraine, where all aboriginal mollusks were found. It is in the Prypiat basin that the highest indicators rates are estimated for such species as: *U. crassus* – 41% and *P. complanata* – 31. One of the highest indicators is also for *A. cygnea* – 19% (although this number was correct until 2018, in recent years it has critically declined).

In the Desna basin, mollusks settlements, where there are six and five species, was not found at all. However, frequency index for *U. crassus* – 31% and *A. cygnea* – 19 is rather high in this basin. There is no location in the Dnieper basin where six Unionidae species coexist. The attention is called by too low frequency index for *P. complanata* (3%), *U. crassus* (6). Toothless *A. cygnea* lives in 20% of collecting sites. In the Severskiy Donets basin, six species were not found in any case, five – only in one collecting site (Severskiy Donets, Stanychno-Luhanske, Luhansk region). In general, rheophilic and oxyphilic *U. crassus* and *P. complanata* were identified in 13% of cases, and *A. cygnea* – 20 in this basin.

No unionid mussels were found in five observed sites in the Priazovye rivers, although such findings are known until the 1980s of the XX century. In the XXI century, there is also one report about identification of *U. tumidus*, *U. pictorum*, *A. cygnea* in the Molochnaya river [17].

Also, one of the lowest frequency indexes for unionid mussels was in the reservoirs and watercourses of the Crimea – 17%. Three species – *U. tumidus*, *U. crassus*, *A. anatine* – were identified in one site (the Karasivka river, Zhelyabivka) and it was the maximum number of species. Previously known malacocenoses groups of *U. pictorum* and *A. cygnea* were not found.

#### 4. Conclusions

To sum up, the largest frequency index of unionid mussels is identified in the Prypiat and Desna basins (84 and 79% respectively), then comes the Dnieper and Severskiy Donets basins (74 and 67%), the Southern Bug and Danube (47 and 46%), the Southern and Western Bug (47 and 28%), the Crimea (17%). Such indicators correlate with the level of water pollution and can be used to bioindicate their condition. Most often (33%) there were found groups consisting of only three species (mostly the most hardy and unpretentious species *U. pictorum*, *U. tumidus*, *A. anatina*).

In general, settlements from one to three species make up 70% of all researched collecting sites. Settlements formed by four species are identified only in 23% of habitats. Only 6% of settlements consisted of five and approximately 1% – from six unionid mussels. Locations where six species lived together were identified only in the Danube and Prypiat basins. There are no settlements of five species in the Western Bug and Desna basins at all, and there are not any even four species settlements in the Crimea.

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