

THE ECOLOGICAL AND ZOOGEOGRAPHICAL STRUCTURE OF THE ROVE BEETLE ASSEMBLAGES (COLEOPTERA: STAPHYLINIDAE) IN THE FLOODPLAINS OF THE LARGE PLAIN RIVERS (BY THE EXAMPLE OF BELARUS)

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Abstract. *The ecological group spectrum and zoogeographical structure of the rove beetle assemblages has been studied in the floodplain wetlands in Belarus. Results of the long-term studies are presented in the paper. The staphylinid assemblages in the forest and open floodplain ecosystems were selected. The dominant species composition was found out in wetlands of different types. The conception of forming of staphylinid assemblage species diversity in the river wetlands of Belarus was developed. It implies that staphylinid assemblage composition is defined, on the one hand, by the very labile and diverse group of the riparian species and open habitat species, among which the eurytopic hygrophilous and stenoecic wetland species prevail, and on the other hand by the relatively stable in its composition group of the floodplain forest species the core of which are eurytopic forest species. The species composition of the staphylinid assemblages in Byelorussian wetlands is historically relatively young and process of its forming is continuing intensively by means of penetration of the new species, which did not inhabited this territory.*

Keywords: *rove beetles, Belarus, floodplains, ecological groups, zoogeographical structure.*

Rezumat. Structura ecologică și zoogeografică a cenozelor de stafilinide (Coleoptera: Staphylinidae) în luncile râurilor mari (prin exemplul din Belarus). *Lucrarea prezintă spectrul ecologic și structura zoogeografică a cenozelor de stafilinide din luncile umede din Belarus, pe baza rezultatelor pe termen lung. S-au ales ecosistemele de pădure și de loc deschis. Studiul a început în 1996. Marea majoritate a speciilor s-a colectat prin metoda capcanelor Barber, cu lichid fixator. Speciile dominante se găsesc în habitate umede de diferite tipuri. Structura cenozei de stafilinide este definită de speciile ripariene și de locuri deschise, predominând speciile higrofile euritope și stenece și de speciile de pădure euritope. Procesul de formare a structurii și compoziției cenozelor de stafilinide este istoric, relativ tânăr, prin pătrunderea de noi specii.*

Cuvinte cheie: *stafilinide, Belarus, lunci, grupuri ecologice, structură zoogeografică.*

INTRODUCTION

Byelorussian territory is very rich in the water resources. More than 1 million 300 thousands hectares of bogs and fens (or 6.4% of the territory), 10 thousands of lakes and 20,800 rivers remains here in their natural state. The total length of rivers is 90.6 thousand kilometres (Fig. 1). The Byelorussian rivers belong to basins of two seas - The Baltic Sea and The Black Sea. The sources of the Neman, the large Baltic river basin, and the sources of the most of the left Pripyat tributaries, the Berezina River in particular, are situated on the Byelorussian territory. Almost the entire section of the Middle Pripyat runs in the center of the Polesye lowland in the south of Belarus. Therefore, river floodplains are a considerable part of Byelorussian landscapes.

Floodplain ecosystems are formed of a shifting mosaic of the aquatic, semiaquatic and terrestrial landscape elements. While these elements change their location, size and configuration over time, their entire abundance often remains constant. This phenomenon is referred to as "the shifting habitat mosaic" (STANFORD et al., 2005). In the conditions of such shifting habitat mosaic the exchange and transfer of matter exists what determines all matter and energy flow in the natural ecosystems. The flood regime control and river-bed canalization led to the loss of habitat mosaic, deceleration of the organic matter decomposition in some locations and to accumulation of organic matter in other locations. As a result, the natural process of biogenic elements exchange and its flow down to the stream is broken. The key to the quality assessment of the impact of habitat heterogeneity on the ecosystem processes is to understand the relationships between the heterogeneity and function of the river-floodplain system (LANGHANS et al., 2006). The important component for this understanding is the animal community, especially insects, in river landscape.

MATERIAL AND METHODS

The author's studies of Staphylinids in the river floodplains began in 1996. Main attention was focused on the floodplains of the large rivers of Belarus like the Pripiat, the Berezina and the Neman (Fig. 1). The most of the material was collected by pitfall trapping. Plastic cups with an opening diameter of 72 mm and a volume of 250 ml were used as pitfall traps. A formalin mixture (4 %) was used as a fixing agent. Separation of the species into the ecological groups was made using the data of Middle Europe (KOCH, 1989) and author's personal observations. The Gorodkov's classification and nomenclature was used for zoogeographical analysis (GORODKOV, 1984). Analysis of species distribution was carried out according to the Catalogue of Palaearctic Coleoptera (LÖBL & SMETANA, 2004).



Figure 1. The map of the river system in Belarus. Studied rivers are marked with thick lines.
 Figura 1. Harta rețelei cu râuri din Belarus. Râurile studiate sunt marcate cu linii groase.

RESULTS AND DISCUSSIONS

Based on the results, it is possible to assert that river floodplains are distinguished by the greatest staphylinid diversity among all other ecosystems. At the moment, the staphylinid species richness in the studied river floodplains is more than 350 species or about 45% of species of the family known from the Byelorussian territory. That staphylinid species richness is defined by the large habitat diversity in the floodplains. It is possible to distinguish staphylinid assemblages of open and forested ecosystems, also ephemeral habitats, for example, mushrooms and dung of wild and domestic animals.

The black alder forests and oak forests are dominant in the floodplains of the large rivers of Belarus. Also, hornbeam forests are widespread and ash forests occur in some sites. More than 100 staphylinid species are found in the floodplain forests. 15-20 staphylinid species form the core of staphylinid assemblages: *Acrotona fungi* (GRAVENHORST, 1806), *Philonthus decorus* (GRAVENHORST, 1802), *Staphylinus erythropterus* LINNAEUS, 1758, *Olophrum assimile* (PAYKULL, 1800), *O. fuscum* (GRAVENHORST, 1806), *Omalium caesum* GRAVENHORST, 1806, *Tachinus rufipes* (LINNAEUS, 1758), *Atheta sodalis* (ERICHSON, 1837), *Geostiba circellaris* (GRAVENHORST, 1806), *Drusilla canaliculata* (FABRICIUS, 1787), *Stenus humilis* ERICHSON, 1839, *Rugilus rufipes* GERMAR, 1836, *Othius punctulatus* (GOEZE, 1777), *Anthobium atrocephalum* (GYLLENHAL, 1827), *Gabrius osseticus* (KOLENATI, 1846), *Ischnosoma splendidum* (GRAVENHORST, 1806), *Quedius fuliginosus* (GRAVENHORST, 1802), *Myllaena minuta* (GRAVENHORST, 1806), *Anotylus rugosus* (FABRICIUS, 1775), *Zyras collaris* (PAYKULL, 1800), *Tachyporus transversalis* GRAVENHORST, 1806, *Ocypus nitens* (SCHRANK, 1781) and *Xantholinus tricolor* (FABRICIUS, 1787). Most of them are dominants and subdominants.

The highest staphylinid diversity was observed in the floodplain black alder forests. More than 60 species were found here. The species richness is lower in the hornbeam and ash forests. The list of species includes from 35 to 41 species. 24-31 species were found in the studied oak forests. Staphylinid species richness may be very high (60-70 species) in the floodplain broad-leaved forests like oak and hornbeam forests, in the cases, when the high habitat mosaic is observed. Floodplain oak forests occur frequently as raised islands among the open flat areas subjected to flooding. In such cases they are not only habitats of forest species but also refugia for species of open habitats for the period of flood. Therefore, staphylinid species diversity substantially increases in such oak forests during the spring and autumn.

The staphylinid species composition in the open habitats is more diverse in comparison with forests. Totally, more than 150 species were found in the open habitats. Every studied site was distinguished by particular species composition. Therefore, it is difficult to pick out any core of species as a basis of staphylinid assemblage. In the open habitats alternated with forest plots the following species were frequent: *Acrotona fungi*, *Philonthus micans* (GRAVENHORST, 1802), *Philonthus quisquiliarius* (GYLLENHAL, 1810), *Lathrobium geminum* KRAATZ, 1857,

Tetartopeus quadratus (PAYKULL, 1789), *Lathrobium fovulum* STEPHENS, 1833, *Stenus europaeus* PUTHZ, 1966, *S. expectatus* PUTHZ, 1965. On the floodplain meadows and fens the following species are common: *Ochtheophilum fracticorne* (PAYKULL, 1800), *Euaesthetus bipunctatus* (LJUNGH, 1804), *Platystethus nodifrons* MANNERHEIM, 1830, *Aleochara brevipennis* GRAVENHORST, 1806, *Atheta elongatula* (GRAVENHORST, 1802), *Amischa analis* (GRAVENHORST, 1802). It is possible to explain these considerable differences in the species composition by the high heterogeneity of open habitats, where microclimatic conditions in every site are much more variable in comparison with different forest habitats. Most of staphylinid species prefers a particular microhabitat and this preference is greater in comparison for example with carabids. Staphylinids are quite sensitive to the environment changes and so assemblage structure may be used for purposes of bioindication (BOHÁČ & FUCHS, 1991).

The core of ecological groups of the staphylinid assemblages in the forest habitats was composed by the eurytopic forest species, proportion of which was more than 40 % almost at all studied sites (Fig. 2). The dominant species like *Philonthus decorus*, *Staphylinus erythropterus*, *Othius punctulatus* were members of this group. In black alder forest, the dominants were stenoecic hygrophilous species inhabiting various wet forests types and other wetland habitats-*Olophrum assimile* and other species of the genus, for example, *O. fuscum*.

The proportion of eurytopic hygrophilous species inhabiting a wide variety of moist, but not wet habitats was high. The proportion of species of two other groups widely presented in all habitats, ubiquitous sensu lato and ubiquitous saprophiles, was from 8 to 14%. The first group included species inhabiting various forest and open habitats. For example, *Acrotoma fungi*, was dominant in almost all studied sites. The second group included species occurring anywhere because they live in the decayed organic remains or animal dung. Those included, for example, *Omalius caesum* GRAVENHORST, 1806 and *Omalius rivulare* (PAYKULL, 1789) that are found almost in all sites.

The characteristic feature of the staphylinid assemblages in forest habitats is the presence of those of the stenoecic forest species, which may be found almost exceptionally in forests. This group includes species living under tree bark (*Xylodromus testaceus* (ERICHSON, 1840)), and *Mycetoporus eppelsheimianus* FAGEL, 1968 inhabiting the forest litter. Eurytopic xerophilous and mesoxerophilous forest species were found even in swamped floodplain forests. These species-*Bryophacis crassicornis* (MÄKLIN, 1847), *Mycetoporus lepidus* (GRAVENHORST, 1806), *Stenus clavicornis* (SCOPOLI, 1763) and *Stenus geniculatus* GRAVENHORST, 1806 are typical for the dry coniferous forests and only single specimens were collected in floodplain sites.

In open habitats, the staphylinid ecological group composition differed substantially from that of forest habitats (Fig. 3). First of all, the number of ecological groups was higher here. The stenoecic wetland species dominated. Their proportion in many sites was higher than 30 %. As in the forest habitats, the substantial proportion of species in the staphylinid assemblages were eurytopic hygrophilous species, ubiquitous and ubiquitous saprophils.

Eurytopic wetland species were found out in all open habitats. Their proportion, as a rule, was a few times higher in comparison with forest habitats. In the open habitats, only eurytopic meadow species were found, for example, *Micropeplus porcatus* (PAYKULL, 1789) and *Philonthus cognatus* STEPHENS, 1832, also stenoecic ripicolous species like *Stenus intermedius* REY, 1884 or *Bisnius nitidulus* (GRAVENHORST, 1802), found primarily on the banks.

In some floodplain meadows the proportion of the eurytopic xerophilous species (*Acrotoma orbata* (ERICHSON, 1837), *Stenus circularis* GRAVENHORST, 1802, *Stenus clavicornis* (SCOPOLI, 1763)) was very high. It may be caused by hydrological regime peculiarities when meadows on sandy alluvial soil may dry up considerably in the summer. Thus, the staphylinid ecological group spectrum clearly reflects the forest and meadow habitat peculiarities and the habitat conditions for species in individual site.

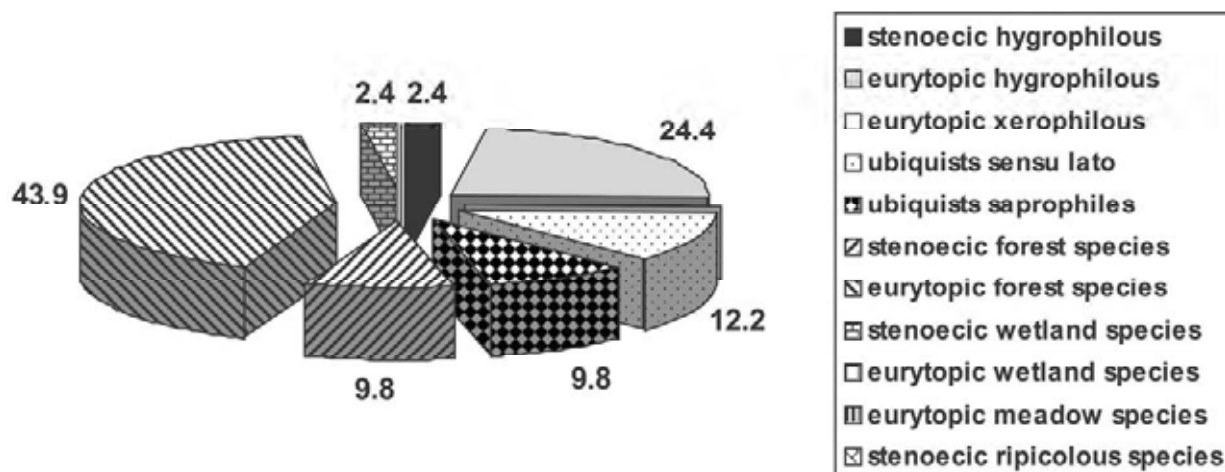


Figure 2. The proportion of the staphylinid beetles of different ecological groups in the forest ecosystems in the Pripjat river floodplain.

Figura 2. Proportia diferitelor grupe ecologice de stafilinide în ecosistemele de pădure din lunca râului Priapit.

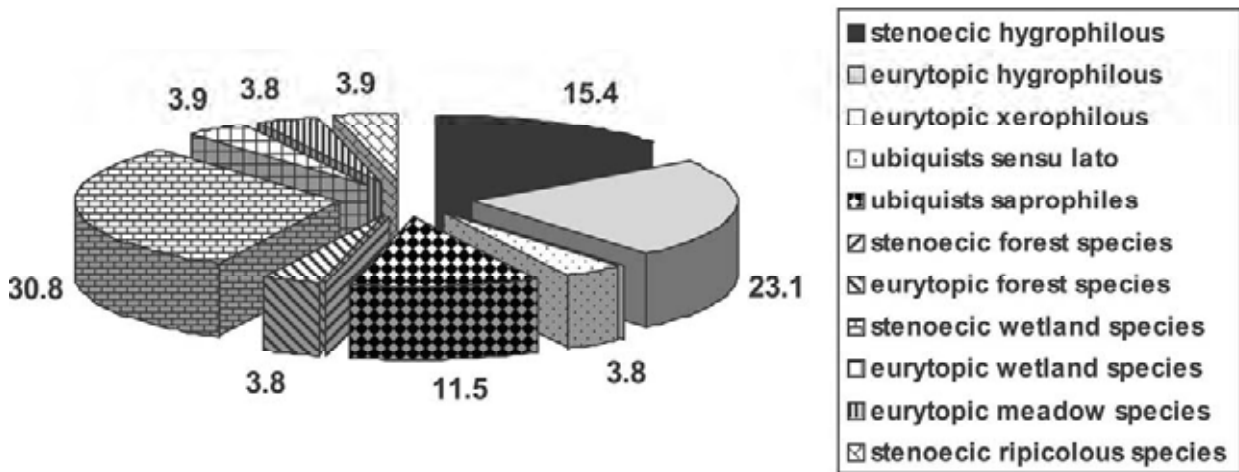


Figure 3. The proportion of the staphylinid beetles of different ecological groups in the open ecosystems in the Pripjat river floodplain.

Figura 3. Proportia diferitelor grupe ecologice de stafilinide în ecosistemele deschise din lunca râului Pripiat.

Based on the zoogeographical analysis of the rove beetle fauna in the wetlands in Belarus it was found that more than 80% of the species are distributed in the Palaearctic only (Fig. 4). Cosmopolitan species are 3.8%. This group is formed first of all from the species inhabiting the animal dung and decaying organic matter and which are independent of the concrete type of biocoenosis. These species may be found most often in the floodplains, in the meadows used like pastures.

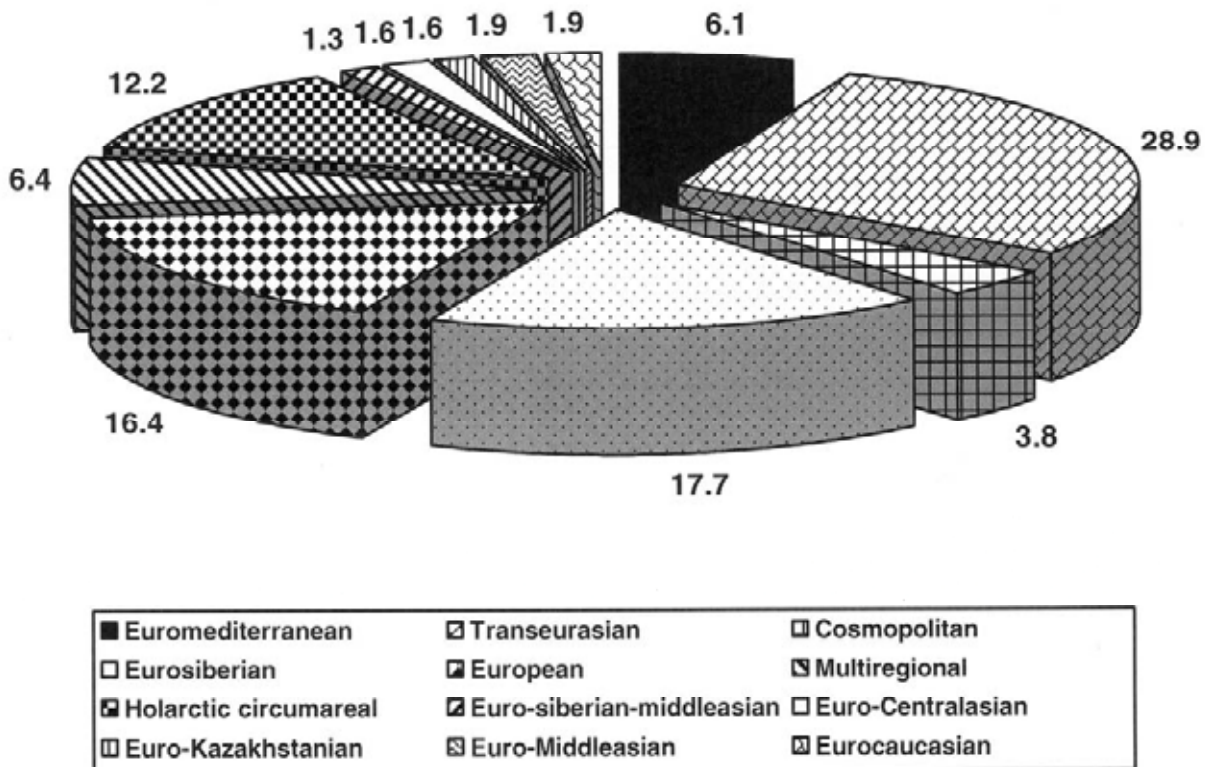


Figure 4. The zoogeographical structure of the rove beetle assemblages in the river floodplains on the Byelorussian territory.

Figura 4. Structura zoogeografică a cenozelor de stafilinide în luncile de pe teritoriul Belarus.

The portion of the circumholarctic species distributed in the Eurasia and North America is more than 12%. Many of them were unpremeditatedly introduced in the North America from Eurasia and expanded their area in that way. Almost two times less (6.4%) species with multiregional distribution were found. These species were distributed at least in 2 or more zoogeographical regions. Most of the studied multiregional species occur except the Palaearctic in the Oriental and Afrotropical regions. Some species are distributed in Neotropic and Australian regions, too. Many species

of this group like cosmopolitan species may be found in the decaying materials, for example, *Philonthus parvicornis* (GRAVENHORST, 1802) and *Anotylus rugosus*. At the same time, many species of this group were distributed in the river valleys, namely in the riverine ecosystems and illustrate the role of the river valleys as intrazonal corridors along which species penetrate to other regions. Such species are *Neobisnius procerulus* (GRAVENHORST, 1806), *Paederus fuscipes* CURTIS, 1826, some species of the genus *Carpelimus*. Ubiquist species *Ischnosoma splendidum* belong to that group too and they it may be found in the different types of ecosystems, in forests, in open biotopes.

Staphylinid assemblages in the river floodplains in Belarus originated from the species that survived the last glaciation and inhabit floodplains from refugiums. The main ways of staphylinid fauna forming maybe the same as for carabid beetles that are studied quite well on the Byelorussian territory (ALEXANDROVICH, 1995). The dispersion of the Westpalaeartic and European-Central-Asian riparian and fen species went along river floodplains from the Mediterranean, South-European and Middle-Asian refugiums. As a result the wetland staphylinid assemblages are very mixed by the zoogeographical composition and they include Euro-Mediterranean, Euro-Siberian-Middle-Asian, Euro-Central-Asian, Euro-Kazakhstanian, Euro-Middle-Asian and Eurocaucasian species.

The Euro-Mediterranean species complex comes to 6.1% and includes mostly riparian species, but also mycetophilous species like *Gyrophana lucidula* ERICHSON, 1837. The high proportion of species from that group is evidenced by the importance of Mediterranean Holocene refugiums in the forming of recent staphylinid fauna on the territory of Belarus.

The proportion of Euro-Central-Asian, Euro-Kazakhstanian, Euro-Middle-Asian, Euro-Siberian-Middle-Asian and Eurocaucasian species is very small. In general, it is a little more than 8%. Most species from that group belongs to subfamily Aleocharinae; their distribution requires accurate definition due to the incomplete data. Maybe some species from those groups are transpalearctic or even multiregional. But, now, the known distribution data may be evidenced by the small role of Middle-Asian refugiums in the forming of recent staphylinid fauna on the territory of Belarus.

River floodplains turned out to be the corridors for penetration of the Central-European and Caucasian species. For example, the species *Paederus limnophilus* ERICHSON, 1840 known only from the Central Europe was found in the Neman river floodplain. In the same place, it was found *Tachinus schneideri* LUZE, 1900 that was previously known as Caucasian endemic (ULLRICH, 1975). Now, this species is widely distributed in the Central Russia (NIKITSKY et al., 1998).

The base of staphylinid species assemblages in the wetlands are Trans-Eurasian, Euro-Siberian and European species. Their proportion was 28.9%, 17.7% and 16.4% accordingly. Some Trans-Eurasian species have Circum-Holarctic distribution, now, as a result of unpremeditated introduction to the American continent with agricultural production, planting material, soil etc. Some Euro-Siberian species inhabit bogs and fens that illustrate azonal character of their habitats.

CONCLUSIONS

The floodplains play the role of intrazonal corridors in the landscape along which it takes place the species migration and species penetration out of the zonal ecosystems. In the floodplain ecosystems an original complex of herpetobiotic insects is formed, among which we mention beetles, in particular rove beetles, which have an important place. In the floodplain ecosystems the diversity of rove beetles is higher than in zonal communities. Floodplain ecosystems in general, especially floodplain forests are key habitats for many rare species, including postglacial relicts.

On the basis of received results the conception of forming the species diversity of staphylinid assemblage in the river wetlands of Belarus was developed. It implies that staphylinid assemblage composition is defined, on the one hand, by the very labile and diverse group of the riparian species and open habitat species, among which the eurytopic hygrophilous and stenoecic wetland species prevail, and on the other hand, by the relatively stable in its composition group of the floodplain forest species, the core of which are eurytopic forest species. Species composition of the staphylinid assemblages in Byelorussian wetlands is historically relatively young and the process of its forming continues intensively by means of penetration of the new species which did not inhabited this territory.

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