

ELATERIDAE (COLEOPTERA: ELATERIDAE) FAUNA IN THE NADWIEPRZAŃSKI LANDSCAPE PARK

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Summary. In the years 2009–2011 the studies on the fauna of click-beetles of the selected plant communities in the Nadwieprzański Landscape Park were conducted. Together 20 species of Elateridae were recorded – 7 in mixed coniferous forests, 5 in lowland willow-poplar forests, 6 in dry ground forests, 4 in fresh meadows, 9 in wet meadows, 8 in psammophilic communities and 4 in mesoxerophilous communities. The click-beetle assemblage of the biotopes of the park had high species diversity ($d = 8.8$), but it was lower in individual biotypes (from 2.1 to 5.3). The most numerous species were: *Dalopium maginatus* ($D_5 = 15.6\%$), *Actenicerus siaelandicus* ($D_5 = 14.9\%$), *Agrypnus murinus* ($D_5 = 12.1\%$) i *Athous haemorrhoidalis* ($D_5 = 12.1\%$). In terms of zoogeographic classification, species with a broad range of occurrence predominated, much less was narrow-range species and the fewest intermediate-range species. Qualitative analysis with respect to habitat preferences and development microhabitats was also performed.

Key words: click-beetle, Elateridae, Nadwieprzański Landscape Park, Poland, species diversity, zoogeography, ecology

INTRODUCTION

The state of knowledge regarding the Elateridae fauna in the Nadwieprzański Landscape Park seems rather rudimentary. In the research carried out in the Park area in the fifties and seventies, only a few beetles from the Elateridae family were ascertained. The species reported in the neighbourhood of Kijany were: *Athous haemorrhoidalis*, *Synaptus filiformis*, *Ampedus pomorum*, *Agriotes obscurus* and *A. lineatus* [Strawiński 1954], whereas in Spiczyn *Agriotes ustulatus* and *A. obscurus* [Honczarenko 1970]. Milejów was another place where *Agriotes obscurus* and *A. sputator* were noted [Pawelska 1951].

Taking into account all the circumstances, in order to gather new information regarding Elateridae found within the protected areas of Lubelszczyzna,

research on click-beetles of the Nadwieprzański Landscape Park was undertaken. What it concerned was the faunistic-ecological characteristics of elaterofauna of the whole area of the Park and selected plant communities.

STUDY AREA

Nadwieprzański Landscape Park is located in central-eastern Poland, where two mesoregions meet: Świdnicki Plateau belonging to the Lublin Upland and the Dorohuckie Depression which is a part of the western Polesie macroregion [Kondracki 2000]. The Park extends 25 km from south-east to north-west and is distinctly elongated in shape. It gives shelter to the most valuable regions, in terms of natural environment and culture, of the central part of the Wieprz valley. What shapes the Park's landscape are physiographic qualities, whereas diverse habitat conditions prevailing in the Wieprz River valley have a significant impact on high diversity of vegetation [Wilgat 1990, Janiec and Rederowa 1992, Chmielewski 1998]. Forest formations accounting for 41.7% of the Park area are dominant. Meadows and pastures occupy 25.8% of the area, arable land 28.5%, and flowing waters 2.02% [Wilgat 1990].

Adult forms of Elateridae were collected from 11 study sites located in the following plant communities: mixed coniferous forests (*Quercus roboris-Pinetum*) (sites: 5, 8), riparian forests (from *Salicetum triandro-viminalis*) (sites: 3, 4, 7, 9, 10), broad-leaved forests (*Tilio-Carpinetum calamagrostietosum*) (sites: 2, 8, 9), fresh meadows (from *Molinio-Arrhenatheretea*) (sites: 6, 9, 11), marshy meadows (from *Molinio-Arrhenatheretea*) (sites: 1, 4, 6, 7, 10), psammophile communities (from *Koelerio glaucae-Corynephoretea*) (site 5) meso-xerothermic communities (from *Festuco-Brometea*) (site 10) (Tab. 1).

RESEARCH METHODS

The study of click-beetles of selected Park biotopes was carried out in the years 2009–2011. Research material was collected monthly beginning from mid April till the end of August. Adult beetles were gathered from herbaceous plants and shrubs with the use of an entomological net, where one quantitative sample consisted of 200 sweeps (4×50) in open biotopes, while in the closed ones (forests) it amounted to 250 sweeps (5×50). Another tool used was an entomological umbrella, with the help of which click-beetles were shaken down from the branches of 5 trees and/or bushes typical of a particular plant community, which constituted one quantitative sample.

The following indices were used for the analysis of the obtained material: dominance (D), constancy of occurrence in samples (C), ecological importance

(Q), Margalef index of species diversity (d) and qualitative similarity (J) of the elaterofauna of the studied communities according to Jaccard's formula I. The indices and the classes of their values were drawn on the study of Kasprzak and Niedbała [1981]. Analysis results were obtained with the use of the BiodiversityPro program [McAleece *et al.* 1997]. The ecological analysis with respect to the microbiotope of development and habitat preferences as well as zoogeographical analysis were provided. Classifications and descriptions included in the papers by Burakowski *et al.* [1985] and Tarnawski [2000] served as a basis to define the species belonging to particular zoogeographical elements and ecological groups.

RESULTS

As a result of conducted studies on click-beetles occurring in selected plant communities of the Nadwieprzański Landscape Park, 20 click-beetle species were reported. Elaterocenoses of the Park were characterised by the high value of species diversity indices ($d = 8.8$). The analysis of the quantitative share of particular species showed that four of them constituted 54.7% of all the beetles gathered, therefore, becoming eudominants. The most numerous were: *Dalopium maginatus* ($D_5 = 15.6\%$), *Actenicerus siaelandicus* ($D_5 = 14.9\%$), *Agrypnus murinus* and *Athous haemorrhoidalis* (12.1% each). The others occurred less numerously and belonged to three different dominant classes. The first class of dominants included 2 species which accounted for 17.0% of collected beetles. 7 species formed the class of subdominants constituting 23.3% of the beetles. The remaining 7 species were collected individually, forming a separate class of subprecedents whose quantitative share was 4.9% (Tab. 1). What is more, with the exception of *Actenicerus siaelandicus*, eudominants turned out to be the species collected most frequently. They were characterised by the highest values of the constancy of occurrence in samples index (Tab. 1).

According to the „C” value classes, those species could be placed in the group of the accessory ones. Other species collected less frequently which also belonged to that class were: *Cidnopus aeruginosus* and *Actenicerus siaelandicus*, *Ectinus aterrimus* and *Athous vittatus*. The remaining group of the species was less numerous and belonged to the class of accidents (Tab. 1). What determined the ecological significance of a given species was its number and frequency in the area under study. The values of the „Q” index are presented in Table 1.

Ecological analysis of Elateridae with respect to the microbiotope of development has shown that the elaterocenoses of the Park was primarily formed by the soil species. They were dominating in the qualitative share (80%), however, they were less numerous when the quantitative share was taken into account (63.8%). The second group comprised soil species frequently found in rotten

wood and their shares were respectively 20.0% and 36.2%. The shares of ecological groups based on their habitat preferences were as follows: forest ones 40% of qualitative and 51.1% quantitative, meadows and hygrophilous environments 25% and 21.9% respectively, xerothermic grasslands 20% and 12.1%, eurytopic species 15% and 14.9%.

The number of Elateridae species reported in the examined plant communities varied from 4 to 9, whereas the species diversity index of individual elaterocenoses had lower levels amounting from 2.1 to 5.3 (Tab. 1). The number of click-beetles in the communities was not considerable. The structure of the species number in the communities was rather similar. What could have been easily observed in all the click-beetle communities was the presence of one dominant species and a slight decrease in the number of the others, except for meso-xerothermic communities and riparian forests (Fig. 1).

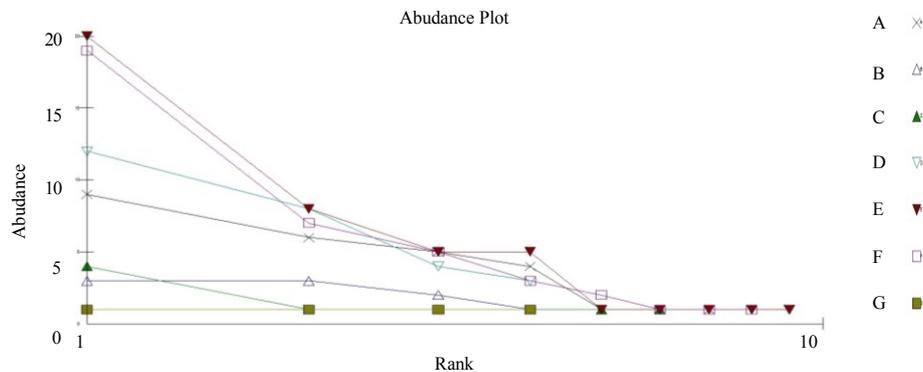


Fig. 1. The structure of species abundance of click-beetles in the examined plant communities in the Nadwieprzański Landscape Park (A – mixed coniferous forests, B – riparian forests, C – broad-leaved forests, D – fresh meadows, E – dry meadows, F – psammophile communities, G – meso-xerothermic communities)

In the open communities (non-forest areas) 16 species of Elateridae were reported. The largest number (9) was noted in the communities of moist meadows (Tab. 1). *Actenicerus sialeandicus* composed the major group (D = 46.5%). *Athous vittatus*, *A. haemorrhoidalis* and *Dalopius marginatus* (5–8 specimens) were less numerous. The elaterocenoses of moist meadows were constituted primarily by the species of a meadow and moist habitat as well as those occurring in the forests – 3 species each. Their quantitative shares were 51.2% and 41.9% respectively. Other reported species were eurytopic – two of them and one xerothermic. Around two-thirds of the collected species were exclusively soil specimens (41.9% of quantitative share). Psammophile communities turned out to take the second place in terms of the number of reported Elateridae taxa (Tab. 1).

Once more *Actenicerus sialeandicus* became the main species of the group (D = 47.8%). There were a few specimens of *Selatosomus aeneus*, *S. gravidus* and *Dalopius marginatus* gathered, whereas the remaining 4 species were collected individually. 3 forest species were reported (33.3% of quantitative share) as well as eurytopic and xerothermic ones – 2 of each (7.7% and 10.3% of quantitative share) and one more typical of meadows and moist habitats (48.7% of the specimen number). 6 species (75%) belonged to the group of the beetles undergoing their development in soil and their quantitative share amounted to 41%. The others represented soil species which could also develop in rotten wood. Fresh and meso-xerothermic meadows were communities inhabited by the smallest number of click-beetle species (Tab. 1). With the exception of *Actenicerus sialeandicus* (soil species which could also develop in rotten wood biotopes), both communities were inhabited by soil species. Elaterofauna of fresh meadows was formed by the following species: eurytopic, xerothermic and forest ones, among which the taxa inhabiting non-forest environments could be observed. 3 of the species in the xerothermic communities turned out to be typical of meadows and moist habitats and one inhabiting forests which could also be found in open biotopes.

In total, 12 Elateridae species were reported in the examined closed communities. Mixed coniferous forest was the community where the biggest number of species was found – 7 of them, 5 of which were forest ones (92.6% specimen) and 2 eurytopic. *Dalopius marginatus* predominated among them (9 specimens). The others occurred in small numbers – from 1 to 6 specimens. As far as quality is concerned, soil species were slightly predominating (4). There were 3 saproxylobiontic ones, though the number of their specimens was prevailing. One less species was reported in broadleaved forests (Tab. 1) and their number was distinctly low. Forest and soil species were most numerous. The characteristics of riparian forest elaterocenoses were similar. Among 5 recorded species, 2 were connected to forests, 2 to meadows and one of them was eurytopic. *Dalopius marginatus* was the only soil species occasionally developing in the rotten wood microbiotope, while the remaining ones belonged to the group of those undergoing development exclusively in the soil.

Elaterofauna of the studied plant communities demonstrated different levels of qualitative similarity (J). The scope of similarities varied from 9.1% (psammophile communities – xerothermic communities) to 44.4% (mixed coniferous forest – broadleaved forests). The system of similarities is presented by the dendrogram in Fig. 2.

Table 1. Occurrence of Elateridae species in study plant communities and at study sites in the Nadwieprzański Landscape Park

Species	D%	C%	Q%	Plant communities							Study sites										
				A	B	C	D	E	F	G	1	2	3	4	5	6	7	8	9	10	11
<i>Agrypnus murinus</i> (L., 1758)	12.1	22.2	16.4	+	+	+	+	+	+			+		+	+	+			+		
<i>Oedostethus quadripustulatus</i> (Fabr., 1792)	0.7	2.8	1.4					+									+				
<i>Cidnopus pilosus</i> (Leske, 1785)	8.5	5.6	6.9				+									+					
<i>Cidnopus aeruginosus</i> (OLIV., 1970)	8.5	13.9	10.9		+		+		+					+	+	+			+		+
<i>Hemicrepidius niger</i> (L., 1758)	2.8	8.3	4.8		+					+							+			+	
<i>Athous vittatus</i> (Gmelin, 1790)	5.0	11.1	7.4			+		+	+		+	+									
<i>Athous haemorrhoidalis</i> (Fabr., 1801)	12.1	22.2	16.4	+		+	+	+		+	+	+		+	+	+	+				
<i>Synaptus filiformis</i> (Fabr., 1781)	2.8	8.3	4.8		+			+				+					+			+	
<i>Actenicerus siaelandicus</i> (O.F. Müll., 1764)	14.9	13.9	14.4					+	+	+				+			+			+	
<i>Prosternon tessellatum</i> (L., 1758)	3.5	8.3	5.4	+											+			+			
<i>Selatosomus aeneus</i> (L., 1758)	2.1	5.6	3.4	+					+						+			+			
<i>Selatosomus gravidus</i> (Fabr., 1801)	2.1	2.8	2.4						+						+						
<i>Adrastus rachifer</i> (Foucroy, 1785)	0.7	2.8	1.4							+											+
<i>Dalopius marginatus</i> (L., 1758)	15.6	25.0	19.7	+	+	+		+	+		+				+			+	+		

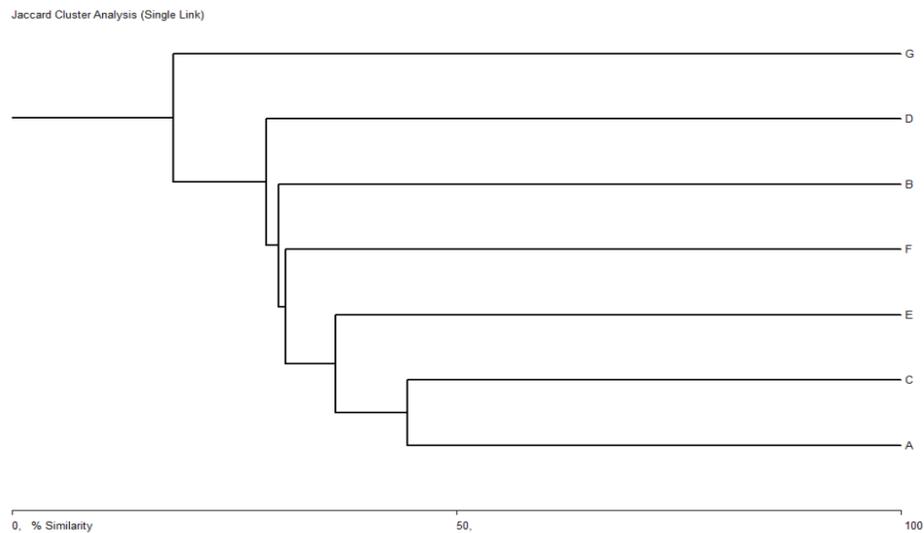


Fig. 2. Faunistic similarities between Elateridae of the examined plant communities in the Nadwieprzański Landscape Park (A – mixed coniferous forests, B – riparian forests, C – broad-leaved forests, D – fresh meadows, E – dry meadows, F – psammophile communities, G – meso-xerothermic communities)

With regard to zoogeographical features, elaterofauna of the Park was characterised by substantial qualitative and quantitative share of the wide-range species (75% and 80.1% respectively) and relatively low share of medium- (10% and 5.7% respectively) and narrow-range elements (15% and 14.2%). Wide range species were dominating in the elaterofauna of each examined plant community. Qualitative and quantitative shares of particular zoogeographical elements were as follows: holarctic 15% and 30.5%, palearctic 5% and 0.7%, Euro-Siberian 25% and 20.5%, Euro-Asian 30% and 28.4%, European 10% and 5.7%, Ponto-Mediterranean 10% and 13.5%, Mediterranean 5% and 0.7%.

DISCUSSION

The study on click-beetles of the Nadwieprzański Landscape Park allowed to record the presence of 20 species of the beetle in question and it still does not seem to be the final number. Conducting further research and expanding its area, which would take into account the microhabitats of species development, especially saproxylobiontic ones, would certainly contribute to the increase of the species reported. Compared to the number of click-beetle species recognised so far in the protected areas of Eastern Poland, of more or less similar habitat features, the recent figures are mostly lower. The same number of Elateridae

species found in moist communities of the Polesie National Park was provided by Pawłęga [2010a], whereas in the Kozłowiecki Landscape Park the number amounted to 28 species. Substantially more species (38) were distinguished in various biotopes of the „Lasy Janowskie” Landscape Park [Pawłęga 2003, 2004a, 2004b, 2010b, 2011a, Pawłęga and Kowalczyk-Pecka 2011]. However, in this case, research was conducted over an extended period of time and focused on a broader spectrum and larval stages. Another figure provided by Pawłęga [2011b] was 20 Elateridae species found in the area around the Bug River within the Włodawa-Kodeń section. It was shown that whenever biodiversity of Elateridae in the Nadwieprzański Landscape Park was compared to the biodiversity of adult specimens occurring in the areas of a broader spectrum of physiological features, the results were in favour of the second group mentioned. 55 species were reported by Burakowski [1979] in Pieniny, 55 in Bieszczady [Burakowski 1971] and 64 species in the upland areas of Roztocze [Burakowski *et al.* 1985].

What was shown by the analysis of the number of species was that the concentration of click-beetles in the studied area had the characteristics of a typical oligodominance which means that four most numerous species (*Dalopium maginatus*, *Actenicerus siaelandicus*, *Agrypnus murinus* and *Athous haemorrhoidalis*) accounted for 54.7% of all the specimens. In the above mentioned parks there was a considerable qualitative similarity of the eudominants occurring in the Nadwieprzański Landscape Park to the dominating group. The same species were dominant in the elaterofauna of the Polesie National Park [Pawłęga 2010a]. Two species mentioned in the first place turned out to be the eudominants of the Kozłowiecki Landscape Park, though *Agrypnus murinus* was also rather numerous [Pawłęga *et al.* 2012]. *Dalopium maginatus* and *Agrypnus murinus* became the eudominants in the above mentioned area of the Bug Valley as well [Pawłęga 2011b]. What influenced the similarity of natural characteristics of the compared parks were the qualitative similarities of the elaterofauna. 14 species reported in the Nadwieprzański Landscape Park were found in the area of the Kozłowiecki Landscape Park as well ($J = 41.2\%$), and as many as 19 in the „Lasy Janowskie” Landscape Park ($J = 48.7\%$). The highest qualitative similarity occurred with respect to the elaterofauna of the area around the Bug River – 60% (only 5 different species).

Despite the oligodominance, the elaterofauna of the Nadwieprzański Landscape Park was characterised by a high diversity of species. It was connected with the structure of the species number – high quantities of species appearing in the collected material in similar numbers, as well as with the diversity of the studied communities which, potentially, increased the chances of collecting the species having narrow habitat preference.

In the open communities of the Nadwieprzański Landscape Park, the number of adult Elateridae species ranged from 4 to 9. Respective communities of the compared areas showed from 5 to 18 species [Burakowski 1971, Pawłęga

2003, 2006, 2010a, 2010b, 2011b, Ścibior and Pawłęga 2000, Pawłęga *et al.* 2012]. Accordingly, fresh meadow and xerothermic communities of the Nadwieprzański Landscape Park were inhabited by the smallest number of species compared to the fresh meadow elaterofauna described in the quoted papers. They were also less diverse as far as the elaterofauna species were concerned. In the case of moist meadows, the number was similar or higher – in the Kozłowiecki Landscape Park only 5 Elateridae species were recorded. The structure of the ecological groups of elaterofauna in the open communities of the Nadwieprzański Landscape Park based on the development microbiotope was similar to the one occurring in other areas compared in the paper. Similarities concerning habitat preferences were easily noticeable in terms of moist meadows Elateridae, whereas in the case of fresh meadows they were much less visible [Pawłęga 2006, 2010b, 2011b, Pawłęga *et al.* 2012]. The diversity of Elateridae species inhabiting mixed coniferous and riparian forests of the Nadwieprzański Landscape Park was smaller than in the Lasy Janowskie Landscape Park [Pawłęga 2004b] and Kozłowiecki Landscape Park [Pawłęga *et al.* 2012], though higher in the case of broadleaved forests – Pawłęga *et al.* [2012] reported 4 species of adult specimens in the Kozłowiecki Landscape Park, whereas Nowakowski [1981] 5 of them in Białoleka Dworska.

Forest species as well as forest species occurring in open biotopes (in the paper presented as forest ones) predominated in the area of the Park and in most of the examined communities. Their dominance was connected to the structure of the Park's vegetation – predominating forest formations and their penetration. The presence of Elateridae in the open biotopes could be explained by the fact that they appear in the neighbourhood of forests. Another factor was the mobility of adult specimens. The shares of the remaining ecological groups divided on the basis of the habitat preferences in particular communities expressed their specificity. Similar relations characterised the shares of ecological groups in the Kozłowiecki Landscape Park and the Polesie National Park, though in the second park mentioned the share of meadow species was slightly higher than in the case of the forest ones [Pawłęga 2010a, Pawłęga *et al.* 2012].

Qualitative similarities of Elateridae groups in the examined plant communities, especially those most visible ones, could have been the result of some biotic and abiotic features of the communities which constitute the environment for particular species, as well as the fact that these communities occurred in close proximity, direct neighbourhood or even merged. Such a phenomenon was observed in the case of mixed coniferous forests merging with broadleaved forests, riparian forests neighbouring fresh and moist meadows as well as meadows placed in close proximity to the psammophile communities.

The dominating zoogeographical elements in the elaterofauna of the Nadwieprzański Landscape Park were those of a wide-range, followed by the narrow- and medium-range. A similar zoogeographical structure characterised the Elateridae

of the areas in the vicinity of the Bug River [Pawłęga 2011b]. The dominance of the wide-range elements was observed in the remaining areas compared, whereas the share of the other elements was the opposite [Pawłęga 2003, 2004a, 2004b, 2006, 2010a, 2010b, 2011a, Pawłęga and Kowalczyk-Pecka 2011, Pawłęga *et al.* 2012].

CONCLUSIONS

1. Species diversity of Elateridae of the Nadwieprzański Landscape Park at the present state of studies is rather low, however relatively high when compared to the protected areas of Poland of more or less similar habitat characteristics.

2. The number of the species reported in the Park does not include all the Elateridae species inhabiting the area. Continuing research and focusing on the larval specimens in their microhabitats would, potentially, contribute to the extension of the list.

3. The Elaterofauna of the Park was the reflection of the faunistic specificity of the region. The fact that Elateridae groups occurring in the Park were faunistically similar to the ones in other examined parks of Lubelszczyzna can serve as a proof of that statement.

4. What influenced the structure of the ecological click-beetle groups were biotic and abiotic features of a given plant community.

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SPRĘŻYKOWATE (COLEOPTERA: ELATERIDAE)
NADWIEPRZAŃSKIEGO PARKU KRAJOBRAZOWEGO

Streszczenie. W latach 2009–2011 prowadzono badania nad fauną sprężykowatych (Elateridae) wybranych zbiorowisk roślinnych Nadwieprzańskiego Parku Krajobrazowego. Łącznie odnotowano 20 gatunków Elateridae, w tym 7 w borach mieszanych, 5 w łągach, 6 w grądach, 4 na łąkach świeżych, 9 w wilgotnych, 8 w zbiorowiskach psammofilnych i 4 w mezokserotermicznych. Zgrupowanie sprężykowatych biotopów Parku cechowała duża różnorodność gatunkowa ($d = 8,8$), chociaż w poszczególnych zbiorowiskach była ona niższa (od 2,1 do 5,3). Dominantami były: *Dalopium maginatus* ($D_5 = 15,6\%$), *Actenicerus siaelandicus* ($D_5 = 14,9\%$), *Agrypnus murinus* ($D_5 = 12,1\%$) i *Athous haemorrhoidalis* ($D_5 = 12,1\%$). Pod względem zoogeograficznym przeważały gatunki o szerokim zasięgu występowania, dużo mniej było gatunków wąskiego, a najmniej średniego zasięgu. Przeprowadzono również analizę ekologiczną opartą na preferencjach siedliskowych i mikrobiotopie rozwoju.

Słowa kluczowe: sprężykowate, Elateridae, Nadwieprzański Park Krajobrazowy, Polska, zróżnicowanie gatunkowe, zoogeografia, ekologia