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Peculiarities of the ecology of Molytinae and Hyperinae (Curculionidae, Coleoptera, Insecta) of the Verkhovynsky national park and adjacent territories

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Abstract

The species composition and ecology of weevil beetles from the subfamilies Molytinae and Hyperinae (Curculionidae, Coleoptera, Insecta) of the Verkhovynsky National Nature Park and adjacent territories were studied. An areological analysis was conducted, the altitudinal gradient, features of ecology, trophic specialization, biotopic and ecotone distribution of the identified species were studied. The results of studies for 2002–2025 inclusive are presented. 27 species were identified, of which 2 species are new to the fauna of the Ukrainian Carpathians, 2 species are endemic to the Carpathians. The largest number of species was identified in mountain wet river meadows (15), the smallest in subalpine meadows (5). 8 of the 27 identified species of Molytinae and Hyperinae were found exclusively in one biotope. The studied biotopes differed significantly in the species complexes of Molytinae and Hyperinae. The most related species complexes of Molytinae and Hyperinae were dry mountain meadows on slopes (E) and the edge of the spruce virgin forest (D) (S = 72.73; K = 0.845). The least related were wet mountain river meadows (A) and spruce virgin forest (C) (S = 4.17; K = 0.080). An altitudinal gradient of the distribution of Molytinae and Hyperinae was found in the conditions of the Verkhovynsky National Park, but the negative linear correlation between the height of the stationary site and species richness was insignificant (ϱ = - 0.564). It was found that the correlation between the species richness of Molytinae and Hyperinae and altitude is nonlinear, which is explained by the dependence of the species richness of Molytinae and Hyperinae primarily on floristic complexes - the presence of food plants for certain species of Molytinae and Hyperinae, and then on temperature factors. Of the 27 identified species of Molytinae and Hyperinae, 11 species have Eurasian range variants, 11 species have European range variants, 2 species have an endemic Carpathian range, 2 species have a subarctic range, and 1 species has a West Palearctic range.

Keywords: Molytinae, Hyperinae, Curculionidae, Coleoptera, fauna, ecology.

1. Introduction

Molytinae and Hyperinae are two subfamilies of the weevil family (Curculionidae, Coleoptera, Insecta). More than 10,000 species of weevils of the Molytinae subfamily are known in the world fauna. More than 100 species of Molytinae are known in Ukraine. Many species of the Molytinae subfamily are associated with coniferous trees and are dangerous pests of forestry. The larvae of many species of Molytinae develop in rotten stumps of coniferous trees, adult beetles of the same species damage coniferous trees and can cause massive drying of trees. Other species of Molytinae are neutral to human activity, feed on various types of plants, the larvae of many species are soil-dwelling, feed on plant roots. Sometimes the subfamily Molytinae includes the subfamilies Cryptorhynchinae, Lixinae and Hyperinae, but in this work we followed the classification where they are separate subfamilies. Hyperinae is a subfamily of weevils, often called cocoon weevils due to the peculiarities of larval development. Hyperinae larvae feed on the surface of the leaves of fodder plants and weave a mesh cocoon before pupation. In temperate latitudes, the main, most numerous and diverse genus is Hypera (Germar, 1817). Today, more than 500 species and more than 40 genera of Hyperinae are known in the world fauna. More than 50 species of Hyperinae are known in Ukraine (Alonso-Zarazaga et al. 2017; Dvořáková et al. 2024; Galko et al. 2022; Germann 2012; Germann 2021; Harde et al. 1981).

The relevance of the work lies in the fact that among the weevils of the subfamilies Molytinae and Hyperinae there are many species that cause significant damage to forestry, and with mass reproduction they can cause mass drying of coniferous trees. In addition, as a result of global climate change, the entomofauna of mountain regions is changing, it is important to assess the state of mountain forest and open ecosystems, including the species composition and distribution of weevils - a group of beetles, which have the most diverse food specialization in feeding on different types of plants. The scientific novelty of the work lies in the fact that for the first time a comprehensive analysis of the fauna and ecology of Molytinae and Hyperinae of the Verkhovynsky National Nature Park has been carried out: an analysis of the biotope distribution, the altitudinal gradient of species complexes, and an areological analysis of the identified species have been carried out. The aim of the work was to investigate the fauna and ecology of Molytinae and Hyperinae (Curculionidae, Coleoptera, Insecta) of the Verkhovynsky National Nature Park and adjacent territories. The following tasks were subordinated to this aim: to investigate the species composition, biotopic and ecotonic distribution of the identified Molytinae and Hyperinae species, the altitudinal gradient of the distribution of Molytinae and Hyperinae species complexes, and to carry out areological and ecological analysis of the identified Molytinae and Hyperinae species in the conditions of the Verkhovynsky National Nature Park and adjacent territories.

The history of research into the fauna and ecology of weevils of the subfamilies Molytinae and Hyperinae of the Ukrainian Carpathians began with the works of (Nowicki 1869; Nowicki 1870; Lomnicki 1884; Roubal, 1936). A certain summary of the research into the fauna and ecology of weevil beetles can be found in the works of (Yunakov 2018), but many aspects of the ecology and fauna of Molytinae and Hyperinae of the Ukrainian Carpathians still remain insufficiently studied.

The fauna and ecology of Molytinae and Hyperinae of the Verkhovynsky National Nature Park has been extremely understudied due to the inaccessibility of the area, the destruction of roads by natural disasters, the border status and depopulation of the territory. The territory of the Verkhovynsky National Nature Park covers the mountain ranges of Chyvchyna and Hrynyava with numerous river valleys, various biotopes and ecotones at altitudes from 800 to 1769 m above sea level, including primeval forest ecosystems, which creates diverse conditions for the species richness of weevils of the subfamilies Molytinae and Hyperinae.

2. Materials and metods

The research was conducted in 2002–2025 inclusive. Collections of various researchers, mainly the authors of the article, were analyzed, which were carried out every year from April to September in different biotopes, ecotones and at different altitudes of the Verkhovynsky National Nature Park and adjacent territories. The collection was carried out by mowing on vegetation, tree crowns and manual collection. Dissection of beetles and identification of species were carried out by classical methods. The following biotopes were studied:

A – mountain river meadows.

B – beech forest.

C – spruce forest.

D – spruce forest edges.

E – dry meadows on mountain slopes.

F – mountain pine (*Pinus mugo*) forests.

G – subalpine meadows.

Species identification was carried out as described in [3, p. 256; 7, p. 210] taking into account modern research on the revision of the classification and species names of Curculionidae (Alonso-Zarazaga et al. 2017; Skuhrovec 2009; Skuhrovec et al. 2016; Yunakov et al. 2018). The Statistica 13.0 program was used for statistical analysis of the results obtained.

3. Results and discussion

As a result of the research conducted in the Verkhovynsky National Nature Park and in the adjacent territories, 27 species of weevil beetles of the subfamilies Molytinae and Hyperinae (Curculionidae, Coleoptera, Insecta) were discovered. The number of specimens found, sex and biotope or ecotone where specimens of the species were found, range and food specialization are indicated. Species new to the fauna of the Ukrainian Carpathians are marked with a *.

Molytinae

1. *Hylobius abietis* (Linnaeus, 1758) – 12 specimens, ♀♀♂♂, spruce primeval forest, mountain pine crooked forest, a species with a Eurasian asiodisjunctive polyzonal range. Feeds on spruce.

2. *Hylobius excavatus* (Laicharting, 1781) (= *Hylobius piceus* Laicharting, 1781) – 1 specimen, ♂, spruce primeval forest, species with Eurasian Asiatic disjunct polyzonal range. Feeds on conifers, mainly spruce.

3. *Hylobius pinastri* (Gyllenhal, 1813) – 4 specimens, ♀♀♂♂, spruce primeval forest, Alpine pine crooked forest, species with Eurasian Asiatic disjunct polyzonal range. Feeds on conifers.

4. *Leiosoma deflexum* (Panzer, 1795) – 1 specimen, ♀, riverside meadows, species with European polyzonal range. Feeds on plants of the Ranunculaceae family.

5. *Lepyrus capucinus* (Schaller, 1783) – 1 specimen, ♂, riverside meadows, species with a European polyzonal range. Feeds on willow and rosebushes.

6. *Liparus coronatus* (Goeze, 1777) – 1 specimen, ♂, riverside mountain meadows, on grass, species with a European-Caucasian-Kazakhstan polyzonal range. Feeds on plants of the Apiaceae family, including Daucus carota.

7. *Liparus germanus* (Linnaeus, 1758) – 1 specimen, ♂, riverside mountain meadows, on grass, species with a European polyzonal range. Feeds on plants of the Apiaceae family and the genus Petasites (Asteraceae).

8. *Liparus glabrirostris* Küster, 1849 – 10 specimens, ♀♀♂♂, riverside meadows, beech forest, dry meadows on mountain slopes, spruce forest, spruce forest edges, mountain pine forests, subalpine meadows. A species with a European montane range. It feeds on plants of the Petasites family (Asteraceae).

9. *Plinthus findeli* Boheman, 1842 – 2 specimens, ♂♂, riverside mountain meadows, dry mountain meadows on slopes, mowing. This species is endemic to the Carpathians. Food specialization is unknown, it probably feeds on plants of the *Plantago genus*.

10. *Plinthus sturmi* (Germar, 1824) – 3 specimens, ♂♂, beech forest, spruce forest, on forest litter. Species with a Central European polyzonal range. Larvae feed on the roots of plants of the Asteraceae family.

11. *Plinthus tischeri* Germar, 1824 – 1 specimen, ♂, beech forest, on beech leaves, species with a European non-moral range. Food specialization unknown.

12. *Pissodes harcyniae* (Herbst, 1795) – 1 specimen, ♂, spruce primeval forest, on spruce, species with a European boreal-montane range. Feeds on conifers.

13. *Pissodes piceae* (Illiger, 1808) – 1 specimen, ♂, spruce-fir primeval forest, on Abies alba, species with a European polyzonal range, feeds on Abies alba.

14. *Pissodes pini* (Linnaeus, 1758) – 2 specimens, ♀♂, spruce primeval forest, mountain pine forest, on spruce, on mountain pine. Species with a European-Siberian polyzonal range. Feeds on conifers.

15. *Pissodes piniphilus* (Herbst, 1797) – 1 specimen, ♂, mountain pine forest, on mountain pine, species with a European-Siberian polyzonal range, feeds on conifers.

Hyperinae

16. *Brachypera dauci* (A. G. Olivier, 1807) – 2 specimens, ♀♂, riverine mountain meadows, spruce forest glades, mowing, species with a European-Caucasian-Turanian polyzonal range. Feeds on plants of the Apiaceae family.

17. *Brachypera zoilus* (J. A. Scopoli, 1763) = *Hypera zoilus* Scopoli, 1763 – 11 specimens, ♀♀♂♂, riverine mountain meadows, beech forest, dry mountain meadows on slopes, spruce forest glades, mountain pine forests, subalpine meadows, on clover, mowing, species with a subarctic polyzonal range (accidentally introduced to North America, where it has become widespread). Feeds mainly on clover.

18. *Hypera arator* (C. Linnaeus, 1758) – 4 specimens, ♀♀♂, mountain river meadows, dry mountain meadows on slopes, spruce forest edges. Species with a European polyzonal range. Feeds on plants of the family Caryophyllaceae.

19. *Hypera carpathica* Petri, 1901 – 1 specimen, ♀, dry mountain meadows on slopes, species with an endemic Carpathian range. Nutritional specialization unknown.

20. *Hypera conmaculata* (J. F. W. Herbst, 1795) – 1 specimen, ♀, mountain river meadows, species with a Eurasian asiodisjunctive polyzonal range. Feeds on plants of the family Apiaceae.

21. *Hypera miles* Stephens, 1829* = *Hypera pedestris* (Paykull, 1792) – 1 specimen, ♀, mountain river meadows, species with a European-Siberian polyzonal range. Feeds on plants of the Fabaceae family.

22. *Hypera nigrirostris* (Fabricius, 1775) = *Phytonomus contaminates* Schoenherr, 1826 – 9 specimens, ♀♀♂♂, mountain river meadows, dry mountain meadows on slopes, spruce forest glades, subalpine meadows, species with a West Palearctic polyzonal range. Accidentally introduced to North America and Japan. Feeds on plants of the Fabaceae family.

23. *Hypera ovalis* Boheman, 1842 – 7 specimens, ♀♀♂♂, mountain river meadows, beech forest, dry meadows on slopes, spruce forest edges, subalpine meadows. Species with a European montane range. Feeds on plants of the Fabaceae family.

24. *Hypera postica* (L. Gyllenhal, 1813) – 5 specimens, ♀♀♂, mountain river meadows, beech forest, dry mountain meadows on slopes, spruce forest edges. Species with a subarctic asiodisjunctive polyzonal range. Accidentally introduced to North America. Feeds on plants of the Fabaceae family.

25. *Hypera (Eririnomorphus) rumicis* (Linnaeus, 1758) = *Phytonomus rumicis* Schoenherr, 1826 – 15 specimens, ♀♀♂♂, riverine mountain meadows, beech forest, dry mountain meadows on slopes, spruce forest glades, mountain pine forests, subalpine meadows, a species with a Eurasian polyzonal range. It feeds on plants from the family Polygonaceae and the genus Rumex.

26. *Hypera striata* (Boheman, 1834)* = *Phytonomus striatus* Boheman, 1834 – 1 specimen, ♀, mountain riverine meadows, mowing. A species with a European non-moral range. It feeds on plants from the family Fabaceae.

27. *Hypera viciae* (L. Gyllenhal, 1813) – 3 specimens, ♀♀, mountain river meadows, dry mountain meadows on slopes, spruce forest glades. Species with Eurasian asiodisjunctive polyzonal range. Feeds on plants of the Fabaceae family.

The biotopic and ecotone distribution of the identified species of Molytinae and Hyperinae in the conditions of the Verkhovynsky National Nature Park and adjacent territories is given in Table 1. The species richness of the investigated biotopes and ecotones of the study area for Molytinae and Hyperinae is given in Fig. 1.

Table 1. Biotopic distribution of the identified species of weevils of the subfamilies Molytinae and Hyperinae in the conditions of the Verkhovynsky National Nature Park and adjacent territories. The designations of biotopes and ecotones are given in the section "Materials and Methods".

№	Species	Biotopes and ecotones						
		A	B	C	D	E	F	G
	Family Molytinae							
1	*Hylobius abietis* (Linnaeus, 1758)			+			+	
2	*Hylobius excavatus* (Laicharting, 1781)			+				
3	*Hylobius pinastri* (Gyllenhal, 1813)			+			+	
4	*Lepyrus capucinus* (Schaller, 1783)	+						
5	*Leiosoma deflexum* (Panzer, 1795)	+						
6	*Liparus coronatus* (Goeze, 1777)	+						
7	*Liparus germanus* (Linnaeus, 1758)	+						
8	*Liparus glabrirostris* Küster, 1849	+	+	+	+	+	+	+
9	*Plinthus sturmi* (Germar, 1824)		+	+				
10	*Plinthus findeli* Boheman, 1842	+				+		
11	*Plinthus tischeri* Germar, 1824		+					
12	*Pissodes piceae* (Illiger, 1808)			+				
13	*Pissodes pini* (Linnaeus, 1758)			+			+	
14	*Pissodes piniphilus* (Herbst, 1797)						+	
15	*Pissodes harcyniae* (Herbst, 1795)			+				
	Родина Hyperinae							
16	*Brachypera zoilus* (Scopoli, 1763)	+	+		+	+	+	+
17	*Brachypera dauci* (Olivier, 1807)	+			+			
18	*Hypera rumicis* (Linnaeus, 1758)	+	+		+	+	+	+
19	*Hypera striata* (Boheman, 1834)	+						
20	*Hypera nigrirostris* (Fabricius, 1775)	+			+	+		+
21	*Hypera conmaculata* (Herbst, 1795)	+						
22	*Hypera miles* Stephens, 1829	+						
23	*Hypera carpathica* Petri, 1901					+		
24	*Hypera postica* (Gyllenhal, 1813)	+	+		+	+		
25	*Hypera viciae* (Gyllenhal, 1813)	+			+	+		
26	*Hypera arator* (Linnaeus, 1758)	+			+	+		
27	*Hypera ovalis* Boheman, 1842	+			+	+		+
Number of species identified		17	6	8	9	10	7	5

As we can see from the above data, the highest species richness of the Molytinae and Hyperinae species complexes was the ecotone of mountain wet riverside meadows (17 identified species), and the lowest was the biotope of subalpine meadows (5 identified species). The faunal relationship of the studied biotopes and ecotones of the Verkhovynsky National Nature Park, determined using the Jacquard (S) and Sørensen (K) criteria, is given in Table 2. The most related species complexes of Molytinae and Hyperinae were dry mountain meadows on slopes (E) and the edge of the spruce virgin forest (D) (S = 72.73; K = 0.845). The least related were the wet mountain river meadows (A) and the spruce virgin forest (C) (S = 4.17; K = 0.080) (Fig. 2, 3).

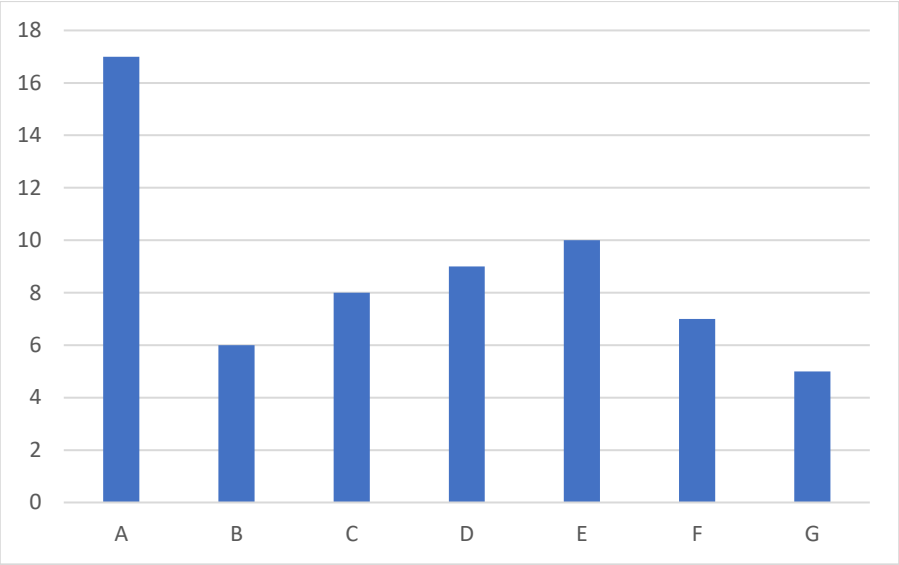

Fig. 1. Species richness of the studied biotopes and ecotones of the Verkhovynsky National Nature Park and adjacent territories for Molytinae and Hyperinae. The number of identified species is shown. The designation of biotopes and ecotones is as in the "Materials and Methods" section.

Table 2. Faunal affinity of different biotopes and ecotones of the Verkhovynsky National Nature Park according to the species complexes Molytinae and Hyperinae according to the Jaccard (S) criterion (%, right, top) and Sørensen (K) (bottom left). The designation of biotopes and ecotones is indicated above.

	A	**B**	**C**	**D**	**E**	**F**	**G**
A	-	21.11	4.17	52.94	50.00	14.29	29.41
B	0.348	-	16.67	36.36	33.33	30.00	37.50
C	0.080	0.286	-	5.88	5.88	36.36	8.33
D	0.692	0.533	0.118	-	72.73	23.08	55.56
E	0.667	0.500	0.111	0.842	-	31.43	50.00
F	0.250	0.462	0.533	0.375	0.353	-	33.33
G	0.455	0.545	0.154	0.571	0.667	0.500	-

The altitudinal gradient of the distribution of species complexes of Molytinae and Hyperinae in the conditions of the Verkhovynsky National Nature Park and adjacent territories was studied. For this purpose, the average height of the study stations (insect trapping) within each biotope or ecotone was calculated and a correlation analysis was conducted with the species richness of Molytinae and Hyperinae of each studied biotope/ecotone. The results of these studies are presented in Table 3 and Fig. 4, 5. As can be seen from the presented results, an altitudinal gradient of the

distribution of Molytinae and Hyperinae in the conditions of the Verkhovynsky National Park was revealed, but the negative linear correlation between the height of the station and species richness is insignificant (ϱ = - 0.564) (Table 3, Fig. 4). The correlation is actually nonlinear (Fig. 5), which is explained by the dependence of the species richness of Molytinae and Hyperinae primarily on floristic complexes - the presence of food plants for certain species of Molytinae and Hyperinae, and then on temperature factors.

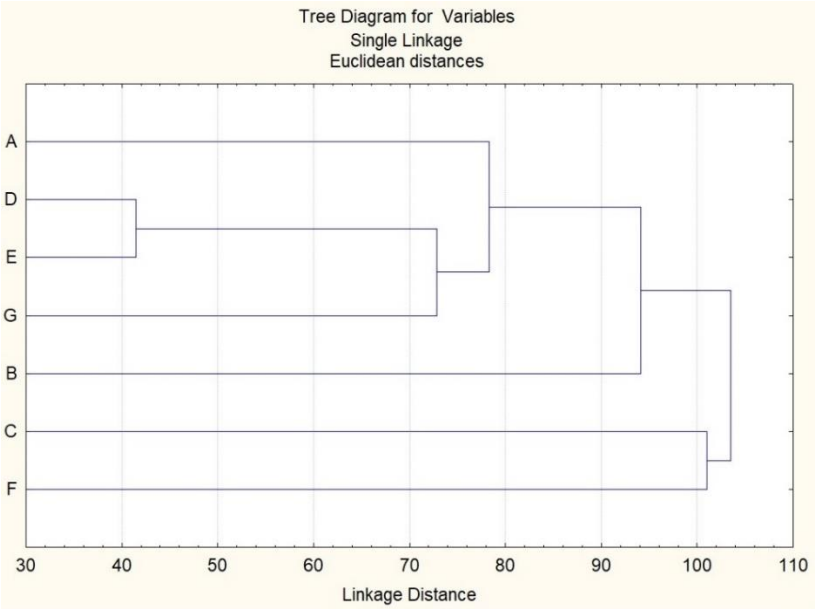

Fig. 2. Dendrogram of faunal affinities of biotopes and ecotones of the Verkhovynsky National Nature Park and adjacent territories by species complexes Molytinae and Hyperinae, constructed on the basis of the definition of the Jaccard criterion. Conventional units, Euclidean distances. Designation of the studied biotopes and ecotones as in the section "Materials and Methods".

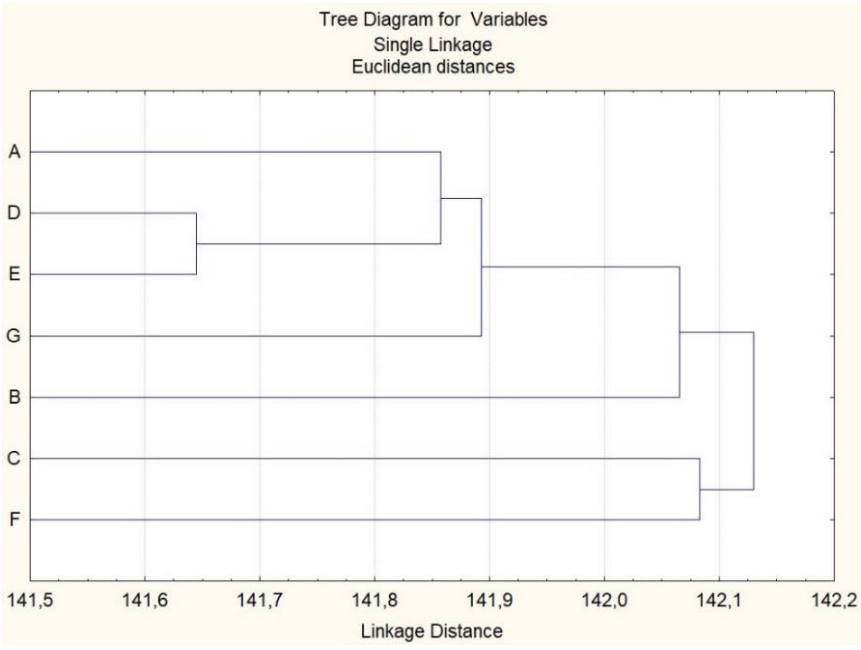

Fig. 3. Dendrogram of faunal affinities of biotopes and ecotones of the Verkhovynsky National Nature Park and adjacent territories by species complexes Molytinae and Hyperinae constructed on the basis of the definition of the Sørensen criterion. Conventional units, Euclidean

distances. Designation of the studied biotopes and ecotones as in the section "Materials and Methods".

Table 3. Altitude gradient of the distribution of Apioninae and Entiminae species in the conditions of the Verkhovynsky National Nature Park. The average height of the studied biotopes above sea level (taking into account collection points and research stations) is shown.

№	Biotopes and ecotones	Average altitude of study sites above sea level (m)	Number of species identified
1.	A	969	17
2.	E	1079	10
3.	B	1100	6
4.	C	1250	8
5.	D	1270	9
6.	F	1350	7
7.	G	1483	5
	ϱ		- 0.564

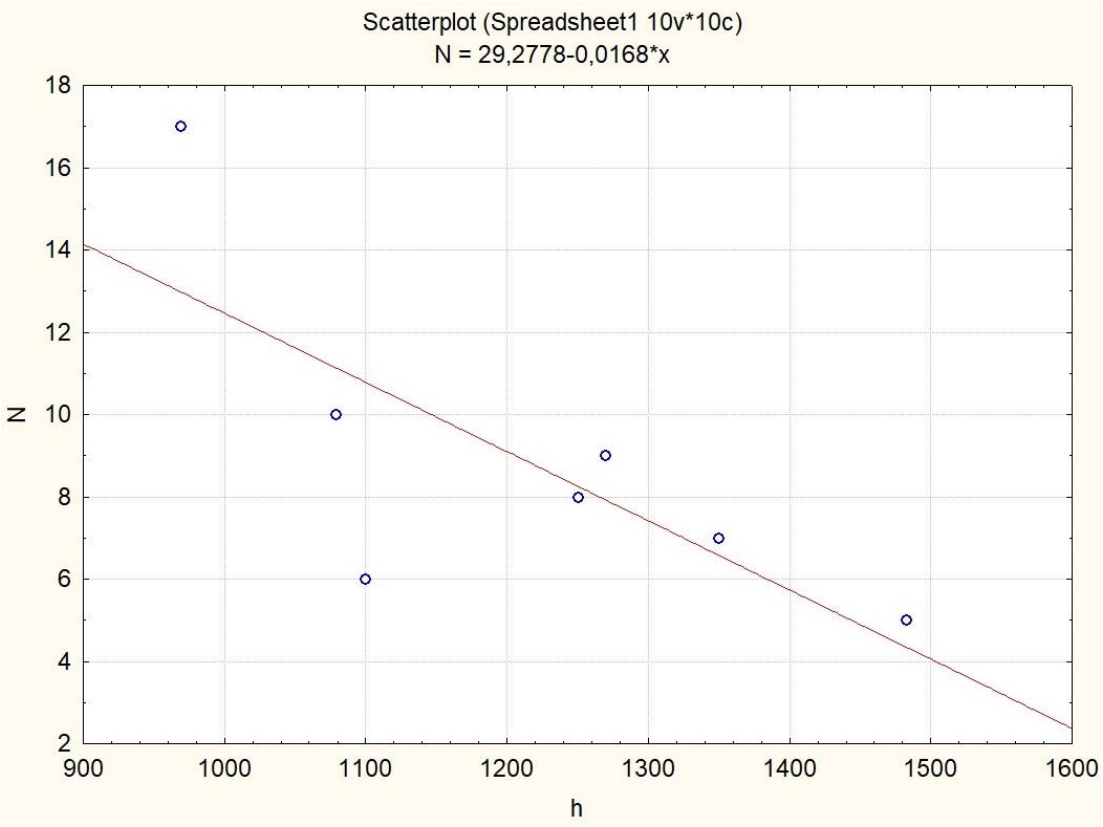

Fig. 4. Linear correlation between the average elevation of study sites within specific biotopes and ecotones and the species richness of Molytinae and Hyperinae (ϱ = - 0.564).

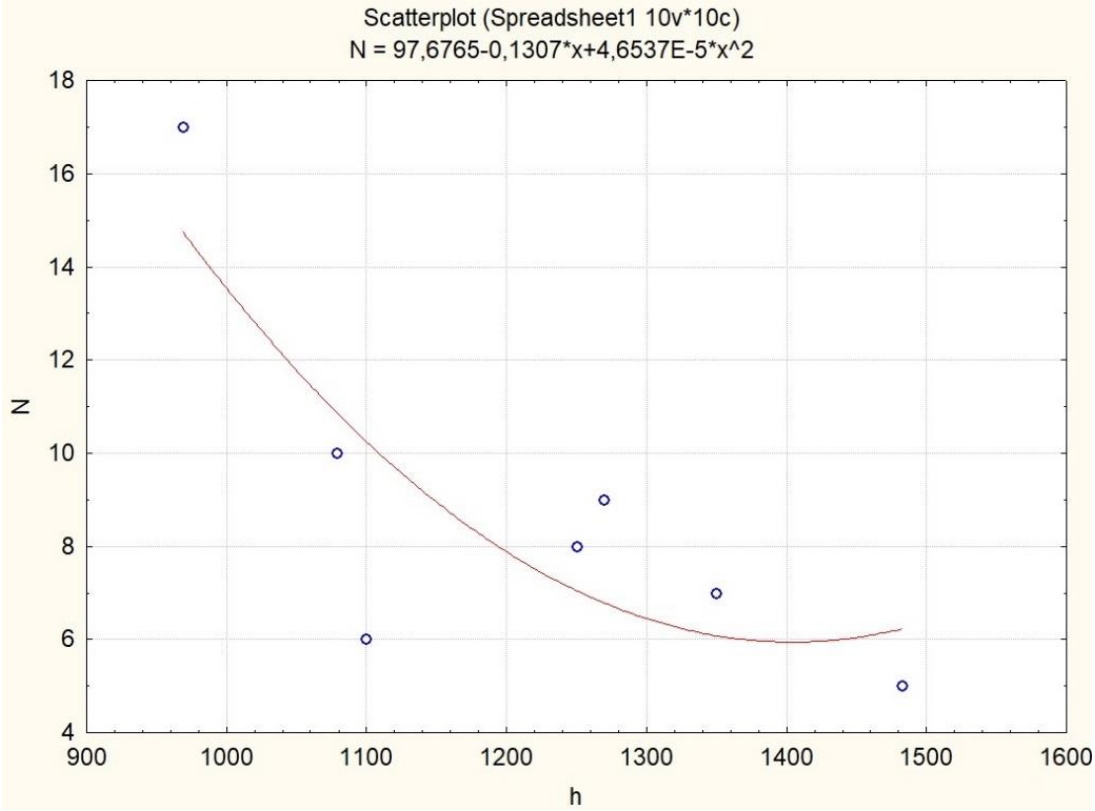

Fig. 5. Nonlinear (polynomial) correlation between the average elevation of study stations within specific biotopes and ecotones and the species richness of Molytinae and Hyperinae.

4. CONCLUSIONS

1. In the Verkhovynsky National Nature Park and adjacent territories, 27 species of weevils from the subfamilies Molytinae and Hyperinae were found, of which 2 species are new to the fauna of the Ukrainian Carpathians, 2 species are endemic to the Carpathians.

2. In the Verkhovynsky National Nature Park and adjacent territories, the largest number of species was found in mountain wet river meadows (15), the smallest number in subalpine meadows (5).

3. In the Verkhovynsky National Nature Park and adjacent territories, 8 out of 27 identified species of Molytinae and Hyperinae were found exclusively in one biotope.

4. The studied biotopes differed significantly in the species complexes of Molytinae and Hyperinae. The most related species complexes of Molytinae and Hyperinae were dry mountain meadows on the slopes (E) and the edge of the spruce virgin forest (D), the least related were wet mountain river meadows (A) and spruce virgin forest (C).

5. The altitudinal gradient of the distribution of the species complexes of Molytinae and Hyperinae is nonlinear. The reason for this is primarily the presence of different forage plants for Molytinae and Hyperinae at different altitudes.

6. Of the 27 identified species of Molytinae and Hyperinae, 11 species have variants of the Eurasian range, 11 species have variants of the European range, 2 species have an endemic Carpathian range, 2 species have a secondary arctic range and 1 species has a western palearctic range.

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Declarations

Conflict of interest. The authors have no competing interests to declare relevant to this article's content.

Research involving human participants and/or animals. All mouse protocols were approved by the Animal Experimental Committee of Vasyl Stefanyk Carpathian National University and were

conducted in accordance with the Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes. The current study complies with the ARRIVE Guidelines for reporting in vivo experiments (https://arriveguidelines.org/arrive-guidelines).

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Бевзюк ЮД, Сіренко АГ. (2026) Особливості екології Molytinae та Hyperinae (Curculionidae, Coleoptera, Insecta) Національного природного парку «Верховинський» та прилеглих територій. *Журнал Прикарпатського національного університету імені Василя Стефаника. Біологія* 13.

Досліджено видовий склад та екологію жуків-довгоносиків з підродин Molytinae та Hyperinae (Curculionidae, Coleoptera, Insecta) Національного природного парку «Верховинський» та прилеглих територій. Проведено ареологічний аналіз, досліджено висотний градієнт, особливості екології, трофічної спеціалізації, біотопічного та екотонного розподілу виявлених видів. Наведено результати досліджень 2002 – 2025 рокі включно. Виявлено 27 видів, з них 2 види нових для фауни Українських

Карпат, 2 види ендеміків Карпат. Найбільше виявлено видів на гірських вологих прирічкових луках (15), найменше на субальпійських луках (5). 8 з 27 виявлених видів Molytinae та Hyperinae зустрічались виключно в одному біотопі. Досліджені біотопи суттєво відрізнялись по видовим комплексам Molytinae та Hyperinae. Найбільш спорідненими по видовим комплексам Molytinae та Hyperinae виявились сухі гірські луки на схилах (E) та узлісся ялинового пралісу (D) (S = 72,73; K= 0,845). Найменш спорідненими виявились вологі гірські прирічкові луки (A) та ялиновий праліс (C) (S = 4,17; K= 0,080). Виявлено висотний градієнт розподілу Molytinae та Hyperinae в умовах Національного парку «Верховинський», але негативна лінійна кореляція між висотою стаціонару та видовим багатством виявилась незначна (ϱ = - 0,564). Виявлено, що кореляція між видовим багатством Molytinae та Hyperinae та висотою над рівнем моря носить нелінійний характер, що пояснюється залежністю видового багатства Molytinae та Hyperinae в першу чергу від флористичних комплексів – наявності кормових рослин для певних видів Molytinae та Hyperinae, а потім уже від температурних факторів. З 27 виявлених видів Molytinae та Hyperinae 11 видів мають варіанти євразійського ареалу, 11 видів варіанти європейського ареалу, 2 види мають ендемічний карпатський ареал, 2 види вторинноголарктичний ареал і 1 вид західнопалеарктичний ареал.

Ключові слова: Molytinae, Hyperinae, Curculionidae, Coleoptera, фауна, екологія.