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DIVERSITY AND SYNECOLOGICAL STRUCTURE OF EPIGEIC BEETLE COMMUNITIES IN THE STRICTLY PROTECTED AREA OF THE “CODRII” SCIENTIFIC RESERVE

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Abstract: This paper presents the results of a study on the diversity of epigeic beetles in a sessile oak (*Quercus petraea*) forest mixed with small-leaved lime (*Tilia cordata*) and common ash (*Fraxinus excelsior*) located in the strictly protected area of the „Codrii” Nature Reserve. A total of 48 species, belonging to 25 genera and 5 families, were identified, and their taxonomic composition, trophic structure, and synecological characteristics were analyzed. The results highlight the characteristic species of the forest ecosystem and document the occurrence of several rare species included in the Red Book of the Republic of Moldova.

Keywords: epigeic beetles, species diversity, synecological analysis, trophic structure, „Codrii” Nature Reserve

INTRODUCTION

Epigeic beetles represent an important component of forest entomofauna, playing a key role in organic matter decomposition, nutrient cycling, regulation of invertebrate populations, and maintenance of ecosystem functioning. Owing to their sensitivity to environmental changes, they are widely recognized as valuable bioindicators for assessing biodiversity and the conservation status of forest ecosystems.

The „Codrii” Nature Reserve preserves some of the most representative deciduous forest ecosystems in the Republic of Moldova, characterized by a high degree of naturalness and biological diversity [10]. The insect fauna of the reserve, including Coleoptera, has been documented in several studies [1-6; 9]. Investigating epigeic beetle communities provides valuable information on forest biodiversity and contributes to the scientific basis for the conservation and sustainable management of natural forest ecosystems.

MATERIALS AND METHODS

The study was carried out in the strictly protected area (Plot 48) of the „Codrii” Nature Reserve, within a sessile oak (*Quercus petraea*) forest mixed with small-leaved lime (*Tilia cordata*) and common ash (*Fraxinus excelsior*), characterized by a high degree of naturalness and minimal anthropogenic disturbance.

Epigeic beetles were collected during the vegetation period of 2024 using Barber pitfall traps. A total of 780 specimens, belonging to 48 species, 25 genera, and 5 families, were collected and analyzed. Species identification was performed using standard taxonomic keys and specialized literature [9, 13].

The structure of the beetle community was evaluated using the following synecological parameters: abundance (A), dominance (D), constancy (C), and the ecological significance index (W), according to the methods proposed by Simionescu [11] and Stan [12].

RESULTS AND DISCUSSION

A total of 780 epigeic beetle specimens, belonging to 48 species, 25 genera, and 5 families, were collected from the sessile oak (*Quercus petraea*) forest mixed with small-leaved lime (*Tilia cordata*) and common ash (*Fraxinus excelsior*) located in the strictly protected area (Plot 48) of the „Codrii" Nature Reserve using Barber pitfall traps. The family Carabidae was the most species-rich, comprising 29 species distributed among 13 genera, followed by Silphidae with 11 species from 6 genera, Scarabaeidae with 6 species from 2 genera, Lucanidae with 2 species from 2 genera, and Geotrupidae, represented by a single species (Table 1).

Table 1.

Taxonomic composition of epigeic beetles in the sessile oak forest mixed with small-leaved lime and common ash

Family	Genus	Species
Carabidae	13	29
Silphidae	6	11
Scarabaeidae	2	6
Lucanidae	2	2
Geotrupidae	1	1

Four rare and threatened beetle species included in the 3rd edition of the Red Book of the Republic of Moldova were recorded in the investigated forest ecosystem: *Carabus ullrichi* Germ., *Carabus violaceus* L., *Lucanus cervus* L., and *Oryctes nasicornis* L. The occurrence of these species highlights the conservation value of the strictly protected forest ecosystem.

The trophic structure of the epigeic beetle community was dominated by zoophagous species (24 species; 42%), followed by necrophagous (11 species; 20%), phytophagous (8 species; 16%), coprophagous (7 species; 12%), while mixophagous and xylophagous species were each represented by three species (5%) (Fig. 1). The predominance of zoophagous species is typical of well-preserved mature forest ecosystems and reflects the stability of trophic relationships within the investigated habitat

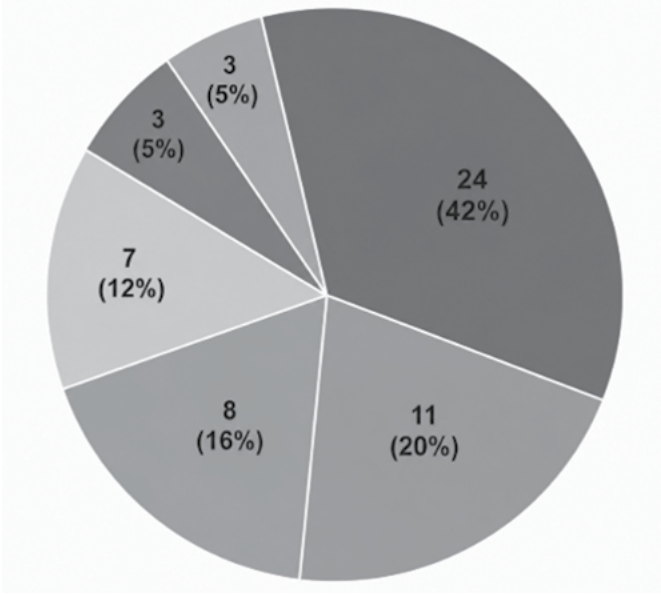

Fig. 1. Trophic structure of the epigeic beetle community in the sessile oak forest mixed with small-leaved lime and common ash

The analysis of analytical ecological indices, including abundance (A), dominance (D), and constancy (C), together with the ecological significance index (W), revealed a well-structured epigeic beetle community in the investigated forest ecosystem. The highest values of abundance and dominance were recorded for *Carabus coriaceus* (163 specimens; 20.90%) and *Necrophorus vespilloides* (159 specimens; 20.38%), both classified as eudominant species (D5). The dominant species (D4) were represented by *Carabus convexus* (42 specimens; 5.38%) and *Silpha carinata* (39 specimens; 5.00%), while the remaining community included 7 subdominant (D3), 10 recedent (D2), and 27 subrecedent (D1) species.

The highest constancy value was recorded for Carabus coriaceus (66.67%), classifying it as the only constant species (C3). Two species were classified as accessory (C2), whereas the remaining 45 species were considered accidental (C1).

The ecological significance index (W) identified *Carabus coriaceus* (13.94%) and *Necrophorus vespilloides* (5.76%) as the characteristic species of this forest ecosystem, belonging to categories W5 and W4, respectively. In addition, 12 species were classified as accessory species (W2–W3), whereas 34 species were considered accidental (W1) (Table 2).

Table 2.

Synecological analysis of epigeic beetle species in the sessile oak forest mixed with small-leaved lime and common ash in the strictly protected area of the "Codrii" Nature Reserve

Nr.	Species	A	D		C		W	
			%	Class	%	Class	%	Class
1.	*Carabus coriaceus*	163	20,9	D5	66,7	C3	13,94	W5
2.	*Necrophorus vespilloides*	159	20,38	D5	28,3	C2	5,76	W4
3.	*Carabus convexus*	42	5,38	D4	32,8	C2	1,76	W3
4.	*Silpha carinata*	39	5,00	D4	15,2	C1	0,76	W2
5.	*Phosphuga atrata*	36	4,61	D3	8,3	C1	0,38	W2
6.	*Nicrophorus investigator*	30	3,84	D3	9,1	C1	0,35	W2
7.	*Molops piceus*	27	3,46	D3	8,3	C1	0,28	W2
8.	*Carabus cancellatus*	25	3,20	D3	6,4	C1	0,20	W2
9.	*Pterostichus melanarius*	23	2,95	D3	6,4	C1	0,20	W2
10.	*Abax paralellus*	22	2,82	D3	8	C1	0,23	W2
11.	*Onthophagus fracticornis*	18	2,30	D3	5,3	C1	0,20	W2
12.	*Carabus excellens*	16	2,05	D2	8,5	C1	0,12	W2
13.	*Onthophagus coenobita*	14	1,80	D2	6,2	C1	0,11	W2
14.	*Abax paralellopipedus*	14	1,80	D2	6,4	C1	0,11	W2
15.	*Necrophorus vespillo*	13	1,67	D2	6,4	C1	0,1	W1
16.	*Ophonus gammeli*	11	1,41	D2	4,8	C1	0,07	W1
17.	*Onthophagus verticicornis*	10	1,28	D2	6,2	C1	0,06	W1
18.	*Onthophagus ovata*	9	1,15	D2	4,6	C1	0,03	W1
19.	*Brachinus crepitans*	8	1,03	D2	4,6	C1	0,03	W1
20.	*Onthophagus taurus*	7	0,90	D2	6,2	C1	0,04	W1
21.	*Oiceoptoma thoracica*	7	0,90	D2	4,8	C1	0,03	W1
22.	*Carabus arcensis*	6	0,77	D1	2,3	C1	0,01	W1
23.	*Carabus ullrichi*	6	0,77	D1	2,3	C1	0,01	W1
24.	*Platynus assimile*	6	0,77	D1	2,3	C1	0,01	W1
25.	*Ophonus rufibarbis*	6	0,77	D1	2,3	C1	0,01	W1
26.	*Necrophorus humator*	6	0,77	D1	2,3	C1	0,01	W1
27.	*Anoplotrupes stercorosus*	5	0,64	D1	2,3	C1	0,01	W1
28.	*Tanatophilus rugosus*	5	0,64	D1	2,3	C1	0,01	W1
29.	*Cychrus caraboides*	4	0,51	D1	2,3	C1	0,01	W1
30.	*Amara ovata*	4	0,51	D1	2,3	C1	0,01	W1
31.	*Pterostichus oblogopunctatus*	4	0,51	D1	2,3	C1	0,01	W1
32.	*Silpha obscura*	4	0,51	D1	2,3	C1	0,01	W1
33.	*Harpalus rubripes*	4	0,51	D1	2,3	C1	0,01	W1

34.	*Abax carinatus*	3	0,39	D1	2,3	C1	0,01	W1
35.	*Harpalus tardus*	3	0,39	D1	2,3	C1	0,01	W1
36.	*Necrodes littoralis*	3	0,39	D1	2,3	C1	0,01	W1
37.	*Pterostichus niger*	2	0,26	D1	2,3	C1	0,01	W1
38.	*Harpalus tenebrosus*	2	0,26	D1	2,3	C1	0,01	W1
39.	*Silpha tristis*	2	0,26	D1	2,3	C1	0,01	W1
40.	*Dorcus paralellopipedus*	2	0,26	D1	2,3	C1	0,01	W1
41.	*Lucanus cervus*	2	0,26	D1	2,3	C1	0,01	W1
42.	*Oryctes nasicornis*	1	0,13	D1	2,3	C1	0,01	W1
43.	*Agonum glacillipes*	1	0,13	D1	2,3	C1	0,01	W1
44.	*Carabus violaceus*	1	0,13	D1	2,3	C1	0,01	W1
45.	*Brachinus psophia*	1	0,13	D1	2,3	C1	0,01	W1
46.	*Anchomenus dorsale*	1	0,13	D1	2,3	C1	0,01	W1
47.	*Pterostichus hungaricus*	1	0,13	D1	2,3	C1	0,01	W1
48.	*Poecilus cupreus*	1	0,13	D1	2,3	C1	0,01	W1

***** Species in the table are arranged in descending order of abundance

The synthetic diversity indices indicated a high diversity of the epigeic beetle community throughout the vegetation period. The Shannon diversity index reached its highest values in spring (0.91) and summer (0.94), while a lower value was recorded in autumn (0.78), reflecting the seasonal decline in the activity of epigeic beetle species. The high evenness values indicate a relatively uniform distribution of individuals among the characteristic species of the investigated forest ecosystem.

CONCLUSIONS

The results of the present study revealed a high diversity of epigeic beetles in the sessile oak forest mixed with small-leaved lime and common ash within the strictly protected area of the “Codrii” Nature Reserve, where 48 species belonging to 25 genera and 5 families were recorded, with the family Carabidae being the most species-rich. The trophic structure of the community was dominated by zoophagous species, while the synecological analysis identified *Carabus coriaceus* and *Necrophorus vespilloides* as the characteristic species of the investigated ecosystem, exhibiting the highest values of abundance, dominance, and ecological significance index.

The occurrence of *Carabus ullrichi*, *Carabus violaceus*, *Lucanus cervus*, and *Oryctes nasicornis*, all listed in the Red Book of the Republic of Moldova, emphasizes the conservation importance of the strictly protected area. Furthermore, the synthetic diversity indices indicate that the epigeic beetle community is well-structured and stable, reflecting the favorable ecological conditions of this natural forest ecosystem.

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