

Contributions to the study of a community of soil-surface arthropods from an anthropic-modified ecosystem in the area of Borod (Bihor county, NW Romania)

Diana CUPȘA¹ and Eva-Gabriella SZABO-OSVATH²

1. University of Oradea, Faculty of Science, Department of Biology, 1 Universitatii str., 410087, Oradea, Romania, E-mail: dcupsa@uoradea.ro
2. Technical College of Vadu Crisului, Department of Biology, Main Street, nr. 25, Vadu Crișului (Bihor County), Romania

Abstract: The present work refers to the study of a community of soil-surface arthropods in a forest established through territorial arrangement in the area of Borod (Bihor County). Invertebrates were determined after collected from 5 habitats with the help of the Barber traps. A total of 348 invertebrates were collected, belonging to 16 different taxa. In habitat No. 4 we found the highest number of individuals, and habitat No. 5 is the richest in taxa. Opiliones and Araneids have the highest occurrence, being euconstant and the number of constant and euconstant taxa combined represents almost 40% of the total taxa, which suggests a lower stability of structure among the main groups of invertebrates that were identified. The trophic spectrum indicates the predominance of carnivore predators, followed by detritivores, herbivores and parasites. The diversity and the similarity indexes have close values showing the uniformity of the zoocenotic composition.

Keywords: soil-surface arthropods, anthropic-modified habitat, arranged forest ecosystem, Barber traps, opiliones, araneids, diversity indexes.

Introduction

Research concerning soil-surface arthropods as a whole is very rare in our country (Panait 2005), although there are many specialists who deal with the study of different groups of arthropods such as the Isopods (Tomescu et al. 2008), Opiliones (Băbălean 2005), Araneids (Urak & Fetzko 2006), Coleoptera Carabidae (Varvara & Zugravu 2006, Varvara & Apostol 2008), Scaraboidee (Chimișliu 2007), Hymenoptera formicide (Marko et al. 2006, Moscaliuc 2008), etc.

In the foreign specialized literature we find such studies (Davis 1979, Finch 2005, Leivas & Fischer 2008, McIntyre 2000, Nummelina & Zilihonab 2004, Trueba et al. 2002, Humble et al. 2000) that have the purpose of describing the soil-surface arthropods community in anthropic affected or natural ecosystems, the way they function and aspects concerning their preservation and protection.

This work aims to accomplish the study of a community of terrestrial arthropods from an anthropic-modified forest ecosystem established on a pasture. The objectives of this study are to catalogue the groups of arthropods in the forest ecosystem, to observe the structure of the community in different areas of the ecosystem according to the vegetation of that area and to establish the trophic spectrum of the arthropods in the studied ecosystem.

Material and methods

The study area

The depression of Borod is situated in the eastern part of Bihor county, being a deepened area between the Plopișului Mountains and the Pădurea Craiului Mountains; it is one of the "gulf" depression of the Apuseni Mountains, with a large opening towards the Depression of Oradea and further on to the Western Hills and Western Plain, having a direct continuity with its morphogenetic steps. The depression is bordered to its north by the Plopișului Mountains, to its south by the Bratca Basin and the Șuncuiuș Basin, and to its south-east it's bordered by the Crisul Repede Strait and The Bratca Basin, having a connection with it through the Piatra Craiului Pass. (Oancea & Velcea 1987)

The studied forest lies on the outskirts of Borod commune, towards Oradea, in the middle of a pasture, near the Borod weather station and the E60 international highway.

The studied ecosystem is a forest established through territorial arrangement around the 1950s, having as purpose: the production of vegetal and animal biomass, an anti-erosion function, the economic capitalization of the wood, a medical role and a recreating place.

The relief of the area is hilly, with an altitude of 316-318 m, north exposure, 5° slope, podzol soil type, 30-40 cm profile, with a mild acidic pH, with no effervescence, litter thickness of 2-3 cm, weak decomposition, and mild erosion; the defined territory has a rectangular shape $L \approx 50\text{m}$, $W \approx 12\text{m}$, surface $\approx 600\text{m}^2$.

On the defined area the forest has a medium production, 85 - 90% covered with a herbal layer, an index of crowning coagulation with the value of ≈ 0.7 , bush surface / test surface defined area < 1 , number of trees: 36 spruce firs, 117 maple trees; the spruce firs are planted on 2 side rows, towards the pasture, and the maple trees are planted on 9-11 rows towards the middle of the forest. Outside the defined area the forest lies on quite a big surface (≈ 48 ha), with the length much bigger than the breadth, having the shape of 2 narrow transects that intersect in only one point, continuing with a prolonged surface towards the top of the hill; downwards, on the opposite slope, it approximately outlines the shape on an inverted Y.

Sampling methods

The samples of invertebrates were collected during May-September 2007, using the Barber traps method, and a total number of 20 traps.

The placed traps are vessels of approximately 200 ml, usually made of glass or plastic, with an opening diameter of 5-10 cm; the traps are placed in the soil, so that the opening of the vessel lies at ground level. In order to avoid the filling of the vessels at rainfalls, a tripod-shape roof, 4-6 cm higher than the level of the vessel is installed above the traps (Chimişliu 2002).

The Barber traps were half filled with preserving liquid, over-saturated saline solution, and placed in 5 different places (habitats) on the surface of the investigated forest; the traps were checked periodically.

This is how the habitats were placed in the investigated area: Habitat No.1 - north, north-west orientation, under a spruce fir; Habitat No.2 - north-west orientation, under a spruce fir; Habitat No.3 - west orientation, under a maple tree; Habitat No.4 - reference point for the other habitats, under a maple tree; Habitat No.5 - south orientation, under a maple tree.

The samples of invertebrates collected with the Barber traps method were selected in a laboratory under a 40X stereo microscope, submerged in 70% ethylic alcohol, followed by their identification and taxonomic classification (Crişan & Cupşa 1999, Cupşa 2004, Mureşan & Crişan 1999) and by the statistic interpretation of the results, after measuring: the frequency, the constancy, the abundance, the Margalef index (D_1), the Simpson index (I), the Shannon-Wiener index (H), the evenness index (E), the similarity indexes (see in: Cupşa 2004, Sârbu & Benedek 2004). In order to establish the conclusions, corresponding graphic representations were made.

Results

In the 5 habitats that were investigated we have identified a total of 342 individuals belonging to 16 taxonomic groups of arthropods. Habitat No.4 is the richest, with 97 individuals, and the poorest one is Habitat No.1 with 52 individuals. The number of taxa is between 12 and 14/habitat, with the lowest number in Habitats No.1 and No.2, and the highest number in Habitat No.5 (Table 1, Fig. 1).

The highest number of individuals belong to the order of Opilionida, except Habitat No.4 where more individuals belong to the order Hymenoptera, followed by the order of Acarina, except Habitat No.1 where more individuals belong to the order Collembola and Dermaptera; the lowest number of individuals belongs to the order Homoptera, represented by an individual in Habitats No.3-5 and the Diplopoda present only in Habitat No.4 (Figs 2-6).

The highest frequency is given by the Opilionida with 96%, and the lowest one, with equal values, by the orders Homoptera, Adefaga, Chalastogastra (16%). (Table 1)

The constancy with the higher values was observed in the order Opilionida and Araneida, these orders being euconstant, and the lowest values in the orders Isopoda, Diplopoda, Homoptera, Adephaga, Chalastogastra, Lepidoptera, these orders' presence being accidental. There are also two other constant groups: the Collembola and the Brachycera Diptera, the other groups being trap accessories (Table 1).

The highest abundance was determined in the case of Opilionida in Habitat No.5, and the lowest one, with equal values, in the case of Isopoda, Heteroptera, and Nematocera in Habitat No.4 (Table 1).

Opilionida have the highest abundance in all the habitats, except in Habitat No.4, where Hymenoptera Clistogastra is more abundant. They are followed by the Araneida in Habitat No. 2, 3 and 5; in these cases the community is formed almost exclusively of Opilionida and Araneida. In Habitat No.1 the Opilionida are followed by the Collembola and the Dermaptera in terms of abundance, and in Habitat No.4 the Clistogastra are followed by the Opilionida, Araneida and Collembola (Table 1).

Depending on the way they were calculated, i.e. related to only the total number of individuals and species or to the number of individuals and the abundance of each separate species, the diversity indexes indicate different collecting points as habitats with maximum diversity. The evenness has high values in all 5 habitats (between 0.706 and 0.861), the highest value being for Habitat No.3, and the lowest one for Habitat No.2 (Table 2).

The similarity indexes of the collected invertebrates had high and also close values in all the habitats, the highest values being recorded between H1-H2, H2-H4 and H3-H4.

Discussions

The total number of individuals collected during this study is relatively small (342) in comparison to the num-

Table 1. The mean abundance (%), frequency (%) and the constancy of the invertebrate taxa collected from the defined area, during May - September 2007

The place where the invertebrates were collected	Nr. of individuals	Nr. of taxa	Taxa															
			Araneida	Oplionida	Acarina	Isopoda	Diplopoda	Colembolla	Dermaptera	Homoptera	Heteroptera	Coleoptera		Diptera		Hymenoptera		Lepidoptera
												Adf	Polf	Nimt	Brh	Chl	Cls	
Habitat .No.1, under the spruce fir	52	12	12.76	43.24	1.92	3.92	-	15.21	-	-	15.21	1.92	3.92	1.92	6	10.41	3.92	-
Habitat .No.2, under the spruce fir	68	12	44.68	61.90	1.49	1.49	3.03	3.03	3.03	4.61	3.03	-	3.03	1.49	3.03	-	8.19	-
Habitat No.3, under the maple tree	58	13	18.36	34.88	3.57	-	3.57	13.72	1.75	13.72	3.57	-	9.43	13.72	5.45	1.75	-	7.40
Habitat No.4, under the maple tree	97	13	8.51	29.11	2	0.99	3.03	8.51	2	0.99	3.03	-	5.15	0.99	3.03	-	72.88	2
Habitat No.5, under the maple tree	67	14	11.66	81.08	3.07	3.07	4.68	1.51	1.51	1.51	3.07	6.34	-	-	3.07	1.51	9.83	4.68
Frequency			76	96	32	24	44	56	28	16	44	16	40	32	52	16	40	24
Constancy			Euconst.	Euconst.	Accs.	Accid.	Const.	Accs.	Accs.	Const.	Accs.	Accid.	Accs.	Accs.	Const.	Accid.	Accs.	Accid.

Legend:

- Adf - Adefağa
- Polf - Polifaga
- Nimt - Nematoçera
- Brh - Brachycera
- Chl - Chalastrogastra
- Cls - Clistogastra

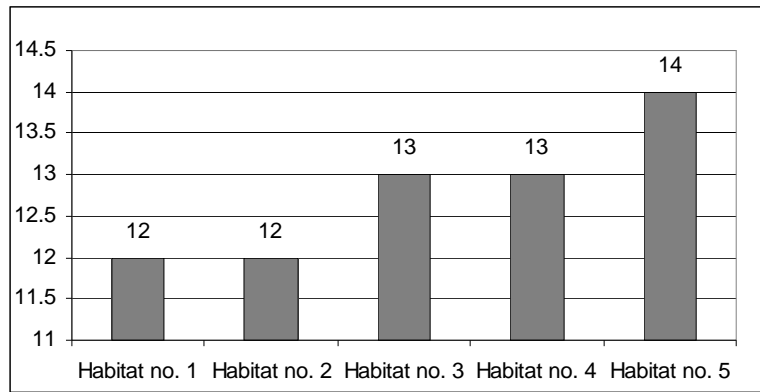


Figure 1. The number of invertebrate taxa collected using the Barber traps method, during May – September 2007

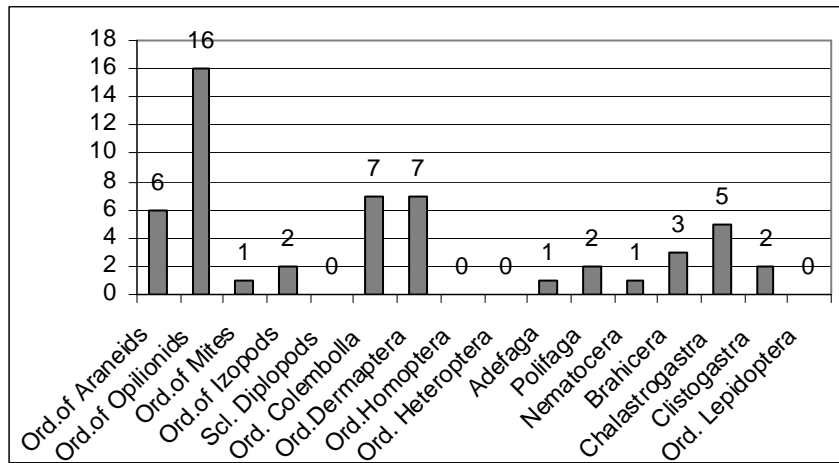


Figure 2. The number of invertebrate individuals that were collected in habitat No. 1, during May – September 2007

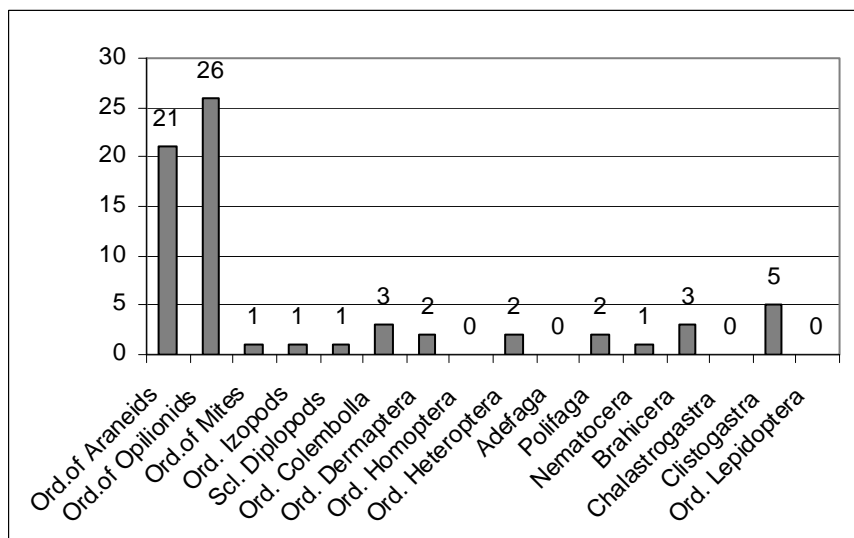


Figure 3. The number of invertebrate individuals collected in habitat No. 2, during May – September 2007

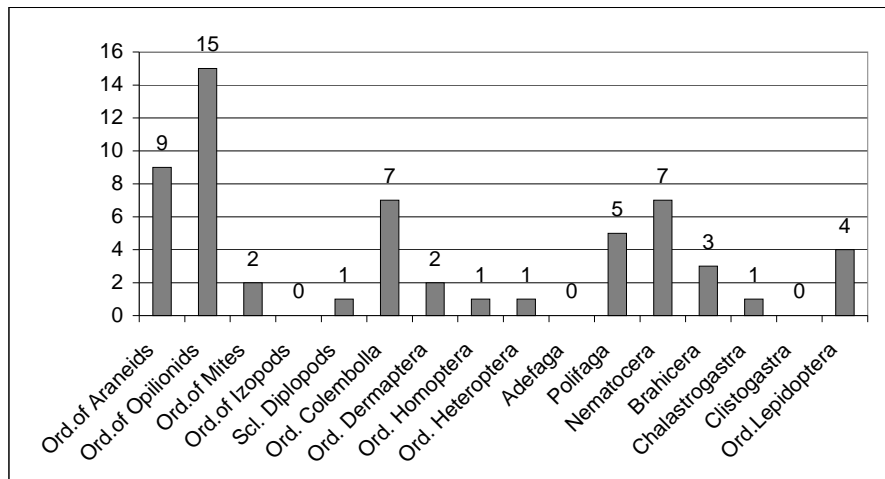


Figure 4. The number of invertebrate individuals collected in habitat No. 3, during May- September 2007

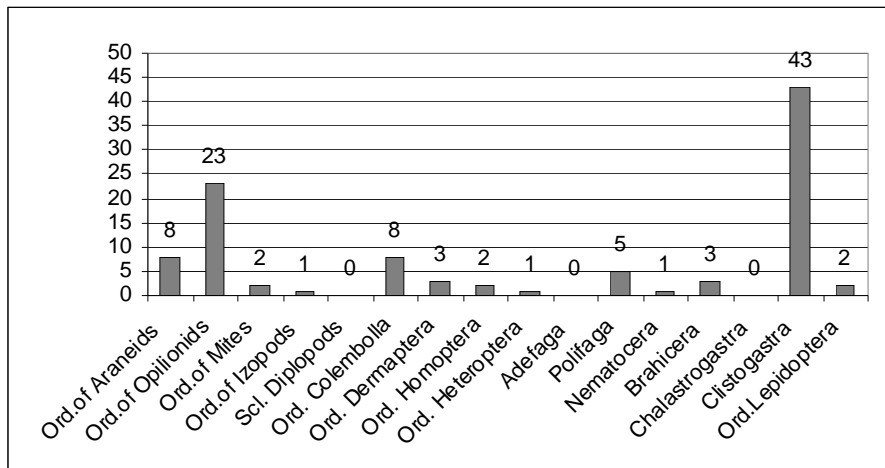


Figure 5. The number of invertebrate individuals collected in habitat No. 4, during May - September 2007

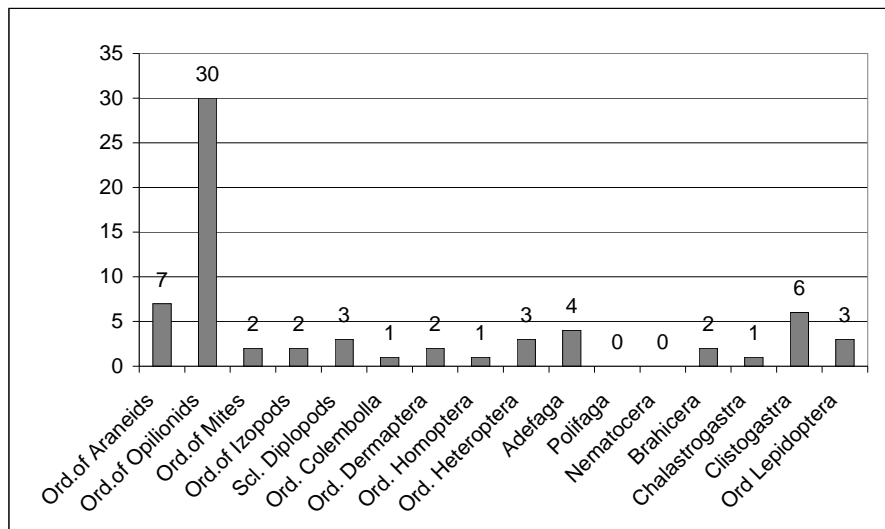


Figure 6. The number of invertebrate individuals collected in habitat No. 5, during May - September 2007

Table 2. The diversity indexes of the invertebrates in the 5 investigated habitats

The places where the samples were collected	Calculated indexes			
	D ₁	I	H	E
Habitat No.1	6.380	0.140	2.122	0.854
Habitat No.2	6.003	0.243	1.755	0.706
Habitat No.3	6.805	0.123	2.207	0.861
Habitat No.4	5.974	0.239	1.821	0.710
Habitat No.5	7.119	0.222	2.003	0.759

Table 3. The similarity indexes between the investigated habitats

	I _c				I _s				I _a			
	H5	H4	H3	H2	H5	H4	H3	H2	H5	H4	H3	H2
H1	38.46	40	36	41.66	76.92	80	72	83.33	71.38	80.12	72.11	83.33
H2	38.46	44	40		76.92	88	80		77.38	88.14	80.12	
H3	37.03	42.3			74.07	84.61			74.17	84.16		
H4	40.74				81.48				81.59			

ber of individuals that could have been collected, with the same effort and in the same time frame, from a compact forest (Finch 2005).

The first two habitats, which are located in the area of spruce fir trees, are a little poorer in taxa, in comparison to the area of maple trees. In the area of the spruce fir trees the Homoptera and the Lepidoptera were not present. This indicates that the forest doesn't have coniferous trees pests belonging to the two mentioned groups. Considering the fact that the forest is over 50 years old, the absence of the pests can be explained by the altitude of the location, an area belonging to the deciduous forest floor, and as a consequence, the pests couldn't migrate from the natural coniferous forests, as they were too far. The Heteroptera are present only in Habitat No.2 amongst the ones in the spruce fir forest, probably withdrawing for winter, as they usually live in pasture ecosystems, and they could come from the nearby pasture. The Isopoda and the Diplopoda, as the main groups of detritivorous invertebrates are also present in low numbers, because of the acid characteristic of the litter in the spruce fir forest, which is being avoided by the detritivorous, specially at this altitude where the species of this group are adapted to a less acid environment, characteristic to the pasture upon which the forest was established.

In Habitats No. 3-5 the number of taxa is slightly higher, respectively 13 (Habitats No.3 and 4) and 14 (Habitat No. 5). In two of these habitats (3 and 4) the

Colleoptera Adephaga were not present, although the Carabides are generally represented by many species both in the deciduous forests and in the coniferous forests (Finch 2005); these species don't find favourable conditions to develop and only species that are general plunders, capable of exploring more types of environments, established themselves here (Halme & Niemela 1993).

The highest number of individuals is represented by the Araneida and the Opilionida, except in Habitat No.4. Although the number of individuals belonging to these groups is high, the number of representatives from these species that were caught is low; that is because of the small surface of the ecosystem they live in, an ecosystem where the trophic offer is quite low and less diversified, compared to a compact forest with a big surface (Miyashita, 1998).

From a trophic point of view, the highest number in all the habitats is registered for the carnivorous plunders, especially the Opilionida and the Araneida, which, together with the general species (Formicidae, Dermaptera, Coleoptera Polyphaga), are predominant in the anthropic-modified ecosystems, where there is a succession of the vegetal covering determined by humans (McIntyre 2000). The small number of Acarina and Collembola is due to the anthropic effect on the forest; as fallen trunks are taken out of the forest to be used as fire wood, the typical environment where these species develop is removed (Dechene 2009).

The highest frequency is recorded for the Opilionida, followed by the Araneida in 4 out of the 5 studied habitats. In terms of constancy, these are the only euconstant orders, so spiders and the invertebrates similar to spiders are predominant. The Araneida and the Opilionida were also identified in the zoocenotic composition of an ecosystem in the rural area (Leivas & Fischer 2007).

The number of constant and euconstant taxa is a quarter of the total number of taxa (4/16), which suggests a lower stability of structure in the case of the main invertebrate groups in the anthropic forest. This is due to anthropic-modifications in the investigated ecosystem. As a consequence, in the community of invertebrates that was studied, the Opilionida, the Araneida, the Collembola and the Brachyceridae are predominant, together with quite numerous other taxa that are characteristic to a forest with a certain degree of anthropic modification, but fewer in comparison to a natural forest with a higher stability. The predominant presence of the Collembola is also noticed in an anthropic-modified forest in the urban environment (Trueba et al. 2002), where they are outnumbered by the Acarina, which, in our case, are only accessories. The relatively high number of taxa, even inside an anthropic-modified environment in our country is due to the specific geographical position (Tomozei 2008). In the ecosystems of plantation type the initial number of taxa is high, but in time their number decreases; on the other hand, the abundance of specific taxa for the new ecosystem (McIntyre 2000) or the number of the general taxa that can survive in this environment, increases. The colonization of the new ecosystems is accomplished using species from the adjacent ecosystems, on a radius of maximum 1 km, considering the relatively low mobility of the discussed species (Davis 1979).

The taxa that were rare in the traps are the Isopoda, Diplopoda, Homoptera, Chalcidostoma, Lepidoptera, summing up to almost 40% (6/16) of the all identified taxa proving a dynamic evolution of the investigated zoocenosis. The Lepidoptera, Hymenoptera, Coleoptera taxa incidence is low when compared with the zoocenosis of a natural forest. (Balog et al, 2008)

In terms of trophic spectrum, the most numerous are the carnivorous plunders (Opilionida and Araneida) followed by the detritivores (Collembola) and then by the herbivores, the lowest number being recorded among the parasites. Being a forest ecosystem we would expect a higher number of detritivorous, considering the detritus available as food, but its limited surface determines a smaller number of representatives in comparison with the compact forests.

The foliage of the forest, especially of the herbal layer is quite dense, the quantity of the fallen leaves

quite big, the litter quite thick, and its decomposition by the detritivorous is obvious. The formed humus is thick enough in order for the forest's soil to be fertile. Almost all the plants in the forest have undamaged organs; no traces of damage by herbivorous invertebrates are obvious or easily noticeable because of their low number, not even a quarter of the number of carnivorous plunders. The herbivorous that are characteristic to the pasture vegetation don't enter the forest because of the different specific composition of the herbal layer that determines a lack of food for the species that are strictly trophically specialized. The herbivorous that are characteristic to the canopy of the trees are absent because the natural forests are found at a large distance from this area. Plants in the forest are visibly healthy, almost free from invertebrate parasites attacks, these parasites' numbers being almost 25 times smaller than the numbers of the carnivorous plunders. The lack of parasites can also be explained by the big distance between the investigated ecosystem and the natural forests.

The Margalef diversity index has the highest value in Habitat No.5 because this habitat has the highest number of taxa and a relatively small number of individuals; the lowest value is seen in Habitat No.4, where the diversity index is low, despite the high number of species, and the number of individuals is also high. The Simpson and Shannon-Wiener indexes, which also take into consideration the number of individuals in each species, point to Habitat No.3, as being the most diversified one, followed by Habitat No.1, and the lowest diversity is recorded in Habitat No.2. We notice that the lowest diversity is recorded in a habitat settled on spruce fir forest, in comparison to the deciduous forest; i.e. in concordance with data presented in other specialized literature (Finch 2005).

The similarity indexes have recorded close values in the investigated ecosystem, proving both the uniformity of the determined zoocenotic composition and the uniformity of the environmental conditions across the studied habitats. This is mainly due to the relative small surface of the investigated area. The three different possible values of this index are explained by the three different ways of calculating them. In all the three cases the highest similarity was noticed between Habitats No. 2 and 4, followed by the similarity between 3 and 4, and then between 1 and 2. It's interesting to notice the maximum similarity between two different habitats from two different ecosystems (Habitat No.2, spruce fir forest; Habitat No.4, deciduous forest), when habitats from the same ecosystem have a smaller similarity. This indicates precisely the homogeneity of the fauna in the investigated area, uniformity that can be explained by the small surface of the planted forest and its

colonization by arthropods from the adjacent pasture able to adapt to the forest ecosystem. We can state that typical forest species are almost missing, because of the big distance between the plantation and the surrounding natural forests; this distance makes it impossible for the soil-surface arthropods fauna to migrate to this ecosystem.

Although the plantation is 50 years old, the fauna of soil-surface arthropods is not well coagulated, a fact that is pointed out by the small number of euconstant and constant species. In conclusion, this fauna is mainly also characteristic to adjacent pasture.

References

- Balog, A., Markó, V., Ádám, L. (2008): Rove beetles (Coleoptera: Staphylinidae) collected during the long term ecological research in a Hungarian oak forest. *Journal of Environmental Biology* 29 (2): 263-266.
- Băbălean, A. F. (2005): General overview on the opilionid fauna (Arachnida, Opiliones) in Romania. *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea Biologie Animală* 51: 47-54.
- Cupşa, D. (2004): Indicii structurali ai biocenozelor: frecvenţa, abundenţa, dominanţa, constanţa, indici de similaritate. Pp. 1168-173. In: Burcă S. et al. (eds): *Lucrări practice de biologie*. University of Oradea Publishing House, Oradea, Romania. [in Romanian].
- Chimişliu, C. (2002): Colectarea, prepararea şi conservarea materialului biologic. I Nevertebrate. Sitech Publishing House, Craiova, Romania. [in Romanian].
- Chimişliu, C. (2007): Contribution to the knowledge of the Romanian fauna of Lucanidae (Coleoptera: Scarabaeoidea). *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea Biologie Animală* 53: 97-102.
- Crişan, A., Cupşa, D. (1999): *Biologie Animală I, Nevertebrate*. Convex S.A. Publishing House, Oradea, Romania. [in Romanian].
- Cupşa, D. (2004): *Lucrări practice de entomologie*. University of Oradea Publishing House, Oradea, Romania. [in Romanian].
- Davis, B.N.K. (1979): The ground arthropods of London gardens. *The London Naturalist* 15: 24-58.
- Dechene, A. (2009): The Effect of Dead Wood on Mite Biodiversity in Quebec's Boreal Forest. *Arthropods of Canadian forest* 4: 18.
- Finch, O.D. (2005): Evaluation of mature conifer plantations as secondary habitat for epigeic forest arthropods (Coleoptera: Carabidae; Araneae). *Forest ecology and management* 204 (1): 21-34.
- Halme, E., Niemela, J. (1993): Carabid beetles in fragments of coniferous forest. *Annales Fennici Zoologici* 30: 17-30.
- Humble, L.M., Winchester, N. N., Ring, R. A. (2000): The potentially rare and endangered terrestrial arthropods in British Columbia. Revisiting British Columbia's biodiversity. pp. 101-108. In: Darling, L.M. (eds.): *Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk*, Kamloops, B.C., 15-19 Feb. 1999. Volume One. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. and University College of the Cariboo, Kamloops
- Leivas, F. W. T., Fischer, M. L. (2008): Avaliação da composição de invertebrados terrestres em uma área rural localizada no município de Campina Grande do Sul, Paraná, Brasil. *Revista Biotemas* 21 (1): 65-73.
- Markó, B., Sipos, B., Csösz, S., Kiss, K., Boros, I., Gallé, L. (2006): A comprehensive list of the ants of Romania (Hymenoptera: Formicidae). *Myrmecologische Nachrichten* 9: 65-76.
- McIntyre, N. E., (2000): Ecology of Urban Arthropods: A Review and a Call to Action. *Annals of the Entomological Society of America* 93 (4): 825-835.
- Miyashita, T., Shinkai, A., Chida, T. (1998): The effects of forest fragmentation on web spider communities in urban areas. *Biological Conservation* 86: 357-364.
- Moscaliuc, L. (2008): Notes on the ant fauna (Hymenoptera: Formicidae) of Rarău Mountains. *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea Biologie Animală* 54: 53-55.
- Mureşan, D., Crişan, A. (1999): *Insecte. Manual de entomologie generală*. Presa Universitară Clujeană Publishing House, Cluj-Napoca, Romania. [in Romanian].
- Nummelina, M., Zilihonab, I.J.E. (2004): Spatial variation of arthropod communities in virgin and managed sites in the Kibale Forest, western Uganda. *Forest Ecology and Management* 195: 107-114.
- Oancea, D., Velcea, V. (1987): *Geografia României III*. Editura Academiei R.S.R. Publishing House, Bucharest. [in Romanian].
- Panait, V. (2005): The influence of the soil parameters upon the soil's mesofauna in function of the environmental conditions within Murighiol-Dunavăț dammed and drainage area as part of the Danube Delta Biosphere Reserve. *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea Biologie Animală* 51: 111-121.
- Sârbu, I., Benedek, A. M. (2004): Biodiversitatea - Diversitatea ecologică. Pp. 195-197. In: Sârbu, I. & Benedek, A. M. (eds.): *Ecologie practică*. The University of Sibiu Publishing House, Sibiu, Romania. [in Romanian].
- Tomescu, N., Bogdan, H., Peter, V.I., Covaciu-Marcov, S.D., Sas, I., (2008): Terrestrial Isopods from the Western and North-Western Romania. *Studia Universitatis Babeş-Bolyai, Biologia* 53 (2): 3-15.
- Tomozoi, B. (2008): Checklist of Bees of the genera Colletes Latreille 1930 and Hylaeus Fabricius 1793 of Romania (Hymenoptera: Apiformes: Colletidae). *Faunistic Entomology* 61 (3): 87 - 97.
- Trueba, D.P., Bonfanti-Almeida, J. C., Oliveira, A.R., da Rocha, F.E. (2002): Litter microarthropod community in an urban forest stand of São José do Rio Preto, State of São Paulo, Brazil. *Revista Biologia* 16 (2): 123-129.
- Urak, I., Fetyko, K. (2006): Arachnological studies in the Retezat National Park (Romania). *Transylvanian Review of Systematical and Ecological Research* 3: 79-88.
- Varvara, M., Zugravu, F. (2006): Diversity and the main ecological requirements of the species of Carabidae (Coleoptera, Carabidae) from Neamţ County. *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea Biologie Animală* 52: 185-196.
- Varvara, M., Apostol, E. (2008): Diversity and the main ecological requirements of the epigeic species of Carabidae (Coleoptera, Carabidae) in the sunflower ecosystem, Broscăuţi (Botoşani County). *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea Biologie Animală* 54: 81-89.

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