DATA CONCERNING THE CARABIDAE FAUNA IN THE BEECH AND MIXED TREES FORESTS FROM BISTRIȚA GORGES (THE BUILA-VÂNTURARIȚA NATIONAL PARK, ROMANIA)

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The Carabidae fauna was collected during April till October 2007 in two forest habitats (the beech and mixed trees (beech and spruce) forests) from Bistrița Gorges (Buila-Vânturarița National Park) using a quantitative sampling method. In the two habitats were identified 26 carabid species, 10 of them occurring in both of them. To characterize the carabid populations, were discussed the structure of numerical dominance, constancy classes, species richness, Shannon-Wiener index of diversity, the structure of the carabid populations according to the species ecological and biological characteristics and the degree of similarity between the tow carabid populations. Both carabid populations differ as species compositions and show variations in time in species numerical abundances. The species diversity is high in both habitats, but the degree of similarity between the two populations is low.

Key words: Carabidae, beech forest, mixed trees forest, diversity index, Buila-Vânturarița, Romania.

INTRODUCTION

The beetles (including carabids) are very important cenotic elements in all types of terrestrial ecosystems, and are used in the ecological researches, as shown by the studies of Desender *et al*. (1991). The studies on the carabid fauna provide information on the ecosystems degree of preservation or deterioration and support the climate change assessment (Thiele, 1977; Magura *et al*., 2000; Brandmayr *et al*., 2005; Niţu, 2008; Avgin & Luff, 2010).

The Buila-Vânturarița National Park is located in the Buila-Vânturarița limestone massif and covers an area of 4500 ha. The landscape is varied, characteristic to the calcareous mountains. The minimum altitude is of 600 meters, in Bistrița Gorges and the maximum one is of 1885 meters, in the Vânturarița Mare peak. Bistrița Gorges is one of the four key sectors of the park.

In this area, to date, no studies have been conducted on the invertebrate populations. The present study brings contribution to the knowledge of the carabid fauna from two representative habitat types of the researched area.

MATERIAL AND METHODS

The carabids were collected in two forest habitats. In the deciduous forest, the dominant species – *Fagus sylvatica* is accompanied by many *Sambucus nigra* shrubs, and the herbaceous layer is mainly formed of *Asplenium scolopendrium*, *Salvia glutinosa* and *Polygonatum latifolium*. The beech forest is 100 years old. The mixed forest is mainly formed of *Fagus sylvatica* and *Picea abies*. The herbaceous layer is here poorly represented (*Dentaria glandulosa* and *Salvia glutinosa* species). The mixed forest is planted and it is 40 years old.

The carabid fauna was collected monthly from April to October 2007, using Barber traps (450 ml plastic cups with 10 cm diameter) filled with 4% formalin solution). The distance between two such traps was of three meters. In each studied site were placed 9 traps, meaning 81 traps in each habitat type, throughout the period of the study. The locations where the traps were set are situated at 650 m altitude.

The collected carabid fauna was determined up to the species level using the identification keys (Jeannel 1941, 1942; Panin, 1955; Trautner & Geigenmüller, 1987; Lindroth, 1974; Hürka, 1996).

For each habitat type I have calculated the relative abundance, the frequency (in order to establish the species numerical dominance and the structure of constancy classes).

The diversity of the carabid populations was evaluated using the Shannon-Wiener index of diversity. The evenness was determined as the ratio between H' and ln S, S being the number of identified species, and H_{max} as ln S, or as the ratio between the value of the H' diversity index and the evenness.

The degree of similarity between the two carabid populations was estimated using Canberra-Metric coefficient.

RESULTS

Numerical abundance, relative abundance and the carabid species frequency.

During the study, the carabids captured represent 669 individuals belonging to 26 species and 9 genera respectively.

In the beech forest I have identified 25 species, among which *Abax parallelepipedus* was the eudominant and constant species, *Carabus arcensis* and *Carabus coriaceus* were eudominant species, and *Carabus scheidleri* and *Carabus violaceus* were dominant.

In the mixed trees forest, of the 11 identified species, 4 were eudominant (*Abax parallelepipedus*, *Carabus coriaceus*, *Carabus violaceus*, *Cychrus semigranosus*) and 2 dominant (*Abax parallelus*, *Cychrus caraboides*). None of the carabid species was constant in samples (Table 1).

Table 1

The numerical abundance (No.), relative abundance (Rel. ab. – %), frequency (F – %) of the carabid species from the beech and the mixed trees forests

Species	Beech forest			Mixed trees forest		
	No.	**Rel. ab. (%)**	**F (%)**	**No.**	**Rel. ab. (%)**	**F (%)**
Abax parallelepipedus Piller et Mitterpacher, 1783	159	28.55	58.03	12	11.01	13.58
Abax parallelus (Duftschmid, 1812)	11	1.96	9.87	9	8.25	9.87
Amara aenea (Degger, 1774)	1	0.18	1.24			
Amara montivaga Sturm, 1825	1	0.18	1.24			
Carabus cancellatus Illiger, 1798	1	0.18	1.24			
Carabus arcensis Herbst, 1784	134	24.06	30.86	2	1.83	2.46
Carabus convexus Fabricius, 1755	18	3.23	13.58	2	1.83	2.47
Carabus coriaceus Linnaeus, 1758	72	12.93	41.89	21	19.27	19.76
Carabus intricatus Linnaeus, 1761	1	0.18	1.24			
Carabus monilis Fabricius, 1792	20	3.59	11.12			
Carabus scheidleri Panzer, 1799	44	7.90	19.76			
Carabus ullrichi Germar, 1824	4	0.72	4.94	1	0.92	1.24
Carabus violaceus Linnaeus, 1758	37	6.64	29.63	34	31.19	29.63
Cychrus semigranosus Palliardi, 1825	4	0.72	3.71	13	11.93	12.34
Cychrus caraboides (Linnaeus, 1758)				10	9.17	8.65
Harpalus latus (Linnaeus, 1758)	1	0.18	1.24			
Harpalus affinis (Schrank, 1781)	6	1.08	6.18			
Leistus rufomarginatus (Duftschmid, 1812)	1	0.18	1.24			
Harpalus laevipes Zetterstedt, 1828	2	0.36	2.47			
Harpalus tardus (Panzer, 1796)	1	0.18	1.24			
Molops piceus (Panzer, 1793)	10	1.80	7.4			
Pterostichus (Haptoderus) unctulatus (Duftschmid, 1812)	5	0.90	2.47			
Pterostichus niger (Schaller, 1783)	7	1.26	7.41	4	3.67	4.94
Pterostichus oblongopunctatus (Fabricius, 1787)	15	2.69	7.41	1	0.92	1.24
Trechus quadristriatus (Schrank, 1781)	2	0.36	2.47			
Trechus rubens (Fabricius, 1792)	3	0.54	3.71			

DISCUSSION

Of the total 26 identified carabid species in the two habitat types, 25 were from the beech forest and only 11 from the mixed trees forest, 10 of them being

common species. 669 individuals were captured: 560 (representing 83.7 %) in the beech forest and 109 (16.3 %) in the mixed ones.

The euritopic forest species *Abax parallelepipedus* and *Carabus coriaceus* were eudominant in the beech forest, as well as in the mixed trees forest. *Carabus violaceus*, which is an euritopic forest species, is numerically dominant in the beech forest and eudominant in the mixed trees forest.

THE NUMERICAL DOMINANCE

Analyzing the dominance structure of the carabid populations, it was noticed that in the beech forest the subrecedent species (56%) were predominant, while in the mixed trees forest they represent only 18.18% of the total identified species.

The carabid populations from the studied forests are characterized by the presence of 3 eudominant carabid species and 2 dominant in the beech forest, 4 eudominant and 2 dominant in the mixed trees forest. The eudominant *Abax parallelepipedus* and *Carabus violaceus* species are common to the two forest habitats.

I have noticed that in both forest habitats most of the carabid species have low frequency values in samples, which puts them in the accidental species class. Considering that most of these species are characteristic to the studied habitats, we can come to the conclusion that it is rather the case of reduced occurrence in samples, than the case of accidental species. This situation can indicate the species dispersion degree, determined by some microclimatic preferences (mainly for temperature and humidity) and food resource needs (Table 2).

Table 2

The structure of the numerical dominance and the constancy classes for the carabid species from the beech and mixed trees forests

Habitats	**Numerical dominance**					**Constancy classes**			
	SR	**R**	**SD**	**D**	**ED**	**ACC**	**ACS**	**CT**	**ECT**
Beech forest – 25 species	14	3	3	2	3	21	3	1	-
Mixed trees forest – 11 species	2	2	1	2	4	10	1	-	-

Abbreviations: SR – subrecedent; R – recedent; SD – subdominant; D – dominant; ED – eudominant; ACC – accidental; ACS – accessory; CT – constant; ECT – euconstant.

Analyzing the variation of the numerical abundance of the carabid during the study, I have noticed that the largest number of individuals from the beech forest was captured during April-June period. A contrary situation was registered in the

mixed trees forest, when the largest number of carabid was captured in August-October period (Fig. 1).

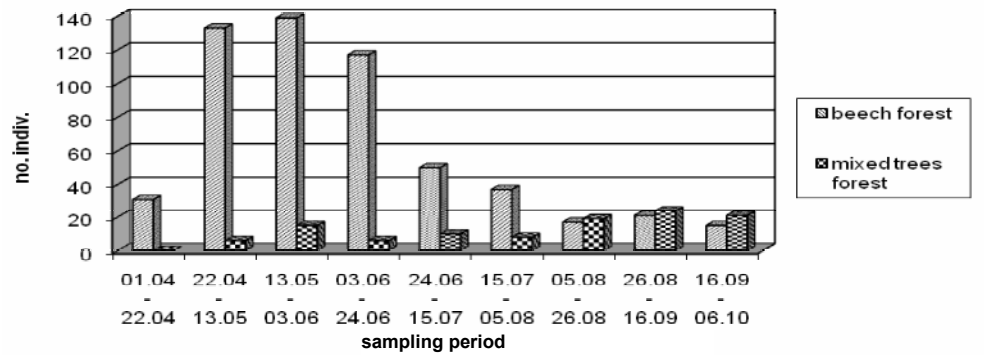

Fig. 1. The variations of the carabids numerical abundances in the beech and mixed trees forest.

In the beech forest, the low numerical abundance of the opportunist *Pterostichus oblongopunctatus* species, which lives in the forest habitats affected by massive and recent cuttings (Szujecki *et al*., 1983; Nitzu, 2007), leads to the idea of a high conservation level of the carabid populations in the studied forest, although there were previous cuttings in the nearby parcel.

The low values of the numerical abundance during summer, could be explained by the interaction species phenology and the limiting microclimatic factors (temperature, humidity) on the carabid populations. The climate factors exert a direct influence on carabid development, and an indirect one, on their food resources (Thiele, 1977).

In both carabid populations, the euritopic forest, mesohygrophilous species were predominant. The spring breeders are more numerous in the beech forest, while in the mixed trees forest the percentage of the spring breeders is equal to the one of the autumn breeders. Regarding the temperature preferences, most of the carabid species (66% in the beech forest and 46.5% in the mixed trees forest) are mesothermic. The euritopic of open areas species from the beech forest came probably from the mountain meadow situated nearby (Table 3).

High proportions of brachipterous species in both populations were noticed. In the carabid population from the beech forest, the macropterous flying species are represented by the carabids coming accidentally from the neighboring meadow.

The high proportion of surface walker species reflects low microclimatic variations and the presence of rich resource of food for carabids.

Table 3

The structure (%) of the carabid populations from the beech and the mixed trees forests, according to the species ecological and biological characteristics

Species characteristics	Habitats	
	Beech forest	**Mixed trees forest**
Habitat affinity		
Euritopic forest species	52.38	81.81
Stenotopic forest species	14.28	9.09
Euritopic of open areas	23.8	-
Euritopic species	4.76	9.09
Breeding period		
Autumn breeders	32	45.45
Spring breeders	64	45.45
Variable	4	9.09
Humidity preferences		
Hygrophilous	8.33	-
Mesoxerophilous	33.33	9.09
Mesohygrophilous	58.33	90.90
Xerophilous	8.33	-
Temperature preferences		
Mesothermic	66	46.5
Thermophilous	13.33	25
Low temperature preferences	20.66	28.5
Wings type		
Brachipterous species	52	72.72
Macropterous non-flying species	20	27.28
Macropterous flying species	28	-

THE SPECIES RICHNESS

The Shannon-Wiener index of diversity has high and close values for both carabid populations, although the species number and their numerical abundances are higher in the beech forest than in the mixed tree forest (Table 4).

For the two carabid populations, the maximum theoretical values of the Shannon-Wiener index of diversity should be of 3.218 for the carabid populations from the beech forest and 2.397 for the one from the mixed trees forest. The difference between the theoretical species richness (H max) and the observed one is smaller in the case of the mixed trees forest (in the beech forest H` observed = = 2.181, H`max = 3. 221, in the mixed trees forest: H` observed = 1.956., H` max = = 2.397).

The greater number of carabids in the beech forest is due to the species coming from the adjacent meadow, occurring especially in the forest edge, in some periods of the year. These variations in species richness occur usually during spring, when forest species go towards the neighboring meadow and come back during summer (Nitzu, 2007).

The species richness of the carabid population from the beech forest of Buila-Vânturariţa National Park (H' = 2.181) is higher compared to the one noticed in some beech forests from the national reservations (in the Tocarnia forest-the Maramureş Mountains Nature Park) (Niţu, 2008), which reflects the heterogeneity of beech forest habitats in terms of inhabiting carabid fauna.

The evenness calculated for the two carabid populations shows that the two integrating habitats are in a high state of preservation and have a favorable dynamic equilibrium for carabids.

Table 4

The Shannon-Wiener of index diversity in the beech and mixed trees forest

Habitats	**The Shannon-Wiener index of diversity (H')**	**The theoretical diversity (H' max)**	**Evenness (E)**	**No. of species**	**t (α = 0.05)**
Beech forest	2.181	3.218	0.677	25	0.569
Mixed trees forest	1.956	2.397	0.816	11	

The index of diversity varied from one collecting period to another, for each carabid population. During May-June, in both populations, the diversity had high values. During summer (July-August) I have noticed a decrease of the diversity index values for the population from the beech forest, but an increase of that one of the mixed trees forest. This fact can be explained by to the variations of the abiotic factors (the temperature increase and the humidity decrease) during summer, modifications which are more obvious in the beech forest, while in the mixed forest habitat these microclimatic variations seem to be in the normal limits for the carabid species. To the end of the autumn season, I have noticed a decrease of diversity, determined by the decreasing species number and their numerical abundances (Fig. 2).

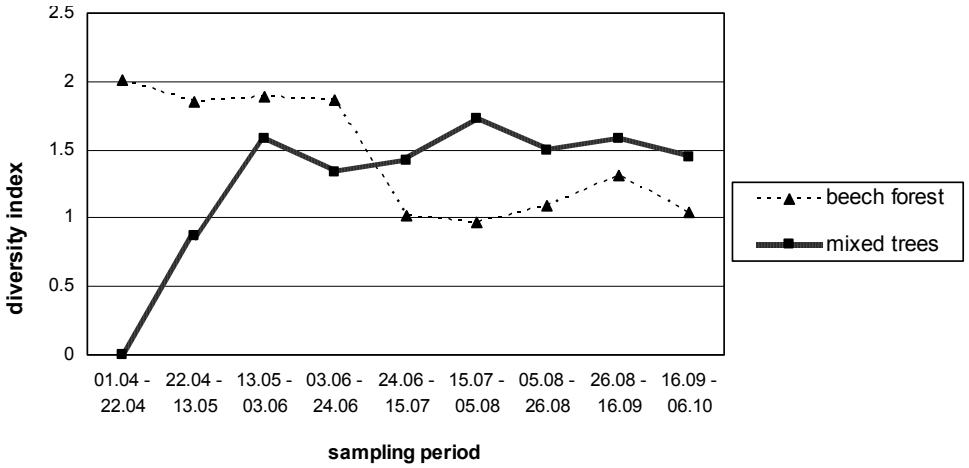

Fig. 2. Dynamics of the Shannon-Wiener index of diversity values during 2007 in the beech and mixed trees forest.

THE SIMILARITY OF THE STUDIED CARABID POPULATIONS

According to the Canberra-Metric coefficient (0.167), the two carabid populations seem to differ very much, though the differences in Shannon-Wiener index of diversity are not statistically significant. This is due to the only 10 common species for both populations and their numerical abundances.

Another reason is that 14 carabid species were found only in the beech forest (species belonging to *Amara, Harpalus* and *Trechus* genera, which are euritopic of open areas and come from the nearby meadow). Also, the microclimatic differences (temperature, humidity, earth pH) of the two forests are the abiotic background of the low similarity level between the carabid populations from the studied areas.

CONCLUSIONS

Carabidae fauna shows similarities in terms of population structure in the two studied forests. Thus, the species numerical abundances, noted similar, vary, having high values during spring and minimum ones in summer. Also, in terms of constancy classes, in both populations, the highest proportion is represented by accidental species, while only few species (the typical forest ones) are numerically dominant. In both habitats, species diversity is high and shows similar patterns of variation in time; the high values of Shannon-Wiener index of diversity are typical for natural forest habitats.

Differences between the two carabid populations consist mainly, on the one hand, in specific composition and species ecological characteristics, on the other

hand. The low degree of similarity between the two studied populations, as was also emphasized by different authors in previous similar studies, is due to accidental species in each population, with origins in the neighboring habitat (s).

The presence of macropterous flying carabid species, even accidentally from the meadow in forest habitat, shows not only that carabids (especially euritopic ones) use their abilities to fit to the habitat availabilities according to their specific needs, but also the importance of edge forest as shelter and food sink.

The carabid populations in the studied forest habitats are heterogeneous as a whole in light of species biological and ecological characteristics, providing partially to integrating cenoses more effective ways of regulating ecological processes.

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