# The community structure of the ground dwelling carabid beetles (Coleoptera: Carabidae) and spiders (Arachnida: Araneae) in peat bog "Mohos" (Transylvania, Romania)

István Máthé, István Urák, Adalbert Balog and Enikő Balázs

**Abstract**

1. Were examined the community structure indices (dominance, similarity, diversity) of carabid beetles and spiders in the peat bog Mohos in the East of Transylvania (Romania).

2. Studies were carried out in four different habitats: in Scoth pines forest, in birch forest, in meadow and in the nearest beech forest.

3. During the survey the peat bog carabid fauna were the purest (84 specimens belonging to the 17 species) and the beech forest fauna were the richest (606 specimen belonging to the 21 species), while the spider fauna were represented inverse (546 specimens and 48 species in peat bog and 119 specimens and 12 species in beech forest).

4. We can conclude that the habitat structure (soil types, plant cover) and the disturbances have a significant role in forming the dominance of species and also the diversity and the similarity of the communities are highly influenced.

**Keywords:** Carabidae beetles, spiders, beech, pine, birch, meadow, diversity, similarity.

## Introduction

In Europe a large number of natural peat lands can be found in northern part of the continent, but they are very rare in Central Europe. Several natural and semi-natural bogs were situated in the Romanian Carpathians. These are known as glacial refuges for rare and of high value plant species (Pop 1960, Rupreht & Szabó 1999, Margóczi et al. 2000), but some recent faunistical papers deal about also interesting spider fauna with rare species (Gallé & Urák 2001, 2002).

A previous study about the Mohos peat bog spider fauna, mentioned only 6 species (Kolosváry 1941).

The Romanian peat bogs carabid fauna are still little known. The Mohos carabid fauna, due to the habitat character, are relative pure in species. In South Bohemia – (Czech Republic) in "Červené Blato bog" 20 species were collected with pitfall traps (Spitzer at all. 1999).

## Material and Methods

### Site description

The Mohos peat bog and his region are one of the most valuable botanical reserves in Romania. The site is located in the east of Transylvania, in the middle part of the East Carpathian massive in 1050 m above the see (Horváth 2002). The geographical coordination of the site is $46^0$ 08' degrees of northern latitude and $43^0$ 34' degrees of eastern longitude. The total area of the meadow is approximately 80 ha.

Investigations took places in three different biotopes in Mohos peat bog (in meadow, in birch forest, in pine forest) and in the nearest beech forest.

1. Mohos meadow: open area with scattered dwarf Scotch pine trees (*Pinus silvestris)* formed the central part of the meadow with a mosaic structure. Considering the dominant plant associations, it can be divided in two micro formations, one with *Scheucherietum* and *Andromeda* and the other with *Eriophoretum vaginati* and *Oxycocco-Sphagnetea* (Ferencz 1996).

2. Mohos birch forest *(Pineto - Betuletum)* are located to the upper part of the water-course which divide the area into two (Ferencz 1996).

3. Mohos pine forest *(Vaccinio - Pinetum sylvestris)* situated to the east part of the mean water-course (Coldea 1997).

4. Mohos beech forest *(Symphyto cordatae - Fagetum)* surrounding the peat bog Mohos in east, south-east part. The forest is more than 100 years old and has a size of 7 ha.

### Sample collection

Covered pitfall traps (500 ml in size, 10 cm in diameter, half-filled with ethylene glycol 30% solution) were used to collect samples. Five pitfall traps were placed in transects in each habitats. Samples were collected monthly (Niemalä 1990) from May to October in 2003.

The collected carabid and spider individuals were identified to the lowest taxonomic level possible. For the identification the works of Freude *et al*. (1976), Hůrka (1996), Roberts (1985, 1987), Heimer & Nentwig (1991) and Platnick (2000) were used.

### Data analyses

Nested analyses of variance (ANOVA) were used to determine the habitat effects to the observed species and specimens' number of carabides and spiders in peat bog.

The forming similarities of the carabid and spider communities in the different habitats were studied with "Principal Coordinate Analyse" (PCoA) methods, and the Jaccard and Horn indices were calculated (Krebs 1989).

The Jaccard are used to compare the species composition of two communities using binary dates and registered only the presence and the absence of the species. These results can be derived from:

$S_a = a / b+c-a$

Where: $S_a$ = similarity Jaccard coefficient, a = the species number in both samples, b = the species number in sample b, c = the species number in sample c. If $S_a = 0$, the samples are completely differed from each-other, if $S_a = 1$, the samples are completely similar.

The Horn is used to compare the species composition and the dominance structure of the communities, considering the relative abundance of species. These results can be derived from:

$$R_o = \Sigma[(X_{ij}+X_{ik})\log(X_{ij}+X_{ik})]- \Sigma(X_{ij}\log X_{ij})-\Sigma(X_{ik}\log X_{ik}) \Big/ [(N_j+N_k)\log(N_j+N_k)]-(N_j\log N_j)$$

Where: $R_o$ = Horn similarity index in samples j and k, $X_{ij}$, $X_{ik}$ = The specimens number of i species in samples j and k, $N_j = \Sigma X_{ij}$ = The total specimens in sample j, $N_k = \Sigma X_{ik}$ = The total specimens in sample k.

Data were transformed using $\log_{10}$ for reducing the importance of the dominant species and were accentuated the importance of the subdominant species.

The Rényi diversity index with Nucosa PC program was used as a measure of the carabid and spider diversity in different habitats

$$H_a = \log \sum_{i=1}^{S} pi_a \Big/ 1-\alpha, \text{ were: } \alpha \geq 0, \alpha \neq 1$$

The α parameter indices were compared with t-test (Tóthmérész 1993, 1996, 1997).

## Results

### Faunistical studies

Altogether were collected 690 carabid specimens belonging to the 29 species and a number of 665 spider specimens belonging to the 57 species were collected.

Considering the different habitats, carabidae species were frequently found in beech forest (606 specimens and 21 species), while they density in other habitats were the lowest (66 specimens and 13 species in pine, 12 specimens and 4 species in birch and 6 specimens and 6 species in meadow).

The highest spider densities were found in pine forest (293 specimens belonging to the 30 species), while the lowest in beech forest (119 specimens and 12 species). In the other habitats the spider densities were also relative high (137 specimens and 25 species in meadow, and 116 specimens and 24 species in birch).

After the cumulative assay studies of the Carabidae and Araneae communities, were identified the most widely occurring species in peat bog Mohos and in the beech forest.

Can not be considered any dominant carabid species in peat bog, while in beech forest *Pterostichus oblongopunctatus* were the most frequent occurred, and other four (*Carabus linnei, Cychrus semigranosus, Pterostichus unctulatus* and *P. foveolatus*) were subdominant, accounted for 76.07% of all carabides recorded here.

Considered the spider species, the most widely occurring in peat bog were *Pirata hygrophilus,* while species *Walckenaeria atrotibialis, Coelotes inermis, Trochosa terricola* and *Aulonia albimana* were subdominant, altogether accounted 52.56% of all spider species collected here. In beech forest species *Coelotes terrestris* were dominant and *C. inermis* subdominant (Table 1).

**Table 1**

The cumulative number of the dominant species and they relative proportion.

| Carabid Species | Beech | Pine | Birch | Meadow |
|---|---|---|---|---|
| ***Carabus linnei*** | 67 | 1 | - | - |
| *Cychrus semigranosus* | 36 | - | - | - |
| ***Pterostichus foveolatus*** | 41 | - | - | - |
| ***Pterostichus oblongopunctatus*** | 262 | 6 | 5 | 1 |
| ***Pterostichus unctulatus*** | 65 | - | - | 1 |
| **Σ** | **471** | **7** | **5** | **2** |
| | **76,07%** | - | - | - |
| **Spider species** | **Beech** | **Pine** | **Birch** | **Meadow** |
| ***Aulonia albimana*** | - | 23 | 3 | 22 |
| ***Coelotes inermis*** | 26 | 26 | - | 1 |
| ***Coelotes terrestris*** | 52 | - | - | - |
| ***Pirata hygrophilus*** | - | 69 | 40 | - |
| ***Trochosa terricola*** | - | 29 | 11 | 10 |
| ***Walckenaeria atrotibialis*** | - | 41 | 10 | 2 |
| **Σ** | **78** | **188** | **64** | **35** |
| | - | → | → | **52,56%** |

After the cumulative studies of the carabid beetles and the spiders were observed that the activity-density of the species and specimens varied differently. In habitats were the carabid density were high (beech forest), the spider density were low, while were the spider density were the highest (pine, birch and meadow) the carabid density were low (Fig. 1, 2).

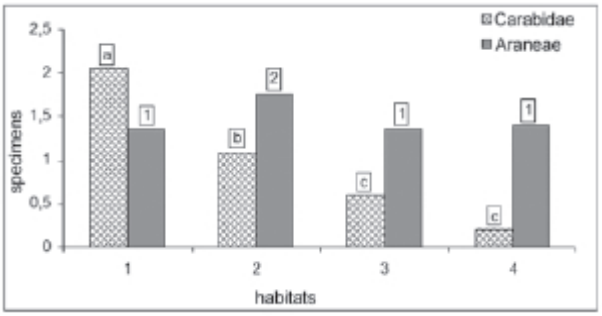


**Fig. 1.** The mean specimens' number (log) caught in investigated habitats.

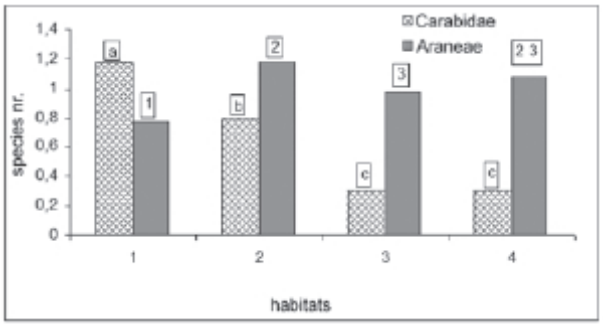


**Fig. 2.** The mean species number (log) caught in investigated habitats.

## Diversity studies

The Rényi diversity indexes were used as a measure of the carabid and spider diversity in different habitats. During the diversity studies of the carabidae, the meadow was excluded because of the low species number. There were no significant differences between the rare species (low α scale parameters) diversity in beech, pine and birch forest. Considering only the dominant species (high α scale parameters), the diversity in birch forest were the lowest and the diversity in beech forest were the highest (Table 2, Fig. 3).

**Table 2**

α parameter indices, compared with t-test.

| α parameter indices | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| **Beech-Pine** | 40,05 ** | 1,52 n.s. | 0,95 n.s. | 1,43 n.s. | 1,53 n.s. | 1,53 n.s. | 1,51 n.s. | 1,49 n.s. |
| **Beech-Birch** | 74,13 ** | 5,52 ** | 1,66 n.s. | 0,64 n.s. | 0,27 n.s. | 0,09 n.s. | 0,009 n.s. | 0,038 n.s. |
| **Pine-Birch** | 37,18 ** | 3,82 ** | 2,02 * | 1,45 n.s. | 1,18 n.s. | 1,01 n.s. | 0,9 n.s. | 0,82 n.s. |

Explanation: ** $p < 0,01$; * $p < 0,05$; n.s. – non significant.

The diversity indices of the spider communities were significantly highest in meadow and in pine forest than in birch and beech forest. The lowest diversity was observed in beech forest in whole area of alpha scale parameters (Table 3, Fig. 4).

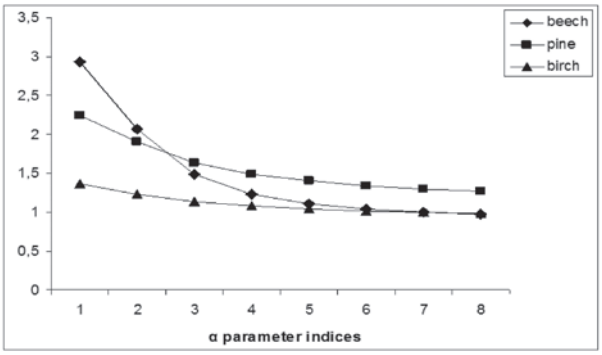


**Fig. 3.** The diversity profile of the carabid beetles in Mohos peat bog.

**Table 3**

α parameter indices, compared with t-test.

| α parameter indices | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Beech-Pine** | 8,48 ** | 6,14 ** | 5,17 ** | 4,71 ** | 4,46 ** | 4,33 ** |
| **Beech-Birch** | 4,46 ** | 2,5 ** | 1,83 * | 1,6 n.s. | 1,5 n.s. | 1,46 n.s. |
| **Beech-Meadow** | 8,03 ** | 6,25 ** | 5,44 ** | 5,08 ** | 4,92 ** | 4,83 ** |
| **Pine- Birch** | 2,16 * | 2,19 * | 2,25 *+ | 2,29 *+ | 2,31 *+ | 2,31 *+ |
| **Pine-Meadow** | 0,25 n.s. | 0,88 n.s. | 0,97 n.s. | 1 n.s. | 1,03 n.s. | 1,06 n.s. |
| **Birch-Meadow** | 2,22 *+ | 2,68 ** | 2,82 ** | 2,92 ** | 2,98 ** | 3,02 ** |

Explanation: ** $p < 0,01$; *+ $p < 0,02$; * $p < 0,05$; n.s. – non significant.

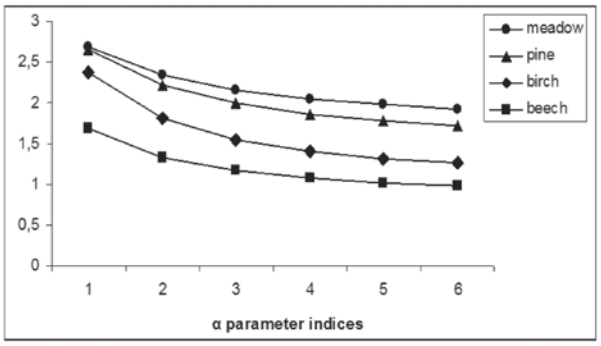


**Fig. 4.** The diversity profile of the spiders in Mohos peat bog and in beech forest.

### Similarity studies

The similarities of the carabid and spider communities in different habitats, using binary dates (Jaccard index) were the following: the species composition of carabid beetles in beech forest (1), and in pine forest (2) differed from each-other, and bouts differed from the species composition observed in birch and meadow (3, 4) (Fig. 5 a).

The species composition of the spider communities shows a higher similarity, and only the beech forest (1) differed significantly from the other habitats (2, 3, 4) (Fig. 5 b).

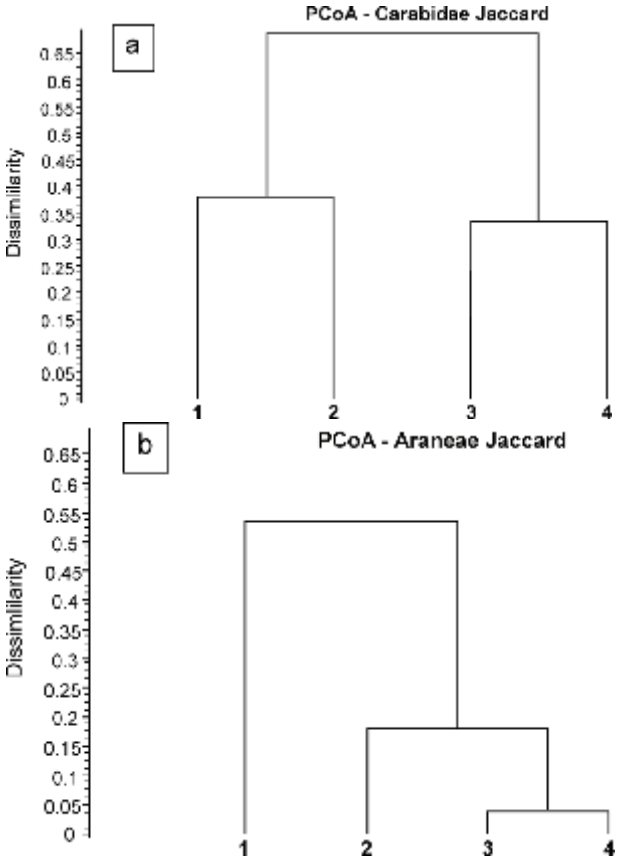


**Fig. 5.** The Jaccard indices of the Carabidae (a) and Araneae (b) in Mohos peat bog and in the nearest beech forest.

Using the ratio scale data to compare the dominance structure of the communities considering the relative abundance of the species (Horn), were observed the same results in species composition of spider communities (Fig. 6 b), while the dissimilarity in carabid communities were the highest (Fig. 6 a).

With logarithmic transformation of the Horn indices (Horn $\log_{10}$) to accentuate the importance of the subdominant species, were observed the same results (Fig. 7 a, b).

## Discussions

### Faunistical studies

During the survey were collected 29 carabid and 57 spider species.

Carabid species were frequently found in beech forest while the highest spider densities were found in peat bog in pine forest.

The dominant and subdominant carabid species in beech forest were *Pterostichus oblongopunctatus, Carabus linnei, C. violaceus, Pterostichus unctulatus* and *P. foveolatus* accounted for 76.07% of all carabides recorded in Mohos.

From spider species, the most widely oc-

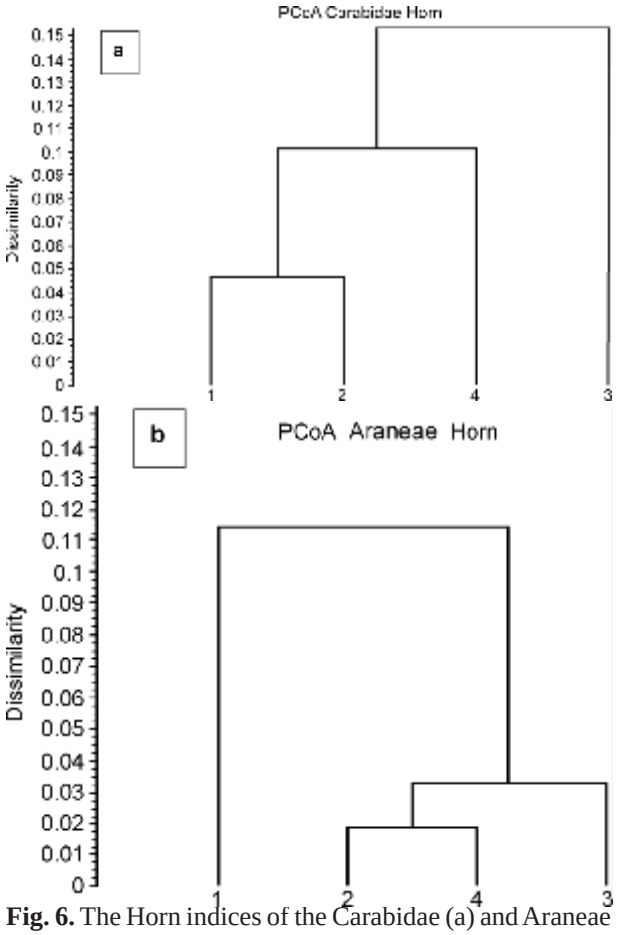


**Fig. 6.** The Horn indices of the Carabidae (a) and Araneae (b) in Mohos peat bog and in the nearest beech forest.

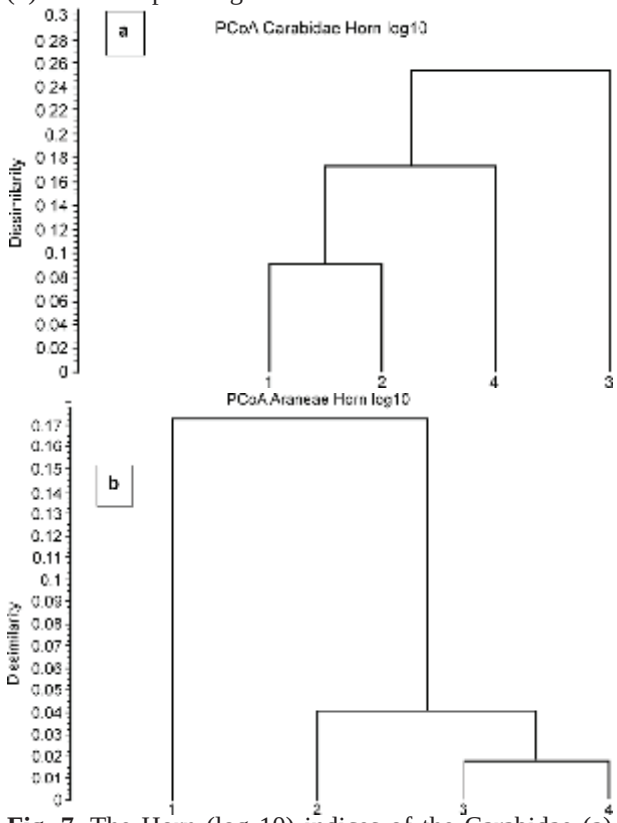


**Fig. 7.** The Horn (log 10) indices of the Carabidae (a) and Araneae (b) in Mohos peat bog and in the nearest beech forest.

curring in peat bog were *Pirata hygrophilus, Walckenaeria atrotibialis, Coelotes inermis, Trochosa terricola* and *Aulonia albimana,* accounted 52.56% of all species collected here. In beech forest species *Coelotes terrestris* were dominant and *C. inermis* subdominant.

Using the analyses of variance it can conclude that the habitat structure like the soil composition, the plant composition and the plant cower could have a significant effect to the activity-density of the carabides and spiders in these habitats. We can conclude also that the ecological preferences of the two groups differed significantly ($p< 0,01$).

These could explain why the species richness and the abundance varied inverse in two groups (Fig. 1, 2). Also it can be concluded that the species composition of carabides and spiders in peat bog, are deeply influenced by the disturbance rates in different habitats.

## Diversity studies

Considering only the rare species (low α scale parameters), there were no significant differences between the diversity of the carabid species in beech, pine and birch forest. Considering the dominant species (high α scale parameters), the diversity of the birch forest were the lowest, and the diversity of the beech forest the highest.

The diversity of the spider communities was high in meadow and in pine forest and bouts were more diverse than in birch and beech forest.

## Similarity studies

The similarity studies of the carabid and spider communities in different habitats, considering the binary dates (Jaccard index) and the ratio scale dates (Horn and Horn $\log_{10}$) shoves a high dissimilarity in carabid communities between the habitats, while the similarity in spider communities were high.

We can conclude that the forming structures of the species composition of carabid beetles are highly influenced by the different ecological conditions, while the spider communities are less influenced.

## Conclusion

The habitat structure promotes the carabid and spider fauna in different ways and has a significant effect to the species composition. These could have an inverse influence to the species richness and to the abundance of carabid and spider communities in the same time.

Also the diversity of the spider communities and the diversity of the dominant carabid species are deeply influenced by the ecological conditions in these habitats.

The similarity indices of the carabid communities are more influences by the habitat effects, compared with the spider communities.

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**Authors' adresses:**

István MÁTHÉ
Sapientia University
Department of Natural and Technological Sciences
Ro-530104 Miercurea Ciuc
Piaţa Libertăţii Nr. 1
E-mail: matheistvan@sapientia.siculorum.ro

István URÁK
Sapientia University
Department of Natural Sciences
Ro-400112 Cluj Napoca
Str. Matei Corvin Nr. 4
E-mail: kui@email.ro

Adalbert BALOG
Sapientia University
Department Humanities and Technical Sciences
Ro-540053 Târgu Mures
Piaţa Trandafirilor Nr. 61
E-mail: balogadalbert2002@yahoo.co.uk

Enikő BALÁZS
Babeş-Bolyai University
Faculty of Biology and Geology
Cluj-Napoca, Str. Clinicilor 5-7

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