Species composition and distribution of ground beetles (Coleoptera, Carabidae) in the forests of the Kamanos State Strict Reserve (Lithuania)

Algimantas Žiogas, Stasys Vaičikauskas


Studies on ground beetles (Coleoptera, Carabidae) in eight forest types of the Kamanos State Strict Reserve were carried out in 2001-2002. 43 species of ground beetles, which belong to 15 genera were recognized. Dominating species, number of individuals of the species, seasonal activity of dominating species, ecological and zoogeographical characteristics of the ground beetles were ascertained at each forest type. The results show that soil moisture is the most important factor determining differences in ground beetle coenoses between the forest types.

Key words: ground beetles, specific composition, forest type, abundance.

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INTRODUCTION

At present, in Lithuania more than 290 species of ground beetles are known and about 50 species, which have not been detected up to now, are assumed to occur on the territory (Pileckis & Monsevičius 1995). Most ground beetles are polyphagans with a wide food range. In the forest litter 61 – 85% are entomophagans (Litvinova et al. 1985). The abundance of ground beetles depends not so much on the nutrition as on the sum of biotic and abiotic factors in the respective habitat. Close relations with corresponding soil types characterize most genera and species of ground beetles, because soil is one of the preconditional factors with respect to structure and state of ecosystems. These peculiarities of ground beetles, as well as long-term standard investigation methods predetermined the use of ground beetles as indicators of environmental conditions (Sharova 1971, 1981).

Ground beetles suffer from non commercial thinning cutting in forest stands. The degree of disturbance is more pronounced in older stands. First of all disappear large forest ground beetles, living in small areas. They are substituted by widely spread small sized ground beetles of meadows and fields. According to the Mean Individual Biomass Index it is suggested to increase tree species diversity in forests to accelerate restora-
tion of fauna (Szyszko 1987). In damaged ecosystems in Belarus prevail mesophilous species, especially in bogs and in meadows (Chotko 1991). The lists of Lithuanian ground beetles are presented in the works of Pileckis (1960, 1976), Silfverberg (1992), and Pileckis & Monsevičius (1995). It has to be admitted, that there are few separate works on Lithuanian ground beetles. Ground beetles in the Vilnius region were studied by Ogijevich (1931/1932). Later on, species composition and distribution of ground beetles with respect to biotopes in the Žuvintas strict reserve and Curonian Spit (Sharova & Gryuntal 1973) as well as in the Dukstyna entomological reserve (Dvilevicius et al. 1988) were studied.

Studies on beetles in the Kamanos State Strict Reserve started in 1980. 110 species of ground beetles were found and described. They comprise 38% of the species known in Lithuania (Report on the ... 2000, Annual report on ... 2001). Forest, marshland and peatland coenoses of ground beetles are characteristic for the Kamanos Strict Reserve. The most abundant species and individuals of ground beetles are found in marshy forests and high moors, slightly less in woods and pine-forests. In high moors 24 species of ground beetles were found, however specific ones were scarce. In recent years, due to dryer climate and changes in marshland vegetation, *Pterostichus cupreus* L. has become very common (Pileckis & Monsevičius 1995). Rather frequently *Amara* species, characteristic for arable fields and meadows, are observed. The coenosis of ground beetles characteristic for meadows in the reserve is quite poor. It shows an abundant admixture of forest ground beetles species. This coenosis will disappear after overgrowing of the meadows by forests. The riparian coenosis is very poor in species. It consists of scanty ground beetles species living on the banks of temporary water basins and the Kamanos lake (Report on the ... 2000-2001).

**METHODS**

Studies on ground beetles were carried out in forest sites varying in humidity and fertility of their soils. Six Barber traps (0.5 l capacity) were installed 10 m from each other in a row in each of the following forest sites: Oxalidosum spruce stand, Myrtillosum pine stand, Myrtillo – oxalidosum spruce stand, Oxalidosum broadelved birch stand, Calamagrostics birch stand, Sphagno – ledosum pine stand, Caricoso – ledosum pine stand, and Caricosum birch stand. Beetles were collected from the traps once per two weeks from the end of April up to the end of October in 2001 and 2002.

The following indices were used for characterisation of the ground beetle communities:

1. Species composition and number of species.
2. Relative abundance (dominance) – percentage share of the species within a sample.

According to relative abundance, all species were divided into 5 classes (Table 1). The upper limit of the classes was ascertained by J. Pesenko’s method (Pesenko 1982):

\[ N^{ak}, (a = 1,2, \ldots, k; \; k = \text{number of classes}). \]

3. As Lopatin (1979) points out, there are two main fauna types: Mediterranean (paratetuic) and

<table>
<thead>
<tr>
<th>Point</th>
<th>Limits of class intervals</th>
<th>Dominance of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>Upper</td>
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</tr>
<tr>
<td>1</td>
<td>1</td>
<td>( N^{0.2} )</td>
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<tr>
<td>2</td>
<td>( N^{0.2} + 1 )</td>
<td>( N^{0.4} )</td>
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<tr>
<td>3</td>
<td>( N^{0.4} + 1 )</td>
<td>( N^{0.6} )</td>
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<tr>
<td>4</td>
<td>( N^{0.6} + 1 )</td>
<td>( N^{0.8} )</td>
</tr>
<tr>
<td>5</td>
<td>( N^{0.8} + 1 )</td>
<td>( N )</td>
</tr>
</tbody>
</table>

Table 1. Five - classes logarithmic scale of assessment of relative species abundance (dominance).
Species composition and distribution of ground beetles (Coleoptera, Carabidae) in the forests...

Siberian (boreal). In the present study, according to zoogeographical characteristics species are divided into 2 main types of fauna: boreal (Holarctic, Palearctic, Eurosiberian and European species) and paratetic (Western Palearctic, Euromediterranean and Europontean species).

4. The similarity of individual communities was ascertained by indices of species similarity (qualitative) as well similarity in dominance values (quantitative) based on the Czekanowski - Sorensen’s formula (Magurran 1998):

$$I_{cs} = \frac{2A}{S_j + S_k}$$ - for qualitative indices,
$$I_{cs} = I_{min}(p_{ij}, p_{ik})$$ - for quantitative indices,

with A - number of species common in both samples; $S_j$ - number of species in sample j; $S_k$ - number of species in sample k. $I_{cs}$ for quantitative data - sum of the smaller values of relative abundance (dominance) of species common in both samples ($p_{ij}$ – dominance of species i in sample j; $p_{ik}$ – dominance of species i in sample k).

Based on the calculated similarity values dendrograms of the study areas were created using the weighted pair group average clustering method (Felsenstein 1989).

The beetles were identified using identification keys for beetles (Lešinskas & Pileckis 1967; Plavilschikov 1950, Kryzanovskij 1983). Data on the distribution of beetles were taken from the Polish catalogue of beetles (Burakowski et al. 1973) and other faunistic works (Kryzanovskij 1985; Pileckis 1960, 1976; Pileckis & Monsevičius 1995).

RESULTS AND DISCUSSION

During the study 2117 individuals of ground beetles belonging to 43 species of 15 genera were captured (Table 2).

In the oxalidosum spruce stand *Calathus micropterus* Duft. (59.9%) was an eudominant species, dominant – *Harpalus quadripunctatus* Dej. (20.5%), subdominant – *Carabus hortensis* (4.7%) and *Pterostychus oblongopunctatus* Fabr. (7.9%), recedent – *Cychrus caraboides* L. (1.9%), and subrecedent – *Amara aenea* Deg., *A. familiaris* Duft., *A. brunnea* Gyll., *Carabus cansellatus tuberculatus* Dej., *C. nemoralis* Müll., *Harpalus rufipes* Deg., *Nebria brevicollis* Fabr., *Pterostichus melanarius* Ill., *P. strenuus* Panz. and *P. versicolor* Sturm. (all of them together summed up to 5.1%).

The biggest number of the dominant species, *Calathus micropterus* Duft., is marked in August (137 beetles per trap). The majority of the species (80%) are boreal and mesophilous species. Only in this forest type representatives of dry biotopes (*Amara familiaris* Duft. and *Harpalus rufipes* Deg.) could be detected.

<table>
<thead>
<tr>
<th>Forest type</th>
<th>Number of species</th>
<th>Number of individuals</th>
</tr>
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<tbody>
<tr>
<td>Oxalidosum spruce stand</td>
<td>15</td>
<td>317</td>
</tr>
<tr>
<td>Myrtillosum pine stand</td>
<td>13</td>
<td>314</td>
</tr>
<tr>
<td>Myrtillo - oxalidosum spruce stand</td>
<td>21</td>
<td>824</td>
</tr>
<tr>
<td>Oxalidosum broadleaved birch stand</td>
<td>17</td>
<td>139</td>
</tr>
<tr>
<td>Calamagrostis birch stand</td>
<td>25</td>
<td>195</td>
</tr>
<tr>
<td>Sphagno - ledosum pine stand</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td>Caricoso - ledosum pine stand</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Caricosum birch stand</td>
<td>24</td>
<td>245</td>
</tr>
</tbody>
</table>
In the myrtillosum pine stand (33.8%) *Calathus micropterus* Duft. was eudominant, dominant were *Pterostichus oblongopunctatus* Fabr. (25.8%) and *Carabus hortensis* L. (19.4%), subdominant – *Cychrus Caraboides* L. (3.8%), recedents – *Carabus glabratus* Payk. (2.9%) and *Pterostichus melanarius* Ill. (1.9%). *Carabus hortensis* L. and *Calathus micropterus* Duft. were collected in high abundances at the end of summer – beginning of autumn and *Pterostichus oblongopunctatus* Fabr. – in the spring and in the beginning of summer. Only in this forest type *Stomis pumicatus* Panz. was found, a species characteristic for dry woods. The majority of the species belong to the boreal (77%) and mesophilous (77%).

In the myrtillo – oxalidosum spruce stand *Calathus micropterus* Duft. was eudominant (23.3%) and *Pterostichus melanarius* Ill. (24%). *Carabus hortensis* L. (17.8%), *Pterostychus oblongopunctatus* Fabr. (8.6%) were dominant. The other 14 species were recedent (3.3%) and subrecedent (9.6%). As well as in the myrtillosum pine stand *Pterostichus oblongopunctatus* Fabr. shows high abundances in May – April and the other dominant species at the end of July and in August. Boreal species prevail (95%). 12 of these species (57%) are mesophilous, 7 of them (33%) hygrophilous and 2 of them (10%) euryhygrophilous.

In the community structure of the oxalidosum broadleaved birch forest eudominants were absent. It is possible to attribute 7 species to the subdominants: *Carabus nemoralis* Müll. (13%), *C. hortensis* L. (7.9%), *C. granulatus* L. (13%), *Cychrus caraboides* (7.2%), *Pterostichus oblongopunctatus* Fabr. (7.9%), *P. melanarius* Ill. (13.7%) and *Platynus assimilis* Payk. (12.2%).

In the spring the most numerous species were *Carabus granulatus* L., *Pterostichus oblongopunctatus* Fabr. and *Platynus assimilis* Payk. and in the summer – autumn time *Carabus nemoralis* Müll., *C. hortensis* L. and *Cychrus caraboides* L. The latter species occurs not only in woods but also in meadows and fields. The majority of the sampled species are boreal species (95%). Concerning demands on moisture the species were distributed as follows: 16 species (65%) - mesophilous, 5 (20%) - hygrophilous, 1 (6%) – euryhygrophilous.

In the community structure of the ground beetles in the calamagrostis birch stand eudomains were not present. *Carabus granulatus* L. was dominant (14.4%) and 6 species – *Pterostichus atrorufus* Strom. (9.7%), *Pterostichus anthracinus* Ill. (10.8%), *P. nigrita* Schall. (9.7%), *P. melanarius* Ill. (12.3%), *P. nigrita* Fabr. (11.3%), *Platynus assimilis* Payk. (6.7%) – subdominant. 5 of the remaining species (15%) were recedents and 13 species subrecedents (10.1%). In this forest type the dominant species *Carabus granulatus* L. is most common. Only in this forest type the hygrophilous species *Pterostichus anthracinus* Ill. was detected, which can be regarded as an indicator of this forest type. There are three species – *Agonum thoreyi* Dej., *A. gracile* Sturm and *Platynus lives* Gyll. – which were not found in other forest types. Boreal species (88%) prevail. At this site the soil is fertile and boggy. Hygrophilous species (48%) were more numerous than mesophilous (40%) and euryhygrophilous (12%) ones. The dominant species *Carabus granulatus* and *Pterostichus nigrita* Fabr. can serve as indicator of marshy forest types.

In the sphagno – ledosum pine stand dominated *Agonum ericeti* Panz. (36.4%) and *Pterostichus diligens* Sturm (21.1%). *A. ericeti* Panz. is included in the Red List Data Book of Lithuania, though in this forest type it is not scarce - 12 beetles of *A. ericeti* have been caught in June. The remaining 10 species of beetles were recedents and subrecedents. All species are boreal, 6 of them are mesophilous and 4 hygrophilous.

In the spring the myrtillosum pine stand were *Carabus arvensis* Herbst (20%), *Pterostichus oblongopunctatus* Fabr. (16%) and *Cychrus caraboides* L. (22%). The first two species were active in the spring but *C. caraboides*...
L. was active in the autumn. 87% of the species are boreal. Each 7 of the detected species are hygrophilous and mesophilous.

Representatives of 24 species were collected in the caricosum birch stand. All species are boreal, 13 species are hygrophil.

A qualitative analysis of similarities between the coenoses concerning the species composition of ground beetles shows, that there are two groups of forests separated with respect to soil humidity (Fig. 1). The first group comprises medium moist and temporarily flooded forest types. To this group belong the oxalidosum spruce stand, the myrtillosum pine stand, the myrtillo - oxalidosum spruce stand and the oxalidosum broadleaved birch stand. Altogether, 30 species of ground beetles were detected in these stands. The second group included the flooded and marshy woods where the following types prevail: calamagrostis birch stand, caricosum birch stand, caricoso - ledosum pine stand and sphagno - ledosum pine stand. 36 species of ground beetles were found in these stands. Forests of the first group are characterized by a rather low degree of diversity of ground beetle species. High diversity of species of ground beetles in the flooded and marshy forests in the second group was preconditioned by a low dominance level and high number of species. All the data show a great impact of moisture on the development of ground beetles coenoses. Among the boggy forests, the sphagno - ledosum pine stand should be distinguished, which is characterised by poor living conditions for the carabids and the lowest number (11) of their species.

Fig. 1. Similarity (Ics) between the forest types of the Kamanos State Strict Reserve with respect to species composition of ground beetles according to quantitative data (species similarity) (1 - oxalidosum spruce stand, 2 - myrtillosum pine stand, 3 - myrtillo - oxalidosum spruce stand, 4 - oxalidosum broadleaved birch stand, 5 - calamagrostics birch stand, 6 - caricosum birch stand, 7 - caricoso - ledosum pine stand, 8 - sphagno - ledosum pine stand).
sides, it contains a species adapted to the conditions of this biotope type - Agonum ericeti Panz. It is listed in the Red List Data Book of Lithuania (Lietuvos Raudonoji knyga 1992), although in high moor it is not scarce.

Forests of the first group are characterized by obvious dominants of ground beetles (Calathus micropterus Duft., Pterostichus melanarius Ill. (P. vulgaris L.), Pterostichus oblongopunctatus Fabr.).

According similarity diagram (Fig. 2), three forest types have a similar species composition: myrtillo-oxalidosum spruce stand (21), calamagrostis birch stand (26) and caricosum birch stand (24). This result may be explained by the fertility characteristic for all these forest types. The calamagrostis birch stand belongs to the flooded marshy stands, the caricosum birch stand to the marshy woods, while the myrtillo-oxalidosum spruce stand grows on temporarily flooded soil.

However, with exception of the sphagno-ledosum pine stand, all stands show very high similarity (differences among the stands are very small).

Summarizing, it can be stated that the greatest differences in the species variety of ground beetles exist among forest - types differing by the degree of soil moisture content. Obviously, species diversity of ground beetles is preconditioned by soil moisture content in a certain forest type. In the Moscow district, humidity of soil was detected as a more important factor with respect to ground beetles communities than species of trees (Gryuntal 1983).

Fig. 2. Similarity (Ics) between the forest types of the Kamanos State Strict Reserve with respect to species composition of ground beetles according to qualitative data (similarity in dominance values) (1 - oxalidosum spruce stand, 2 - myrtillosum pine stand, 3 - myrtillo-oxalidosum spruce stand, 4 - oxalidosum - broadleaved birch stand, 5 - calamagrostis birch stand, 6 - caricosum birch stand, 7 - caricoso - ledosum pine stand, 8 - sphagno - ledosum pine stand).
Carrying out zoogeographical analysis of animals, including beetles, boreal species are those species, which migrated in post-glacial subarctic and pre-boreal periods from the East, Usuria, Manchuria and Mongolia centres. Ecologically these species are related to forests and marshlands. Namely these species and their derivatives comprise the main portion of species of the studied territory. They inhabited Kamanos approximately 7,000 - 12,000 years ago.

The Mediterranean fauna type comprises species, which in boreal and atlantic periods migrated from Mediterranean, Pontomediterranean and Caspian centres. During the study in the Kamanos State Strict Reserve 8 mediterranean species (18%) have been found. At present they are characterized by western palearctic (6 species), euromediterranean (1 species) and europontic (1 species) areas. By intrazonal biotops these species can move far to the north. Ecologically, paratetuic species are related to dry meadows, well warmed by the sun, light woods and broadleaved forest. Migration optimum of pontic species coincides with pre-boreal period (6,000 – 7,000 years ago). There are only 2 of them in the strict reserve: *Nebria brevicollis* Fabr., and *Badister unipustulatus* Bon. During the study only one was detected - *Nebria brevicollis* Fabr.

Euromediterranean and western palearctic species inhabited the area of Lithuania and the strict reserve in the atlantic period (4,000 – 6,000 years ago). A characteristic euromediterranean species found in the reserve is *Stomis pumicatus* Panz. Most of the ground beetles fauna in the Kamanos State Strict Reserve is comprised of boreal type, which includes 35 species (82%). These boreal species are made up by holarctic (3 species), palearctic (13 species), eurosiberian (11 species) and European (8 species) species (Fig. 3).

Paratetuic species in the strict reserve are rather scanty and their relative share is far less than in general in Lithuania.

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![Species composition and distribution of ground beetles (Coleoptera, Carabidae) in the forests...](image_url)

**Fig. 3.** Distribution of ground beetle species according to faunal types in the Kamanos State Strict Reserve.
In the whole Lithuania prevails the boreal fauna type, covering 58% of Carabidae (Pileckis, Moncevičius 1995). During the studies in the Kamanos State Strict Reserve it was revealed, that the share of ground beetles belonging to the boreal type (82%) is far greater than in general in Lithuania (69%). This result can be explained by the fact that studies of Carabidae in Lithuania covered their complexes in forests, meadows and riparian areas, whereas in the Kamanos State Strict Reserve only forests were studied.

The largest share of the boreal fauna type is found in the boggy forest types: sphagno - ledosum pine stand (100%), caricoso - ledosum pine stand (87%), caricosum birch stand (100%), myrtillo - oxalidosum spruce stand (95%) and oxalidosum broadleaved birch stand (94%). The greatest share of paratetuic fauna type is observed in dry forests: oxalidosum spruce stand (20%) and myrtillosum pine stand (23%).

An analysis of the obtained data shows that the present study corresponds to the descriptions of fauna types, where it is admitted that boreal species of Carabidae are ecologically related to forests and bogs, while paratetuic species of Carabidae ecologically depend on dry meadows, well - warmed up by the sun, light pine woods and broadleaved forests.

CONCLUSIONS

In eight studied forest types of Kamanos State Strict Reserve 2117 ground beetles were collected, belonging to 43 species from 15 genera. One species, i.e. Agonum ericeti Panz., is included in the Red List Data Book of Lithuania (Lietuvos Raudonoji knyga 1992). A second species, i.e. Agonum gracilipes Duft., has not been detected in the Kamanos State Strict Reserve up till now. Dominant species were Calathus micropterus Duft. in the oxalidosum spruce stand, Calathus micropterus Duft., Pterostichus oblongopunctatus Fabr. and Carabus hortensis L. in the myrtillosum pine stand and Calathus micropterus Duft., Pterostichus melanarius III. (P. vulgaris L.) and Carabus hortensis L. in the myrtillo - oxalidosum spruce stand. In the oxalidosum broadleaved birch stand no dominants were present, mostly Pterostichus melanarius III. (P. vulgaris L.) and Cychrus caraboides L. (C. rostratus L.) were captured. In the calamagrostic stand prevailed Calathus granulatus L., in the sphagno - ledosum pine stand prevailed Agonum ericeti Panz., a high moor stenobiont, in the caricoso - ledosum pine stand prevailed Cychrus caraboides L. (C. rostratus L.) and in the caricosum birch stand dominated Pterostichus oblongopunctatus Fabr. According to qualitative data of Carabidae species composition, the most were three forest types: the myrtillo - oxalidosum spruce stand, the calamagrostis and the caricosum birch stand. According to moisture requirements, the species of ground beetles are distributed as follows: 56% hygrophilous, 35% - mesophilous and 9% - euryhygrophilous.

The background of Carabidae fauna consists of boreal type, to which belong 35 species (82%). Boreal species are characterized by holarctic (3 species), palaeartic (13 species), eurosiberian (11 species) and european (8 species) areas. The largest portion of boreal species is found in the boggy forest types, while the greatest share of paratetuic species are detected in the myrtillosum pine stand.

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