Baltic J. Coleopterol. 7(1) 2007
ISSN 1407 - 8619

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

Algimantas Žiogas, Stasys Vaičikauskas

Žiogas A., Vaičikauskas S. 2007. Species composition and distribution of ground beetles (Coleoptera, Carabidae) in the forests of the Kamanos State Strict Reserve (Lithuania). *Baltic J. Coleopterol., 7(1): 73 - 82.*

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.

Algimantas Žiogas, Stasys Vaičikauskas (Lithuanian Agricultural University Studentų 11, Lt - 4324, Academy, Kaunas reg., e-mail:aa@nora.lzuu.lt)

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 were 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 broadleaved 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):

$N^{a/k}$, (a = 1,2, ... , k; k = number of classes).

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

Table 1. Five - classes logarithmic scale of assessment of relative species abundance (dominance).

Point	Limits of class intervals		Dominance of species
	Lower	Upper	
1	1	$N^{0.2}$	Subrecedents – individual species
2	$N^{0.2} + 1$	$N^{0.4}$	Recedents - unabundant species
3	$N^{0.4} + 1$	$N^{0.6}$	Subdominants - species of average density
4	$N^{0.6} + 1$	$N^{0.8}$	Dominants - abundant species
5	$N^{0.8} + 1$	N	Eudominants – very abundant species

Table 2. Number of species and individuals of ground beetles in the forests of the Kamanos State Strict Reserve collected in the study.

Forest type	Number of species	Number of individuals
Oxalidosum spruce stand	15	317
Myrtillosum pine stand	13	314
Myrtillo - oxalidosum spruce stand	21	824
Oxalidosum broadleaved birch stand	17	139
Calamagrostis birch stand	25	195
Sphagno - ledosum pine stand	11	33
Caricoso - ledosum pine stand	15	50
Caricosum birch stand	24	245

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 paratetuic (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):

$I_{cs} = 2A/(S_j+S_k)$ - 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 cataloque 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 micropteres* 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.

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 eudominant and dominant species are 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%), *Pterostychus 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 eudominants were not present. *Carabus granulatus* L. was dominant (14.4%) and 6 species – *Patrobus atrorufus* Strom. (9.7%), *Pterostichus anthracinus* Ill. (10.8%), *P. niger* 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 scare - 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 caricoso – ledosum pine stand three species dominated: *Carabus arvensis* Herbst (20%), *Pterostychus oblongupunctatus* 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. Be-

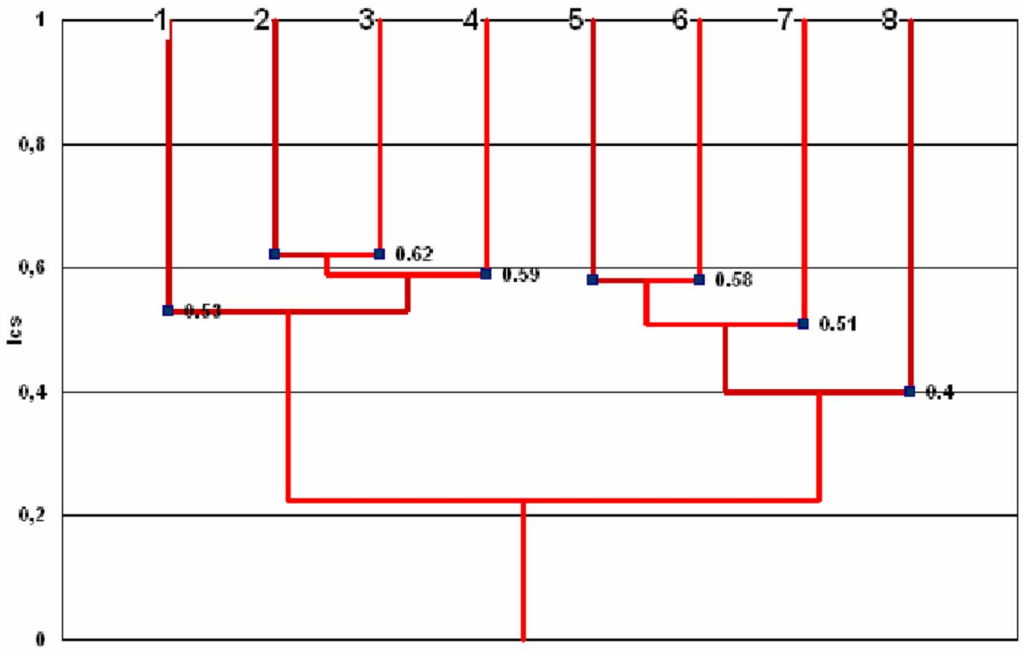

Fig. 1. Similarity (Ics) between the forest types of the Kamanos State Strict Reserve with respect to species composition of ground beetles according to quantitative data (species similarity) (1 - oxalidosum spruce stand, 2 - myrtillosum pine stand, 3 - myrtillo - oxalidosum spruce stand, 4 - oxalidosum 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).

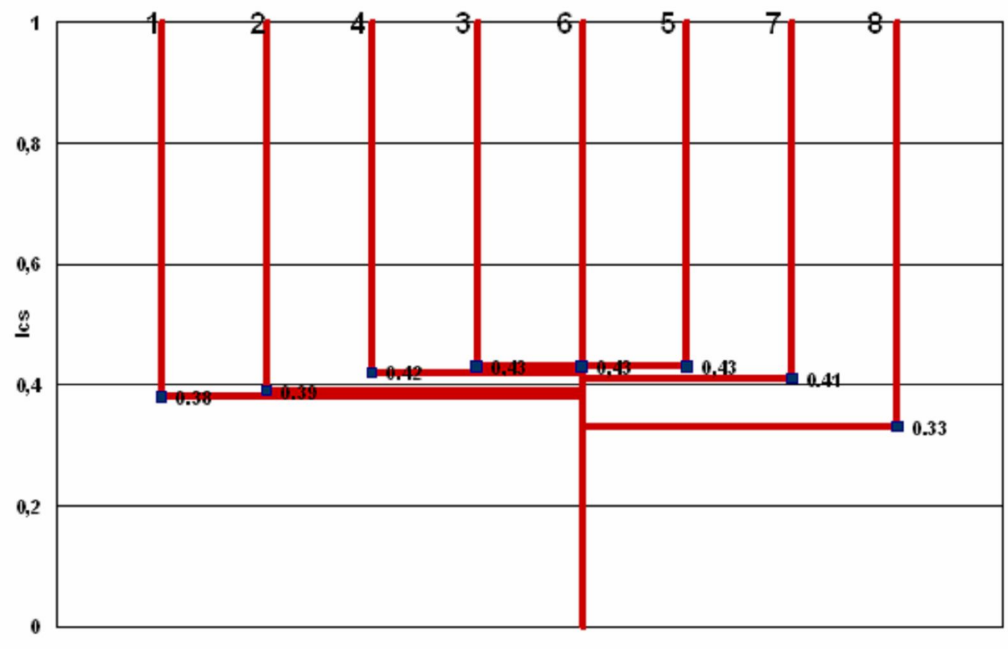

Fig. 2. Similarity (Ics) between the forest types of the Kamanos State Strict Reserve with respect to species composition of ground beetles according to qualitative data (similarity in dominance values) (1 - oxalidosum spruce stand, 2 - myrtillosum pine stand, 3 - myrtillo - oxalidosum spruce stand, 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.

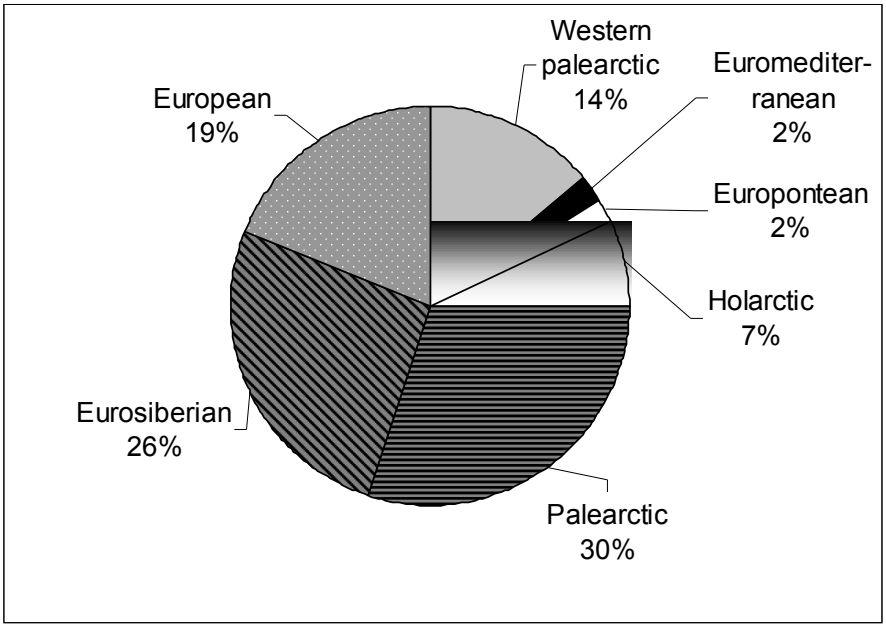

Fig. 3. Distribution of ground beetle species according to faunal types in the Kamanos State Strict Reserve.

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 riperian 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* Ill. (*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* Ill. (*P. vulgaris* L.) and *Cychrus caraboides* L. (*C. rostratus* L.) were captured. In the calamagrostic birch stand prevailed *Carabus 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), palearctic (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.

REFERENCES

Burakowski B., Mroczkowski M., Stefanska J. 1973. Katalog fauny Polski 23 (2), Chrząszcze. Państwowe Wydawnictwo Warszawa, Warszawa. (In Polish).

Chotko E. I. 1991. Fauna and ecology of beetles in Belorusia // The review of research of herpetobiotic beetles. Minsk. Nabuka & technic: 4 – 35 (in Russian).

Dvilevicius R., Ģonsevicius V., Shvitra G. 1988. Fauna and biotop distribution of Carabidae in Dukstas entomological reserve in the

Lithuanian SSR // Acta entomologica Lituanica. Vilnius: Mintis: 26 - 35. (In Russian).

Felsenstein J. 1989. PHYLIP – Phylogeny Inference Package (version 3.2). Cladistics 5:164 – 166.

Gryuntal S. I. 1983. Complexes of ground beetles (*Coleoptera, Carabidae*) in broadleaves – spruce forests//Fauna & ecology of ground invertebrates in Moscow district. – Moscow. Nayka: 85 – 98 (in Russian).

Kamanų valstybinio rezervato direkcijos 2000 m. veiklos ataskaita. 2000. (Report onųyuthe activities of Kamanos state strict reserve in 2000). Akmenė. 403 pp. (In Lithuanian).

Kamanų valstybinio rezervato metinė darbo ataskaita. 2001. (Annual report on the activities of Kamanos state strict reserve 2001). Akmenė. 202 pp. (In Lithuanian).

Kryzanovskij O. 1983. Fauna of the USSR. Coleopterus. - Leningrad: Science. V. I. 340 pp. (In Russian).

Kryzanovskij O. 1985. Carabidae - ground beetles // Descriptor of insects in the European part of the USSR. - Leningrad: Science - V. II: 29 - 77. (In Russian).

Lešinskas A., Pileckis S. 1967. Vadovas Lietuvos vabzdžiams pažinti (Reference book to recognize Lithuanian insects). Vilnius: Mintis. 372 pp. (In Lithuanian).

Lietuvos Raudonoji knyga. 1992. Lietuvos Respublikos aplinkos apsaugos departamentas. Environmental protection department of the Republic of Lithuania. Red Data book of Lithuania, 1992. Retosios ir nykstančios gyvūnų, augalų bei grybų rūšys (Rare and threatened species of animals, plants and fungi). Vilnius. 364 pp. (In Lithuanian).

Litvinova A. N,. Pankeviez T. P., Molczanova P. B. 1985. Insects of pine forests. Minsk: 22 – 28 (in Russian).

Lopatin I. 1979. Regular structure and the zoogeographical characteristics of a fauna of Coleoptera Chrysomelidae of the European part of USSR. VII international symposium on entomofauna of central Europe. Ėåķčķćšąä – ń. 179 – 182 (In Russian).

Magurran A.E. 1988. Ecological diversity and its measurement. Princston Univ. Press, Princston. N.Y. 179 pp.

Ogijewiez B. 1931/1932. Przyczynek do znajomosi chrząszczy (Adephaga i Palpicornia) okolic Wilna i Trok. (Same data into recognition of beetles near Vilnius and Trakai) // Prace Towarzystwa przyjaciol nauk w Wilnie. 1931/1932.T.7.

Pesenko J. 1982. Principles and methods of quantitative analysis in faunistic studies. Ģīscow: Science. 287 pp. (In Russian).

Pileckis S. 1960. Indėlis į Lietuvos vabalų (*Coleoptera*) faunos pažinimą (Input into recognition of Lithuanian beetles (*Coleoptera*). LAA scientific papers 7, 3 (6): 303-335. (In Lithuanian).

Pileckis S. 1976. Lietuvos vabalai (Lithuanian beetles). Vilnius: Mokslas. 238 pp. (In Lithuanian).

Pileckis S., Monsevičius V. 1995. Lietuvos fauna. Vabalai (Lithuanian fauna.Beetles). Vilnius: Mokslas. T.I. 251 pp. (In Lithuanian).

Plavilschikov N. 1950. Descripton of insects. Ģīscow. 544 pp. (In Russian).

Silfverberg H. 1992. Enumeratio Coleopterorum Fennoscandiae, Daniae et Baltiae. Helsinki. P. - 350. (In Finnish).

Sharova I. 1971. Fauna and ecology of animals. Peculiarities of biotop distribution of

ground beetles (Coleoptera, Carabidae) in the zone of mixed forests nearby Moscow. Çīscow: 1-85. (In Russian).

Sharova I. 1981. Life form of ground beetles (*Coleoptera, Carabidae*). Moscow: Science. 395 pp. (In Russian).

Sharova I., Gryuntal S. 1973. Studies of Coleoptera and Carabidae in Žuvintas reserve and Curonian Spit // Acta entomologica Lituanica. 2: 72-74. (In Russian).

Szyzko J. 1987. How can the fauna of Carabidae be protected in managed pine forest?// Acta Phytopath. Entomol. Hung. 22: 293 - 303. (In Polish).

Received; 20.02.2007.
Accepted: 31.05.2007.