ACTA SCIENTIARUM POLONORUM
Acta Sci. Pol.
Silv. Colendar. Rat. Ind. Lignar. 6(2) 2007, 45-63

ROVE BEETLES (*COLEOPTERA*, *STAPHYLINIDAE*) AS AN ELEMENT OF MONITORING OF FOREST ECOSYSTEMS IN THE KARKONOSZE NATIONAL PARK PART II. THE SPRING SEASON ASPECT AND CONCLUDING REMARKS

Andrzej Mazur, Agata Skoczek
Agricultural University of Poznań

Abstract. In the course of forest management works in the Karkonosze National Park a total of 630 circular sample plots arranged in a 200 × 300 m graticule were established using the mathematical statistical method. Litter samples were collected from the centres of these plots in the spring and early summer of 2004 in order to determine the species composition of groups of rove beetles (*Staphylinidae*) and to conduct their zoocenological characteristics. A total of 83 beetles, belonging to 22 taxa, were found in samples. Identified groups were analysed using zoocenological indexes for subalpine and montane forests. It was found that the dominant species were *Geostiba circellaris* (Grav.), *Atheta tibialis* (Heer) and *Amischa analis* (Grav.), as well as *Othius subuliformis* Steph. In the groups of the montane forest eight taxa were distinguished with a distinct domination of *Geostiba circellaris*. Spring *Staphylinidae* groups of the subalpine forest consist of 21 taxa and indicate a domination structure characteristic for undisturbed ecological systems with high frequencies of *Atheta tibialis* and *Amischa analis*.

Key words: ecological monitoring, forest ecosystems, the Karkonosze National Park, *Coleoptera*, *Staphylinidae*

INTRODUCTION

This study presents the results obtained in the course of monitoring of forest ecosystems in the Karkonosze National Park in the spring season of 2004. It is a continuation and supplementation of the project initiated in 2002 [Mazur et al. 2007] and completes the 3-year period of survey and monitoring works on the occurrence of invertebrates in the forest ecosystems of the Karkonosze National Park.

Corresponding author – Adres do korespondencji: Dr inż. Andrzej Mazur, Department of Forest Entomology of Agricultural University of Poznań, Wojska Polskiego 71 C, 60-625 Poznań, Poland, e-mail: andrzejm@au.poznan.pl

THE SITE OF THE STUDY

Monitoring works were based on a network of fixed points, being centres of circular sample plots established using the mathematical statistical method in the course of forest management works. The network of points was identical as that used in the course of monitoring work conducted in the autumn season in the years 2002 and 2003 [Mazur et al. 2007]. Table 1 lists basic information on the location and site and stand conditions of the plots, in which rove beetles were recorded.

Table 1. Characteristics of monitoring plots in the Karkonosze National Park, in which rove beetles (*Staphylinidae*) were reported in spring 2004
Tabela 1. Charakterystyka powierzchni monitoringowych w Karkonoskim Parku Narodowym, na których stwierdzono chrząszcze kusakowate (*Staphylinidae*) wiosną 2004 roku

Number of plot Numer powierzchni	Subcompartment Pododdział	Altitude a.s.l., m Wysokość n.p.m., m	Age of stand Wiek drzewostanu	Site type Typ siedliskowy
1	2	3	4	5
Szrenica Protected Zone – Obwód Ochronny Szrenica				
12-72	204f	1 207	172	BWG
15-76	204b	1 165	177	BWG
21-68	211d	1 242	177	BWG
21-76	195c	1 086	117	BWG
27-68	201d	1 202	177	BWG
27-70	201c	1 161	177	BWG
27-82	190a	965	63	BMG
27-87	186a	872	60	LMG
30-27	194f	1 133	177	BWG
33-68	210b	1 233	157	BWG
36-74	200a	1 190	10	BWG
69-107	214i	577	92	LMG
Śnieżne Kotły Protected Zone – Obwód Ochronny Śnieżne Kotły				
75-54	164b	1 275	38	BWG
78-56	163h	1 245	27	BWG
84-62	161a	1 125	31	BWG
90-64	151g	1 083	40	BWG
90-74	147b	875	18	BMG
90-86	135b	706	132	LMG
93-78	132b	812	122	LMG
96-84	134d	760	117	LMG
99-80	132b	780	122	LMG
99-90	120c	644	82	BMG
99-96	114b	620	77	LMG
102-86	118j	684	67	LMG
Przełęcz Protected Zone – Obwód Ochronny Przełęcz				
78-62	136f	1 097	73	BWG
102-60	157b	1 143	52	BWG
102-68	141i	950	85	BWG
108-52	153b	1 226	137	BWG
108-54	154d	1 198	28	BWG
108-58	155f	1 165	137	BWG
111-46	169f	1 251	117	BWG

Table 1 – cont.

1	2	3	4	5
114-50	86b	1 150	123	BWG
114-58	123g	1 018	50	BWG
114-68	124c	852	107	BMG
114-80	107h	673	157	LMG
114-88	104g	589	45	LMG
135-112	212m	526	45	LMG
135-116	212c	433	102	LMG
Wang Protected Zone – Obwód Ochronny Wang				
111-44	85f	1 254	147	BWG
117-40	83f	1 124	215	BWG
123-36	82f	1 159	163	BWG
144-34	98b	1 273	197	BWG
180-34	54k	1 006	18	BWG
180-49	35f	938	110	LMG
186-44	33m	981	35	LMG
Stanica Protected Zone – Obwód Ochronny Stanica				
174-28	63f	1 070	167	BWG
177-22	71j	1 206	127	BWG
177-24	71d	1 178	10	BWG
177-28	63d	1 089	107	BWG
183-20	69c	1 119	163	BWG
186-24	60g	1 037	122	BWG
Śnieżka Protected Zone – Obwód Ochronny Śnieżka				
195-8	23m	1 203	207	BWG
198-26	49b	954	22	LMG
204-10	23b	1 218	57	BWG
204-22	38a	969	47	LMG
207-22	37g	902	165	LMG
207-32	31g	720	102	LMG
210-32	31b	710	25	LMG
213-14	22a	1 157	167	BWG
228-12	17b	1 176	53	BWG
228-20	16c	987	62	BWG
259-18	2b	1 030	18	BWG

METHODOLOGY

Methodology of field work and analysis of results was identical as in the monitoring work conducted so far [Mazur et al. 2007]. Experimental material was obtained from a series of litter and humus samples collected in 630 circular sample plots established in the Karkonosze National Park. The dimensions of 40 × 40 cm were adopted as the size of the litter sample. Samples were collected on site in the period from 1 June to 15 July 2004.

Fixed beetle specimens are gathered in Andrzej Mazur's collection at the Department of Forest Entomology, the August Cieszkowski Agricultural University of Poznań.

The following zoocenological indexes were used to characterize groups of rove beetles: constancy of occurrence (C) and individual domination (D) adopted following the

definition by Szujecki [1983], the index of estimation fidelity, thus distinguishing: R – relict species, F_4 – exclusive characteristic species – found regularly in a given habitat, appearing occasionally in others; mountain and boreal mountain species were included in this class, F_3 – selective characteristic species – found in abundance in a given habitat, although found also in others; first of all forest species connected with coniferous forest sites were included in this class, F_2 – accessory (accompanying) species – found in a given habitat in smaller numbers than in others or not exhibiting a preference for any habitat, F_1 – species alien for the habitat, F_0 – ubiquitous species.

The Margalef species richness (d) and the Shannon-Weaver species diversity index (H') were adopted following Szujecki [1983], while the group fidelity index (Q) was adopted after Smoleński and Szujecki [2001]. The Boháč index (S_i) – the consistency of the analysed groups with the model group and the group ecological value index (Q_2) were adopted after Szujecki [1995].

A LIST AND ANALYSIS OF RESULTS

In the spring season of 2004 in 64 samples a total of 83 rove beetles were recorded, coming from 22 taxa. A list of reported *Staphylinidae* species is presented in Table 2. Names of beetles from family *Staphylinidae* were adopted following a study by Assing and Schülke [2001].

Analysis of domination structure and frequency of occurrence. Figure 1 presents an analysis of occurrence of rove beetles depending on the age of stands. No eudominants were found among collected species. Dominants included *Atheta tibialis*, *Geostiba circellaris*, *Amischa analis* and *Othius subuliformis*. Species caught most frequently, classified as constants, were *Atheta tibialis* and *Geostiba circellaris*. It results from the analysis of the domination structure and the frequency of occurrence that *Atheta tibialis* was the species found most often and in biggest numbers in the spring-summer period in the forest habitats of the Karkonosze Mountains. This species was recorded throughout the entire forested area of the Karkonosze National Park, being caught in biggest numbers in the Szrenica Protected Zone. Sites, in which the analyzed species was recorded, represent mixed mountain coniferous forest sites (77% locations) and mixed mountain forest sites (23% locations). The second species from the group of constants – *Geostiba circellaris* was recorded in much bigger numbers in montane habitats in mixed mountain forest sites (73% locations) than in subalpine forests in the mixed mountain coniferous forest sites (27% locations).

Distribution of dominant species. Frequencies of distinguished species dominant depending on the age of stands are presented in Figs 2-5. *Amischa analis* and *Atheta tibialis* were recorded in biggest numbers in stands aged 161-180 years. The other dominant species had similar frequencies and were found primarily in stands of younger and middle age classes.

Characteristics of *Staphylinidae* groups in montane and subalpine forests in the Karkonosze National Park. In the spring-summer season in the montane forest habitats of the Karkonosze National Park eight taxa were recorded, represented by 24 specimens (Table 3). *Geostiba circellaris* was the dominant species in this habitat. The *Staphylinidae* group of montane forests is composed of species characteristic for coniferous forest sites. Only two mountain species were found there: *Quedius paradisianus* and *Atheta tibialis*.

Table 2. A list of species of rove beetles (*Staphylinidae*) recorded in the Karkonosze National Park during monitoring of forest ecosystems in the spring--summer season of 2004

Tabela 2. Lista gatunków chrząszczy kusakowatych (*Staphylinidae*) stwierdzonych na terenie Karkonoskiego Parku Narodowego w czasie monitoringu ekosystemów leśnych w okresie wiosenno-letnim 2004 roku

Staphylinidae species Gatunek *Staphylinidae*	Population size and locations in KNP protected zones (n/number of plot) Liczebność i stanowiska w obwodach ochronnych KPN (n/numer powierzchni)						Total number of specimens Suma osobników (n)	Dominance Dominacja (D) %	Number of samples Liczba prób (q)	Constancy of occurrence Stałość występowania (C) %	Fidelity class Klasa wierności	Faunistic element Element faunistyczny
	Stanica	Śnieżka	Wang	Przełęcz	Śnieżne Kotły	Szrenica						
1	2	3	4	5	6	7	8	9	10	11	12	13
Aleocharinae				1/108-54			1	1.2	1	1.6		
Amischa analis (GRAV., 1802)	1/177-22	1/207-22	1/186-44		1/90-86	1/21-76 2/36-74 3/12-72	10	12.0	7	10.9	F2	P
Atheta sp.			3/111-44				3	3.6	1	1.6		
Atheta fungi (GRAV., 1806)				1/102-68	1/90-74 1/99-80 1/99-96		4	4.8	4	6.3	F2	H
Atheta tibialis (HEER, 1839)	1/174-28 1/186-24	1/204-22 1/195-8	1/180-34 1/180-49	1/114-58	1/78-56	1/21-68 2/21-76 1/27-87 2/12-72 1/27-70	15	18.1	13	20.3	F4	BG
Eucnecosum brachypterum (GRAV., 1802)				1/108-52			1	1.2	1	1.6	F4	P, BG
Geostiba circellaris (GRAV., 1806)		1/259-18		4/135-116 2/135-112 1/114-80 1/114-88	1/96-84 1/102-86 1/93-78	1/15-76 1/27-82 1/69-107	15	18.1	11	17.2	F3	EK
Lathrobium brunnipes (FABR., 1792)					1/99-90		1	1.2	1	1.6	F2	ES
Lathrobium fulvipenne (GRAV., 1806)	1/183-20 1/177-28	1/228-20		1/111-46 1/108-58	1/90-64	1/33-68 1/21-68	8	9.6	8	12.5	F2	ES

Table 2 – cont.

1	2	3	4	5	6	7	8	9	10	11	12	13
Lathrobium sp.	1/177-24						1	1.2	1	1.6		
Leptusa flavicornis (BRANCSIK, 1874)		1/228-12					1	1.2	1	1.6	R	P
Othius subuliformis STEPH., 1833 = *O. myrmecophilus* KIESENW., 1843	2/177-28	1/213-14 1/228-20 1/204-22	1/123-36	1/102-60 1/78-62	1/84-62		9	10.8	8	12.5	F3	EK
Philonthus nigrita (GRAV., 1806)				1/114-50		1/30-27	2	2.4	2	3.1	F2	ES
Quedius cincticollis (KR., 1857)			1/117-40				1	1.2	1	1.6	F3	G
Quedius fuliginosus (GRAV., 1802)		1/198-26					1	1.2	1	1.6	F2	P
Quedius fulvicollis (STEPH., 1833)						1/27-68	1	1.2	1	1.6	F3	H
Quedius paradisianus (HEER, 1839)		1/204-10 1/207-32		1/114-68			3	3.6	3	4.7	F4	EK, G
Quedius punctatellus (HEER, 1839)					1/75-54		1	1.2	1	1.6	F4	E, G
Quedius umbrinus ER., 1839						1/21-68	1	1.2	1	1.6	F2	E
Sepedophilus sp.		1/210-32					1	1.2	1	1.6		
Stenus glacialis HEER, 1839	1/177-28						1	1.2	1	1.6	F4	BG
Tachyporus hypnorum (FABR., 1775)			1/144-34			1/21-68	2	2.4	2	3.1	F2	P
Total – Ogółem							83					

Legend:

Faunistic element: ES – Euro-Siberian, E – European, P – Palearctic, BG – boreal mountain, G – mountain, EK – Euro-Caucasian, H – Holarctic.

Fidelity class: R – relict species, F_4 – exclusive characteristic species – found regularly in a given habitat, appearing occasionally in others; mountain and boreal mountain species were included in this class, F_3 – selective characteristic species – found in abundance in a given habitat, although found also in other habitats; first of all forest species connected with coniferous forest habitats were included in this class, F_2 – auxiliary (accompanying) species – found in a given species in lower numbers than in other habitats or exhibiting no preference for any habitat, F_1 – alien species in a given habitat, F_0 – ubiquitous species.

Objaśnienia:

Element faunistyczny: ES – eurosyberyjski, E – europejski, P – palearktyczny, BG – borealno-górski, G – górski, EK – eurokaukazki, H – holarktyczny.

Klasa wierności: R – gatunki reliktowe, F_4 – gatunki charakterystyczne wyłączne – występujące regularnie w danym środowisku, w innym pojawiające się przypadkowo; zaliczano do tej klasy gatunki górskie i borealno-górskie, F_3 – gatunki charakterystyczne wybierające – występujące licznie w danym środowisku, jednak znajdowane także w innych środowiskach; zaliczano do tej klasy przede wszystkim gatunki leśne związane ze środowiskami borowymi, F_2 – gatunki pomocnicze (towarzyszące) – występujące w danym środowisku mniej licznie niż w innych środowiskach lub niewykazujące skłonności do żadnego środowiska, F_1 – gatunki obce dla środowiska, F_0 – gatunki wszędobylskie, ubikwistyczne.

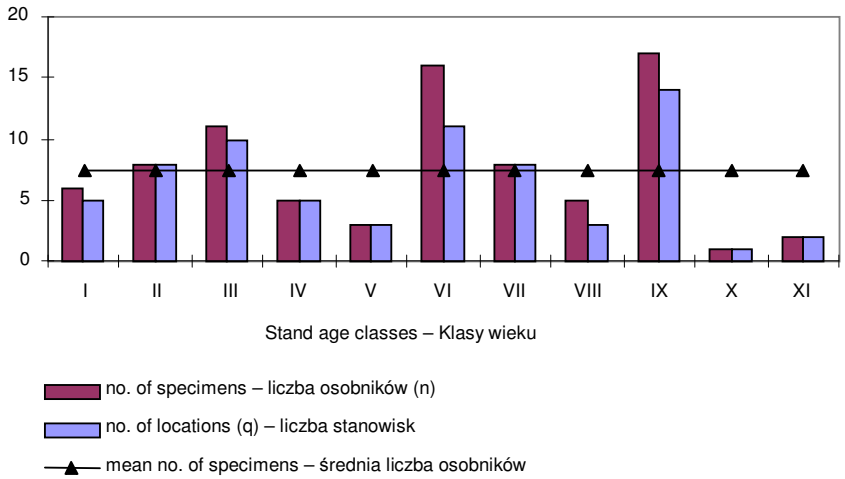

Fig. 1. Frequency of *Staphylinidae* in stands of the Karkonosze National Park in terms of age classes for the spring-summer season of 2004
Rys. 1. Frekwencja *Staphylinidae* w drzewostanach Karkonoskiego Parku Narodowego z rozbiciem na klasy wieku dla okresu wiosenno-letniego 2004 roku

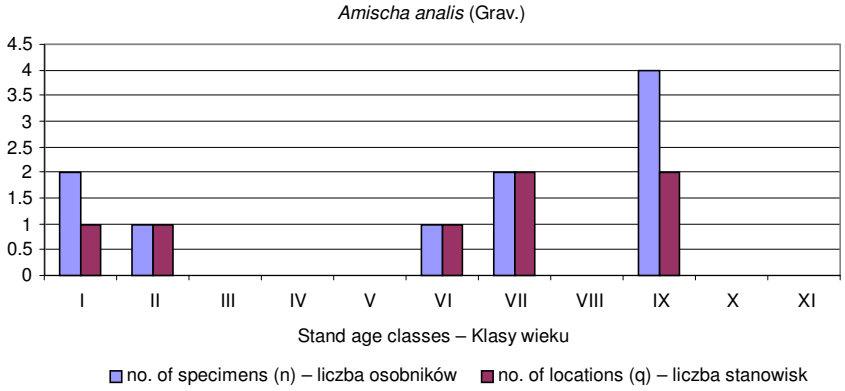

Fig. 2. Frequency of *Amischa analis* (GRAV.) in stands of the Karkonosze National Park in terms of age classes for the spring-summer season of 2004
Rys. 2. Frekwencja *Amischa analis* (GRAV.) w drzewostanach Karkonoskiego Parku Narodowego z rozbiciem na klasy wieku w okresie wiosenno-letnim 2004 roku

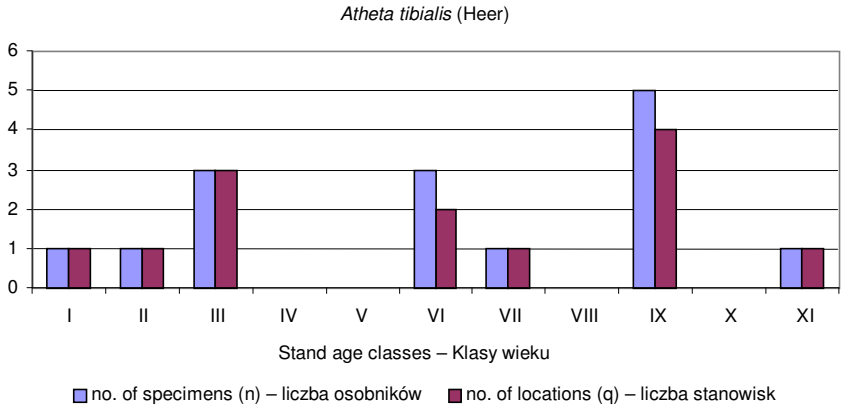

Fig. 3. Frequency of *Atheta tibilas* (HEER) in stands of the Karkonosze National Park in terms of age classes for the spring-summer season of 2004
Rys. 3. Frekwencja *Atheta tibilas* (HEER) w drzewostanach Karkonoskiego Parku Narodowego z rozbiciem na klasy wieku w okresie wiosenno-letnim 2004 roku

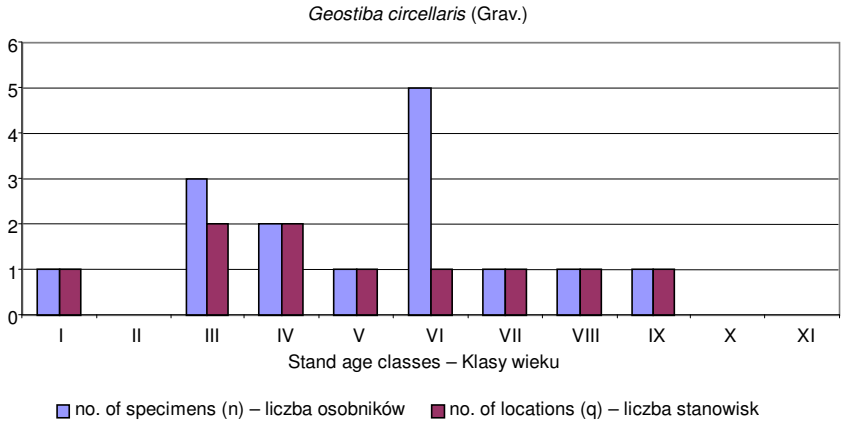

Fig. 4. Frequency of *Geostiba circellaris* (GRAV.) in stands of the Karkonosze National Park in terms of age classes for the spring-summer season of 2004
Rys. 4. Frekwencja *Geostiba circellaris* (GRAV.) w drzewostanach Karkonoskiego Parku Narodowego z rozbiciem na klasy wieku w okresie wiosenno-letnim 2004 roku

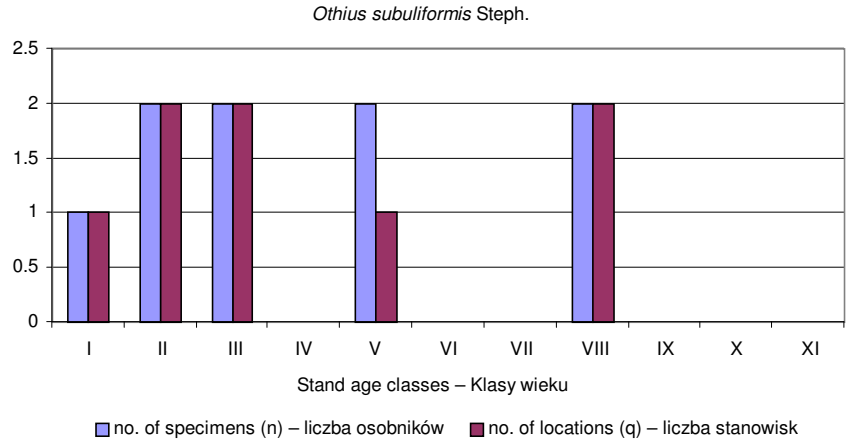

Fig. 5. Frequency of *Othius subuliformis* Steph. in stands of the Karkonosze National Park in terms of age classes for the spring-summer season of 2004
Rys. 5. Frekwencja *Othius subuliformis* Steph. w drzewostanach Karkonoskiego Parku Narodowego z rozbiciem na klasy wieku w okresie wiosenno-letnim 2004 roku

Table 3. A list of *Staphylinidae* species recorded in forest habitats of montane forest zone in the Karkonosze National Park in the spring-summer season of 2004 in the decreasing order of dominace
Tabela 3. Lista gatunków *Staphylinidae* stwierdzonych w środowiskach leśnych regla dolnego Karkonoskiego Parku Narodowego w okresie wiosenno-letnim 2004 roku według malejącej dominacji

Staphylinidae Species Gatunek *Staphylinidae*	Total of specimens Liczba osobników (n)	Domination Dominacja (D)	Number of samples Liczba prób (q)	Konstancy of occurence Stałość występowania (C)
Geostiba circellaris (GRAV., 1806)	12	50.0	8	40.0
Amischa analis (GRAV., 1802)	3	12.5	3	15.0
Atheta tibialis (HEER, 1839)	3	12.5	3	15.0
Atheta fungi (GRAVENHORST, 1806)	2	8.3	2	10.0
Quedius fuliginosus (GRAVENHORST, 1802)	1	4.2	1	5.0
Quedius paradisianus (HEER, 1839)	1	4.2	1	5.0
Othius subuliformis STEPHENS, 1833	1	4.2	1	5.0
Sepedophilus sp.	1	4.2	1	5.0
Total – Ogółem	24			

In the *Staphylinidae* groups of subalpine coniferous forests a total of 59 specimens were reported, coming from 21 taxa (Table 4). Atheta tibialis was the dominant species here. Zooindication indexes, calculated for distinguished groups, are presented in Table 5. Zooindication indexes, calculated for protected zones of the Karkonosze National Park, are presented in Table 6 and Figure 6.

Table 4. A list of *Staphylinidae* species recorded in spruce coniferous forests of the subalpine forest zone in the Karkonosze National Park in the spring-summer season of 2004
Tabela 4. Lista gatunków *Staphylinidae* stwierdzonych w borach świerkowych regla górnego Karkonoskiego Parku Narodowego w okresie wiosenno-letnim 2004 roku

Staphylinidae Species Gatunek *Staphylinidae*	Total of specimens Liczba osobników (n)	Domination Dominacja (D)	Number of samples Liczba prób (q)	Konstancy of occurrence Stałość występowania (C)
Atheta tibialis (HEER, 1839)	12	20.3	10	20.0
Lathrobium fulvipenne (GRAV., 1806)	8	13.6	8	16.0
Othius subuliformis STEPH., 1833	8	13.6	7	14.0
Amischa analis (GRAV., 1802)	7	11.9	4	8.0
Geostiba circellaris (GRAV., 1806)	3	5.1	3	6.0
Atheta sp.	3	5.1	1	2.0
Philonthus nigrita (GRAV., 1806)	2	3.4	2	4.0
Quedius paradisianus (HEER, 1839)	2	3.4	2	4.0
Tachyporus hypnorum (FABR., 1775)	2	3.4	2	4.0
Atheta fungi (GRAV., 1806)	2	3.4	2	4.0
Aleocharinae	1	1.7	1	2.0
Eucnecosum brachypterum (GRAV., 1802)	1	1.7	1	2.0
Lathrobium brunnipes (FABR., 1792)	1	1.7	1	2.0
Lathrobium sp.	1	1.7	1	2.0
Leptusa flavicornis (BRANCSIK, 1874)	1	1.7	1	2.0
Quedius cincticollis (KR., 1857)	1	1.7	1	2.0
Quedius fulvicollis (STEPH., 1833)	1	1.7	1	2.0
Quedius punctatellus (HEER, 1839)	1	1.7	1	2.0
Quedius umbrinus ERICHSON, 1839	1	1.7	1	2.0
Stenus glacialis HEER, 1839	1	1.7	1	2.0
Total – Ogółem	59			

Table 5. Values of zooindication indexes for groups of rove beetles (*Staphylinidae*) in habitats of the montane and subalpine forest zones in the spring-summer season of 2004
Tabela 5. Wartość wskaźników zooindykacyjnych dla zgrupowań chrząszczy kusakowatych (*Staphylinidae*) środowisk regla dolnego i górnego w okresie wiosenno-letnim 2004 roku

Zooindication index Wskaźnik zooindykacyjny	Montane forest Regiel dolny	Subalpine forest Regiel górny	Entire area of KNP Cały obszar KPN
Number of specimens (n) Liczba osobników (n)	24	59	83
Number of taxa (S) Liczba taksonów (S)	8	21	22
Value of index H' Wartość wskaźnika H'	11.64	23.88	34.85
Value of index d Wartość wskaźnika d	6.04	9.88	10.94
Value of index Q Wartość wskaźnika Q	9.52	28.29	38.85
Value of index S_i Wartość wskaźnika S_i	50	60.46	63.85
Value of index Q_2 Wartość wskaźnika Q_2	17.38	25.04	26.43

Table 6. Values of zooindication indexes for groups of rove beetles (*Staphylinidae*) recorded for protected zones of the Karkonosze National Park in the spring-summer season of 2004
Tabela 6. Wartość wskaźników zooindykacyjnych dla zgrupowań chrząszczy kusakowatych (*Staphylinidae*) wyróżnionych dla obwodów ochronnych Karkonoskiego Parku Narodowego w okresie wiosenno-letnim 2004 roku

Zooindication index Wskaźnik zooindykacyjny	Protected zones – Obwody ochronne					
	Stanica	Śnieżka	Wang	Przełęcz	Śnieżne Kotły	Szrenica
Number of specimens (n) Liczba osobników (n)	9	13	9	18	12	22
Number of taxa (S) Liczba taksonów (S)	6	9	6	9	8	9
Value of index H' Wartość wskaźnika H'	6.43	8.95	4.95	9.79	7.68	8.34
Value of index d Wartość wskaźnika d	4.82	7.18	5.24	6.37	6.49	5.96
Value of index Q Wartość wskaźnika Q	5.67	10.72	4.58	12.36	6.24	8.10
Value of index S_i Wartość wskaźnika S_i	66.67	66.67	77.78	77.78	50	50
Value of index Q_2 Wartość wskaźnika Q_2	20.7	21.88	20.19	22.25	18.01	17.26

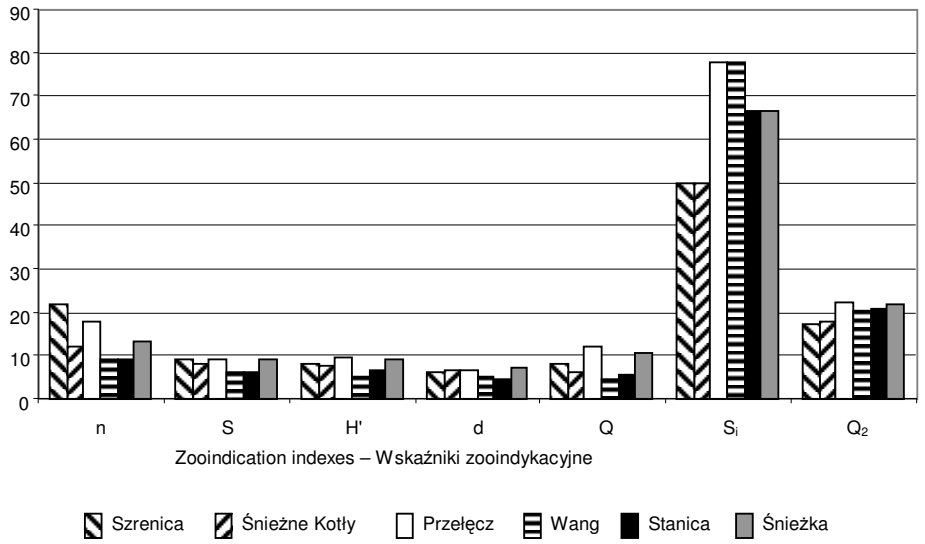

Fig. 6. Values of zooindication indexes: n – number of specimens, S – number of taxa, H' – Shannon-Weaver species diversity, d – Margalef species richness, Q – group fidelity, S_i – Bohač index, Q_2 – ecological value of the *Staphylinidae* group calculated for protected zones of the Karkonosze National Park for the spring-summer season of 2004
Rys. 6. Zestawienie wartości wskaźników zooindykacyjnych: n – liczba osobników, S – liczba taksonów, H' – różnorodność gatunkowa Shannona-Weavera, d – bogactwo gatunkowe Margalefa, Q – wierność zgrupowania, S_i – wskaźnik Bohača, Q_2 – wartość ekologiczna zgrupowania *Staphylinidae* obliczona dla obwodów ochronnych Karkonoskiego Parku Narodowego dla okresu wiosenno-letniego 2004 roku

DISCUSSION OF RESULTS

These investigations are a supplementation and continuation of monitoring work conducted in the Karkonosze National Park in the autumn season of 2002 and 2003 [Mazur et al. 2007]. Results published in this study pertain to the spring-summer season of 2004. The very low frequency of beetles reported in collected samples is surprising. It may be explained both by the adopted method (flushing of invertebrates from litter), the relatively small area from which substrate was collected, as well as changes in the environment in the Karkonosze Mountains, especially the transformation of montane stands into spruce monocultures.

The method of sample collection in case of litter or another substrate and the method used to flush invertebrates inhabiting it, e.g. with the Tullgren funnel, were applied in numerous bioindication studies using *Staphylinidae* as an indicator of environmental quality [Szujecki 1966, 1978, Mazur 2000]. This method – as one of the three research methods – was also applied in the first monitoring study, carried out in forests of the Karkonosze Mountains using *Carabidae* [Leśniak 1984] and scarce experimental material was collected. This may indicate and confirm the low biodiversity of habitats in the Karkonosze, resulting from the characteristics or the current state of the forest habitats.

Summing up the obtained monitoring results from the whole period (2002-2004) several similarities and a few differences need to be pointed out. The species composition of rove beetle groups in the autumn and spring-summer seasons is generally similar. The dominant role is played by species characteristic for coniferous forests with an acid soil environment, i.e. *Othius subuliformis* and *Geostiba circellaris*. The auxiliary and distinguishing role in those groups is played by numerous mountain species. The species richness and frequency of *Staphylinidae* in subalpine coniferous forests are higher than in montane forests. In the spring-summer season this difference is evident.

In contrast, domination relationships in the autumn and spring-summer seasons differ. In the spring groups the role of the dominant is played by *Atheta tibialis*, found frequently and in abundance, especially in subalpine coniferous forests. The frequency of *Lathrobium fulvipenne* in the spring season is also markedly higher. Moreover, species not recorded in the autumn season appear in the groups. They are *Lathrobium brunnipes*, *Leptusa flavicornis*, *Quedius cincticollis* and *Tachyporus hypnorum*.

Characteristics of dominant species

Atheta tibialis (Heer, 1839) is a species known mainly from the higher parts of mountains in central Europe. In Poland it is reported in scarce and scattered locations in the southern part of the country, being probably carried away with mountain flood waters to lowland locations in the Silesia region. Vague remarks published 100 years ago on the incidence of the species in the Baltic Coastland and in Prussia seem unreliable [Burakowski et al. 1981].

It is found in mountains up to the mountain pine zone, on the mountain of Babia Góra it is caught at the altitude of 1500-1600 m, while in the Sudeten at 800-1300 m above sea level. It is found primarily in moist locations, especially near melting snow patches [Pawłowski 1967, Burakowski et al. 1981]. In the Karkonosze Mountains this species was recorded in the habitats of montane and subalpine forests, with a higher constancy reported for subalpine habitats and the spring season.

Othius subuliformis Stephens, 1833 (= *Othius myrmecophilus* Kiesenwetter, 1843). A European species, reported also in the Caucasus. In the north it reaches the farthest provinces, while in the south it reaches southern Tyrol, Portugal and Spain. It has not been recorded in the Balkan Mountains [Horion 1965, Assing 1999]. In Poland it is found commonly throughout the country [Burakowski et al. 1981]. According to Szujecki [1976] it inhabits woodland areas in lowlands and in the mountains, not reaching the highest parts of the mountains, where it is replaced by mountain species from this genus.

It inhabits forest litter, moss phytocenoses, it is also found under fallen leaves, among decaying plant debris and on bracket fungi. In the opinion of Horion [1965] no permanent relationships of this species were found with ants (despite its name), although it was reported in anthills. Beetles are spotted in autumn and spring, in the mountains in the summer months (June-July). It is also reported in nests of small rodents and bigger mammals; its occurrence in mole nests was defined as accidental [Nowosad 1990, 2000].

It is a forest species [Köhler 1996], found in different habitats. In an experiment conducted by Szujecki [1965] beetles showed preferences for moist and very moist sand and on this basis this species was defined as a representative of fauna of fresh mixed

pine forests. In further studies of the above mentioned author *Othius subuliformis* was defined as a characteristic species (F_3) for the fauna of fresh pine forests [Szujecki 1995].

In studies on *Staphylinidae* in the Beskid Mały Mountains [Paśnik 1998] *O. subuliformis* was recorded in the habitats of alder brush (*Alnetum incanae*), willow-poplar brush (*Salici-Populetum*), brush of boundary strips and forest margins (*Prunetalia spinosae*) – where it occurred as a recendent. It is a dominant in the habitats of hornbeam forests (*Tilio-Carpinetum*) and in the Carpathian beech forest (*Dentario glandulosae-Fagetum*). However, the highest frequency was shown in coniferous forests in the *Abieti-Piceetum montanum* association, where it is the only eudominant [Paśnik 1998].

In studies on *Staphylinidae* groups of beech forests in the Sudeten Foreland [Mazur 2000] *O. subuliformis* was recorded in habitats of acidophilous beech forests *Luzulo--Fagetum*, as well as fertile deciduous forests with *Ficario-Ulmetum* and *Dentario enneaphyllidis-Fagetum* associations, as well as oligotrophic deciduous forests with *Melico-Fagetum* and *Galio-Carpinetum* associations. In the latter habitats this species showed a much higher frequency.

In studies carried out in the Białowieża Primeval Forest [Smoleński and Szujecki 2001] *Othius subuliformis* was considered a forest selective species (F_4) and exhibited the biggest dominance in sites of fresh mixed coniferous forests and fresh coniferous forests, as well as moist coniferous forest and fresh mixed forests. Among all forest sites in the Białowieża Primeval Forest it was not recorded only in alder swamp forest sites.

In the analysis of *Staphylinidae* groups in coastal crowberry coniferous forests [Smoleński 2000] *O. subuliformis* was found as a characteristic coniferous forest species (F_3). A significantly bigger dominance of this species was shown for moist microenvironments and in strongly isolated (closed) subgroups. In the Bieszczady Mountains beetles of this species were caught up to the altitude of 770 m in May, July and September in pine and alder farmland afforestations, pine brushes on pastures and in the litter of a spruce stand [Szujecki 1996].

In studies on the succession of rove beetles on carrion [Topp et al. 1982] *O. subuliformis* was recorded only in forest habitats in the summer season. In studies on other succession processes [Szujecki 1966, Vogel and Dunger 1991] an affiliation of this species was shown to stable forest ecosystems, occurring e.g. in much higher numbers in pine stands of older age classes and immediately after their felling in the clear cutting area [Szujecki 1966]. Also in reclaimed mine dumps with coniferous and deciduous afforestation the frequency of the species was found to increase with the age of afforestation [Vogel and Dunger 1991]. It was reported at all the individual regeneration phases of hornbeam forests in the Białowieża Primeval Forest [Smoleński and Szujecki 2001].

In view of the above the dominant role of this species in natural subalpine coniferous forests in the Karkonosze, as well as its high frequency in spruce monocultures of the montane zone are of great interest. The replacement of *O. subuliformis* by other mountain species from genus *Othius* (e.g. *O. lapidicola, O. angustus*), in the opinion of the authors occurs in the mountainous habitats of the Karkonosze – in corries, in grassy plant communities of the alpine zone and partly also in the mountain pine zone.

Geostiba circellaris (Gravenhorst, 1806) (= *Evanystes circellaris* = *Sipalia circellaris*) is a Euro-Caucasian species, found throughout the entire European continent, except for the Mediterranean and the Caucasus [Burakowski et al. 1981]. It has recently

been reported in north-western Anatolia (Turkey), which extends the range of this species [Assing 2001]. The analysed species was also brought to North America [Lohse and Smetana 1988]. In Poland it is a frequently found species, occurring throughout the country [Burakowski et al. 1981].

It inhabits open and forest areas in lowlands and in the mountains, where it is found in litter, mosses, under alluvia, in compost piles, and even in ant hills and nests of small mammals. In the Bieszczady beetles were found under stones, in scrubs growing in fallowland, in meadows and on stream banks in mixed forests, on peatbogs and in alder forests [Szujecki 1996].

In Carpathian beech forests it is considered an accidental species by Pawłowski [1967]. In the Sudeten Foreland this species was reported in all analyzed habitats with beech forests [Mazur 2000], while it was found in biggest numbers in the fresh forest site and in hornbeam forests.

In groups of rove beetles in coniferous forests a crucial role is played by *Geostiba circellaris*. In mature pine stands in the fresh coniferous forest site it is a characteristic species and dominant in the group. As a result of destructive factors, which may affect a group (e.g. the application of complete felling, a forest fire) the reconstruction of the group and the restoration of original domination relationships in favour of *G. circellaris* occurs after 20-30 years [Szujecki 1966, 1995].

Accoring to Szujecki [1978, 1995], the density of *Geostiba circellaris* in the pine coniferous forest habitat is inversely proportional to the thickness of the litter layer A_0 and the total density of rove beetles, with the latter factors being dependent on moisture conditions.

In the group of rove beetles in the Białowieża Primeval Forest *G. circellaris* is characterized as an accompanying forest species (F_3). The presence of the species was found in all forest site types. An increase in dominance was reported in sites of moist mixed coniferous forest, fresh mixed coniferous forest and moist mixed forest. In the process of hornbeam forest regeneration in the Białowieża Primeval Forest this species was recorded at all the regeneration phases [Smoleński and Szujecki 2001].

Also in groups of rove beetles from crowberry coniferous forests *G. circellaris* has a considerable share in the domination structure. Due to the degree of its affiliation to this habitat it was defined as a characteristic coniferous forest species (F_3). *Geostiba circellaris* reaches the highest position in the domination structure in the subgroup characteristic for coniferous forest microsites of the dry type [Smoleński 2000]. In forests of the Karkonosze Mountains *G. circellaris* occurs in montane and subalpine forests, exhibiting a higher stability of occurrence in montane forests.

Amischa analis (Gravenhorst, 1802) is a Palearctic species, occurring throughout Europe to the areas of the continent extending farthest to the north, as well as in North America and New Zealand. In Poland it is a common species, probably found throughout the country [Burakowski et al. 1981]. Beetles are recorded in different types of habitats: in the mountains and in lowlands, in open areas and in forests. They are found in soils of different type, in litter, among mosses, under fallen leaves and decaying plant debris. In populations of this species very often a lack of male specimens is observed (probably as a result of parthenogenesis).

Amischa analis is defined as a ubiguitous species, found in special abundance in habitats deformed by human activity. In the Bieszczady beetles of this species were reported most often in high-mountain pastures and fallow grounds – former villages

[Szujecki 1996]. For pine forest habitats *Amischa analis* was defined as a foreign species (F_1) [Szujecki 1995]. Its frequency in the forest habitat is interpreted as a result of post-cutting changes in the *Staphylinidae* group in old pine stands favouring eurytopic organisms.

In the Białowieża Primeval Forest the frequency of this species in forest habitats is slight [Smoleński and Szujecki 2001], similarly as in the crowberry coniferous forest habitat [Smoleński 2000]. In the rove beetle groups of field habitats *Amischa analis* exhibits a constant high frequency [Goos 1973].

The fact that this species was recorded with a relatively high frequency in forest habitats of the Karkonosze seems to be of interest, especially that it pertains to specific plant communities, located at high altitudes, i.e. subalpine spruce coniferous forests. On most locations with *A. analis* the age of the stand exceeded 100 years (in the autumn season, the biggest number of specimens was found in 200-year old stands). The age of stands and their resulting decomposition may promote the penetration of this species into the environment. This may also explain the frequency of *A. analis* in the youngest stands.

CONCLUSIONS

Among 630 litter samples collected from circular sample areas distributed in the forest ecosystems in the Karkonosze National Park rove beetles were recorded in 64 samples (10.15%). A comparison of labour input, required both for the collection of samples and their sorting, with the obtained results indicates a very high degree of labour consumption in case of this method, disproportionate to the obtained results.

In spite of low frequencies of beetles in collected samples a total of 37 *Staphylinidae* species were reported in forest ecosystems of the Karkonosze. The dominant role of *Othius subuliformis* and *Geostiba circellaris* was shown as coniferous forest species. In the spring season the role of a dominant is taken over by *Atheta tibialis* – a species characteristic for mountain areas of central Europe. A constant high frequency in forest ecosystems of the montane and subalpine zone was reported for a ubiquitous species – *Amischa analis*.

In forest ecosystems of the subalpine forest zone groups of *Staphylinidae* are characterized by a higher species diversity and higher values of zooindication indexes. These groups may be considered specific, since to a large degree they are composed of mountain species, stenotopic bog species and relict species. In montane forests groups of *Staphylinidae* are characterized by a much smaller species diversity and a simplified structure.

Acknowledgements

The authors would like to thank the following foresters: Mr. Krzysztof Bizaga, Marek Grzegorz, Michał Makowski, Julian Dybalski, Andrzej Wieczorek and Roman Błaszczyk for their kind collection of litter samples from the entire Karkonosze National Park, and Dr. Andrzej Raj – Director of the Karkonosze National Park. Without the dedication and efforts of the above mentioned persons this study would have been impossible.

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CHRZĄSZCZE KUSAKOWATE (*COLEOPTERA*, *STAPHYLINIDAE*) JAKO ELEMENT MONITORINGU EKOSYSTEMÓW LEŚNYCH KARKONOSKIEGO PARKU NARODOWEGO CZĘŚĆ II. ASPEKT WIOSENNY I PODSUMOWANIE

Streszczenie. W czasie prac z zakresu urządzania lasu metodą matematyczno-statystyczną na terenie Karkonoskiego Parku Narodowego założono 630 powierzchni kołowych rozmieszczonych na planie siatki o bokach 200 × 300 m. Wiosną i wczesnym latem 2004 roku ze środków tych powierzchni pobrano próby ściółki w celu określenia składu gatunkowego zgrupowań chrząszczy kusakowatych (*Staphylinidae*) oraz ich charakterystyki zoocenologicznej. W próbach stwierdzono 83 chrząszcze zaliczane do 22 taksonów. Wyróżnione zgrupowania przeanalizowano za pomocą wskaźników zoocenologicznych dla lasów regla dolnego i górnego. Stwierdzono, że gatunkami dominującymi są *Geostiba circellaris* (Grav.), *Atheta tibialis* (Heer) oraz *Amischa analis* (Grav.) i *Othius subuliformis* Steph. W zgrupowaniach regla dolnego wyróżniono osiem taksonów z wyraźną dominacją *Geostiba circellaris*. Wiosenne zgrupowania *Staphylinidae* regla górnego składają się z 21 taksonów i wykazują strukturę dominacyjną charakterystyczną dla niezakłóconych systemów ekologicznych z wysoką frekwencją *Atheta tibialis* i *Amischa analis*.

Słowa kluczowe: monitoring ekologiczny, ekosystemy leśne, Karkonoski Park Narodowy, *Coleoptera*, *Staphylinidae*

Accepted for print – Zaakceptowano do druku: 12.04.2007

For citation – Do cytowania: Mazur A., Skoczek A., 2007. Rove beetles (Coleoptera, Staphylinidae) as an element of monitoring of forest ecosystems in the Karkonosze National Park. Part II. The spring season aspect and concluding remarks. Acta Sci. Pol., Silv. Colendar. Rat. Ind. Lignar. 6(2), 45-63.