DOI: 10.1515/frp-2015-0022
Available online: www.lesne-prace-badawcze.pl

Leśne Prace Badawcze / *Forest Research Papers*
September 2015, Vol. 76 (3): 229–239

ORIGINAL RESEARCH ARTICLE

e-ISSN 2082-8926

Saproxylic beetles (Coleoptera) of the strictly protected area Bukowa Góra in the Roztoczański National Park

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Abstract. The aims of this study were to demonstrate the role of forests in the Roztoczański National Park as a refuge for rare and endangered saproxylic Coleoptera as well as recognition of entomological fauna related to dead wood. The study was conducted in the strictly protected are of Bukowa Góra from 20th April to 30th September 2012 and focused on the wood of beech and fir. We inventoried saproxylic beetles by means of nine 'Netocia' traps, which resulted in a total of 135 recorded species, of which 52 had not been reported in the park before. Twenty-one rare and endangered species were found. The high number of new species in the Roztoczański National Park indicates a high biodiversity value of the area. Our studies therefore show that the strictly protected area of Bukowa Góra is a biodiversity hot spot of saproxylic Coleoptera.

Keywords: beech, fir, insects, Poland

1. Introduction

As a result of progressive human pressure on forests, an interest in the wood of dead trees – a place where many species of organisms develop – has clearly increased in the past few years. Ensuring good sanitary conditions in forests was carried out by removing dying and dead trees, as well as those colonized by secondary pests. Consequently, this led to an impoverished biological diversity in managed forests. Additionally, logging is mainly focused on large trees, which results in the lack of large masses of wood pulp (Maraga, Lempérière 2005). The presence of large-sized dead wood in the forest impacts the species diversity of saproxylic insects (Grove, Meggs 2003; Similä et al. 2003; Johansson 2006). Some of the species use the bark and wood as food, but a large group of these insects are dependent on other organisms (e.g. on cambio- and xylophagous species, fungi and slime moulds) that inhabit decaying wood (Mokrzycki 2011).

In Central Europe, about 1,500 species of beetles are associated directly and indirectly with dead wood. In Poland, about 1,300 of these species exist, belonging to over 70 families (Gutowski 2006).

The quality of dead wood is very important for maintaining the biodiversity of saproxylic beetles. This means that the tree stand should contain standing and fallen dead trees, as well as live trees with variously sized cavities (Hilszczański et al. 2011).

Saproxylic beetles are an inseparable component of forest ecosystems. They are a group of insects with very diverse environmental requirements. For this reason, they have begun to be increasingly used as indicator species. They are favoured in this by their prevalence in the forest ecosystem, their species richness and the presence of endangered species amongst them. The role of saproxylic beetles as bioindicators are indicated by, amongst others, Buchholz, Ossowska (1995); Ranius, Jansson (2000); Byk (2001); Byk et al. (2006); Gutowski et al. (2006) and Byk, Mokrzycki (2007).

The structure of the dense fir and beech forests growing on the hills of the central Roztocze region resembles primary forests. Their current qualities are largely due to the Zamoyski family, who were the first owners of these lands

Received: 17.01.2015, reviewed: 18.02.2015, accepted after revision: 18.03.2015

and regulated their use (Papis 2012). These forests, called the zwierzyniecki forests, were protected and conserved during the time of their first owners (Olaczek 2007). They were treated as a place of rest and a hunting area, which is why the most beautiful fir and beech forests are surrounded by a 30-km fence. In later years, the Roztocze forests were also considered unique and valuable, and for this reason in 1934, the first reserve – Bukowa Góra [Beech Mountain] – was established here (Wilgat 1994). One of the reasons research on saproxylic beetles is being continued here is due to the well -preserved stands with a large amount of dead wood. Earlier studies were conducted in this area by Sieńko (1984), Królik, Szafraniec (2003) and later Maciejewski, Szafraniec (2014).

2. Aims of the research and methodology

The aims of the research are

- to identify the saproxylic Coleoptera occurring in the Carpathian beech forest (*Dentario glandulosae-Fagetum*) and in the upland mixed fir forest (*Abietetum polonicum*) in the strictly protected area of Bukowa Góra,
- to demonstrate the existence of rare and endangered saproxylic beetle species,
- to determine the environmental value of the beech and fir forests for saproxylic Coleoptera in the Roztocze National Park (RPN).

Five beeches (BK1-Bk5) and five firs (JD1-JD5) with distinct necrosis and cavities were marked at the study sites (in the 198, 199f and 210 quadrants of the forest district). In April 2012, a 'Netocia' screen trap (Fig. 1) was placed on each tree. Unfortunately, one trap on a fir was destroyed by a falling tree during the study. Specimens were collected on four dates: May 15, June 23, July 22, and September 30 in 2012.

All species were assigned to fidelity classes in terms of their relationship with the dead wood. The following classes were distinguished: F_0, accidental species (not used in the faunal and statistical analyses); F_1, species facultatively associated with dead wood; F_2, species found on dead wood and also on the fruiting bodies of arboreal fungi; F_3, beetle species obligately associated with the environment of dead wood.

The beetles were also classified in terms of their trophic relationships, adopting the following categorisation: ks, xylophagous; m, mycetophagous; n, necrophagous; p, polyphagous; s, saprophagous; z, zoophagous; ?, unknown food preferences. Rare and endangered species (Pawlowski et al., 2002; Byk, Mokrzycki 2007) were indicated by the letter R. As a result, it was possible to use the following faunal and ecological indicators:

- Margalef's index of species richness (d):

$$S_u = \frac{\sum nh}{HN} x\,100$$

S – number of species in a community,
N – total number of individuals,

- Index of community fidelity (Q_{F3}):

$$Q_{F3} = \sqrt{dU_{NF3}U_{SF3}}$$

U_{NF3} – percentage of individuals in a species obligately associated with highly decayed wood in a community,
U_{SF3} – percentage of species obligately associated with highly decayed wood in a community,

- Index of community faunal value (Q_R):

$$Q_R = \sqrt{dU_{NR}U_{SR}}$$

U_{NR} – percentage of individuals belonging to a rare species of fauna or relics of primeval forests in a community,
U_{SR} – percentage of rare faunal species or primeval forest relics in a community,

- Index of the nature conservation value of a community (W_{F3R}):

$$W_{F3R} = \sqrt{(Q_{F3} + Q_R)/2}$$

and an analysis of the structure and diversity of saproxylic beetle communities occurring on fir and beech trees.

Beetles belonging to the family of rove beetles (*Staphylinidae*) were identified by Melke, the remaining species were identified by the authors. The nomenclature was adopted from the Catalogue of Palaearctic Coleoptera (Löbl, Smetana 2003–2014).

Figure 1. 'Netocia' trap (photograph M. Papis)

3. Results

During the study, we captured and observed 894 specimens of 134 species belonging to 44 Coleoptera families (Table 1). Hundred and four species were in fidelity classes F_1–F_3, of which 44 had not been previously reported in the Roztocze National Park. Amongst the accidental species (F_0), eight were new to the study area. It was a certain surprise to have captured the Asian ambrosia beetle (*Xylosandrus germanus*), a species that was first observed in Poland in 1998 on the island of Wolin (Mokrzycki et al. 2011). The most numerous species captured were *Aulonothroscus brevicollis* (11.63%), *Sciodrepoides watsoni* (9.51%) and *Rhyncolus ater* (5.59%). Twenty-two species (20 in F_1–F_3 and 2 in F_0) are considered rare and endangered insects (Table. 1); the most interesting were *Rhysodes sulcatus*, *Carabus intricatus, Eurythyrea austriaca*, *Lacon lepidopterous*, *Peltis grossa* and *Prostomis mandibularis*. In addition, a number of identified specimens, such as *R. sulcatus, C. intricatus* and *E. austriaca* are protected species in Poland and one – *L. lepidopterus* – is listed in the 'Polish Red Book of Animals – Invertebrates' as a critically endangered species (Buchholz 2005). The highest percentage was represented by species obligately associated with dead wood (Fig. 2).

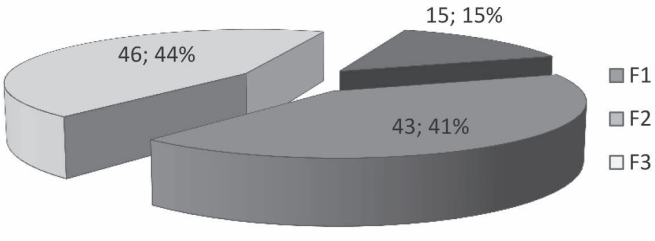

Figure 2. Number and percentage of species F_1–F_3

Table 1. The list of beetles captured in the Bukowa Góra strict protection zone

No.	Family / species	Fidelity class	Trophic types	Type	
				Fir	Beech
	Rhysodidae				
1	*Rhysodes sulcatus* (Fabricius, 1787)	F_3, R	ks	2	10
	Carabidae				
1	*Abax parallelepipedus* (Piller & Mitterpacher, 1783)	F_0			1
2	*Amara plebeja* (Gyllenhal, 1810)	F_0		1	
3	*Carabus convexus* (Fabricius, 1775)	F_1		1	
4	*Carabus intricatus* (Linnaeus, 1761)	F_1, R	z	1	5
5	*Carabus violaceus* (Linnaeus, 1758)	F_1		2	3
6	*Pterostichus niger* (Schaller, 1783)	F_0		2	2
	Histeridae				
1	*Abraeus parvulus* (Aubé, 1842)*	F_3, R	z		2
2	*Abraeus perpusillus* (Marsham, 1802)*	F_3	z		2
3	*Margarinotus striola succicola* (C.G. Thomson, 1862)*	F_0		5	
4	*Paromalus flavicornis* (Herbst, 1791)	F_2	z		1
5	*Plegaderus dissectus* (Erichson, 1839)*	F_3, R	z		1
	Leiodidae				
1	*Agathidium nigripenne* (Fabricius, 1792)*	F_2	m	1	
2	*Anisotoma castanea* (Herbst, 1791)	F_2	m	8	1
3	*Anisotoma humeralis* (Herbst, 1791)	F_2	m	13	15
4	*Anisotoma orbicularis* (Herbst, 1791)*	F_2	m		1
5	*Catops picipes* (Fabricius, 1787)	F_0		1	
6	*Liodopria serricornis* (Gyllenhal, 1813)	F_3, R	m	3	
7	*Ptomaphagus sericatus* Chaudoir, 1845)	F_0			1

No.	Family / species	Fidelity class	Trophic types	Type	
				Fir	Beech
8	*Sciodrepoides watsoni* (Spence, 1813)*	F_0		85	1
	Scydmaenidae				
1	*Stenichnus collaris* (P.W.J. Müller, Kunze, 1822)*	F_1	z	1	
2	*Stenichnus godarti* (Latreille, 1806)	F_3	z	2	
	Silphidae				
1	*Nicrophorus humator* (Gleditsch, 1767)	F_0		3	4
2	*Nicrophorus vespillo* (Linnaeus, 1758)	F_0		2	
3	*Nicrophorus vespilloides* (Herbst, 1783)	F_0		19	5
4	*Oiceoptoma thoracica* (Linnaeus, 1758)	F_0		40	1
	Staphylinidae				
1	*Aploderus caelatus* (Gravenhorst, 1802)*	F_0			1
2	*Atheta boletophila* (C.G. Thomson, 1856)*	F_1, R	m	1	
3	*Philonthus albipes* (Gravenhorst, 1802)*	F_0			1
4	*Rugilus rufipes* (Germar, 1836)*	F_0			
5	*Scaphisoma agaricinum* (Linnaeus, 1758)	F_2	m		5
6	*Tachinus marginellus* (Fabricius, 1781)	F_0			1
	Lucanidae				
1	*Sinodendron cylindricum* (Linnaeus, 1758)	F_3	ks	3	10
	Geotrupidae				
1	*Anoplotrupes stercorosus* (L.G. Scriba, 1791)*	F_0		13	4
2	*Trypocopris vernalis* (Linnaeus, 1758)*	F_0		2	
	Scarabaeidae				
1	*Aphodius ater* (DeGeer, 1774)	F_0		2	
2	*Serica brunnea* (Linnaeus, 1758)*	F_0		2	1
	Buprestidae				
1	*Eurythyrea austriaca* (Linnaeus, 1767)	F_3, R	ks	3	
	Eucnemidae				
1	*Melasis buprestoides* (Linnaeus, 1761)	F_3	ks		2
2	*Xylophilus testaceus* (Herbst, 1806)*	F_3, R	ks	1	3
	Throscidae				
1	*Aulonothroscus brevicollis* (Bonvouloir, 1859)*	F_1	?	98	16
	Elateridae				
1	*Agriotes acuminatus* (Stephens, 1830)	F_0, R		1	
2	*Agriotes pilosellus* (Schönherr, 1817)	F_0, R		1	2
3	*Ampedus balteatus* (Linnaeus, 1758)	F_3		1	1
4	*Ampedus elegantulus* (Schönherr, 1817)	F_3, R	z	9	
5	*Ampedus erythrogonus* (P.W.J. Müller, 1821)	F_3	z	5	4
6	*Ampedus nigrinus* (Herbst, 1784)	F_3	z		1
7	*Ampedus pomonae* (Stephens, 1830)	F_3	z		2
8	*Ampedus pomorum* (Herbst, 1784)	F_3	z	6	14

No.	Family / species	Fidelity class	Trophic types	Type	
				Fir	Beech
9	*Athous haemorrhoidalis* (Fabricius, 1801)	F_1	p	1	1
10	*Athous subfuscus* (O.F. Müller, 1764)	F_1	p		2
11	*Hemicrepidus niger* (Linnaeus, 1758)	F_0		1	
12	*Lacon lepidopterus* (Panzer, 1800)	F_3, R	z	2	2
13	*Melanotus castanipes* (Paykull, 1800)*	F_3	p	21	2
14	*Melanotus villosus* (Geoffroy, 1785)	F_3	p	3	15
15	*Procraerus tibialis* (Lacordaire, 1835)	F_3, R	s	3	8
	Lycidae				
1	*Dictyoptera aurora* (Herbst, 1784)	F_3	z	1	2
	Lampyridae				
1	*Lamprohiza splendidula* (Linnaeus, 1767)	F_0		1	2
	Nosodendridae				
1	*Nosodendron fasciculare* (A.G. Olivier, 1790)*	F_0		1	
	Dermestidae				
1	*Megatoma undata* (Linnaeus, 1758)	F_2	n	1	
	Ptinidae				
1	*Dorcatoma dresdensis* (Herbst, 1792)	F_2	m	8	1
2	*Dorcatoma lomnickii* (Reitter, 1903)*	F_2	m	3	1
3	*Dorcatoma robusta* A. (Strand, 1938)*	F_2	m		3
4	*Dorcatoma setosella* (Mulsant, Rey, 1864)*	F_3, R	m	25	1
5	*Hadrobregmus pertinax* (Linnaeus, 1758)*	F_3	ks		6
6	*Ptilinus pectinicornis* (Linnaeus, 1758)*	F_3	ks	1	10
7	*Ptinomorphus imperialis* (Linnaeus, 1767)*	F_2, R	ks		2
	Lymexylidae				
1	*Elateroides dermestoides* (Linnaeus, 1761)	F_3	ks	1	
	Trogossitidae				
1	*Peltis ferruginea* (Linnaeus, 1758)	F_3	ks	1	3
2	*Peltis grossa* (Linnaeus, 1758)	F_3, R	ks	12	
	Sphindidae				
1	*Sphindus dubius* (Gyllenhal, 1808)	F_2	m		1
	Nitidulidae				
1	*Epuraea neglecta* (Heer, 1841)*	F_2	?	4	
2	*Ipidia binotata* (Reitter, 1875)	F_2, R	z	2	
3	*Omosita colon* (Linnaeus, 1758)*	F_1	s	1	
	Monotomidae				
1	*Rhizophagus bipustulatus* (Fabricius, 1792)	F_2	p	2	1
2	*Rhizophagus dispar* (Paykull, 1800)	F_2	z		1
	Silvanidae				
1	*Uleiota planata* (Linnaeus, 1761)	F_3	z		1
	Cryptophagidae				

No.	Family / species	Fidelity class	Trophic types	Type	
				Fir	Beech
1	*Atomaria alpina* (Heer, 1841)*	F_2	m	4	3
2	*Atomaria vespertina* (Mäklin, 1853)*	F_2	m	7	
3	*Cryptophagus labilis* (Erichson, 1846)*	F_2	m		2
4	*Cryptophagus quercinus* (Kraatz, 1852)*	F_3	m		1
5	*Micrambe abietis* (Paykull, 1798)	F_2	m	19	
	Erotylidae				
1	*Dacne bipustulata* (Thunberg, 1781)*	F_2	m		2
2	*Triplax russica* (Linnaeus, 1758)	F_2	m	4	10
	Cerylonidae				
1	*Cerylon ferrugineum* (Stephens, 1830)	F_2	z		1
2	*Cerylon histeroides* (Fabricius, 1792)*	F_3	z		2
	Endomychidae				
1	*Leiestes seminiger* (Gyllenhal, 1808)*	F_2, R	m	1	
	Coccinellidae				
1	*Scymnus abietis* (Paykull, 1798)	F_0		1	
	Lathridiidae				
1	*Corticaria longicollis* (Zetterstedt, 1838)	F_2	m	1	
2	*Enicmus rugosus* (Herbst, 1793)	F_2	m	7	16
3	*Enicmus testaceus* (Stephens, 1830)*	F_2	m	1	2
4	*Latridius brevicollis* (C.G. Thomson, 1868)*	F_1, R	m		1
5	*Latridius hirtus* (Gyllenhal, 1827)*	F_2	m	1	1
6	*Stephostethus alternans* (Mannerheim, 1844)*	F_2	m		1
7	*Stephostethus angusticollis* (Gyllenhal, 1827)*	F_2	m	1	
	Mycetophagidae				
1	*Mycetophagus atomarius* (Fabricius, 1792)	F_2	m		2
2	*Mycetophagus quadriguttatus* (P.W.J. Müller, 1821)	F_2	m		1
3	*Mycetophagus quadripustulatus* (Linnaeus, 1760)*	F_2	m		2
	Ciidae				
1	*Cis bidentatus* (A.G. Olivier, 1790)*	F_2	m	5	1
2	*Cis fagi* (Waltl, 1839)*	F_2	m	1	
3	*Cis micans* (Fabricius, 1792)*	F_2	m	10	1
4	*Ennearthron cornutum* (Gyllenhal, 1827)	F_2	m		1
5	*Octotemnus glabriculus* (Gyllenhal, 1827)	F_2	m	3	
6	*Ropalodontus perforatus* (Gyllenhal, 1813)	F_2	m		3
	Tetratomidae				
1	*Hallomenus axillaris* (Illiger, 1807)	F_3, R	m	1	
	Melandryidae				
1	*Orchesia undulata* (Kraatz, 1853)	F_2	m		1
2	*Serropalpus barbatus* (Schaller, 1783)	F_3	ks	2	

No.	Family / species	Fidelity class	Trophic types	Type	
				Fir	Beech
	Scraptiidae				
1	*Anaspis frontalis* (Linnaeus, 1758)	F_3	ks	1	
2	*Anaspis thoracica* (Linnaeus, 1758)	F_3	ks		1
	Aderidae				
1	*Euglenes pygmeus* (DeGeer, 1775)*	F_3	z	1	
	Prostomidae				
1	*Prostomis mandibularis* (Fabricius, 1801)	F_3, R	ks	14	
	Salpingidae				
1	*Salpingus ruficollis* (Linnaeus, 1760)*	F_3	z		1
	Tenebrionidae				
1	*Bolitophagus reticulatus* (Linnaeus, 1767)	F_2	m		1
2	*Diaperis boleti* (Linnaeus, 1758)*	F_2	m	7	3
3	*Platydema violaceum* (Fabricius, 1790)*	F_3	m		1
4	*Stenomax aeneus* (Scopoli, 1763)*	F_3	s		1
5	*Uloma culinaris* (Linnaeus, 1758)	F_3	ks	2	3
	Cerambycidae				
1	*Prionus coriarius* (Linnaeus, 1758)	F_3	ks	1	3
	Anthribidae				
1	*Dissoleucas niveirostris* (Fabricius, 1798)*	F_3	ks		1
2	*Platystomos albinus* (Linnaeus, 1758)*	F_3	ks	1	2
	Curculionidae				
1	*Anisandrus dispar* (Fabricius, 1792)	F_1	m	1	
2	*Cryphalus piceae* (Ratzeburg, 1837)	F_1	ks	1	
3	*Orchestes fagi* (Linnaeus, 1758)	F_0		4	5
4	*Otiorhynchus scaber* (Linnaeus, 1758)	F_0			1
5	*Polydrusus mollis* (Strøm, 1768)	F_0		1	
6	*Rhyncolus ater* (Linnaeus, 1758)	F_3	ks	47	3
7	*Scleropteridius fallax* (Otto, 1897)	F_0		1	
8	*Stereocorynes truncorum* (Germar, 1824)	F_3, R	ks	1	10
9	*Strophosoma capitatum* (DeGeer, 1775)	F_0		3	1
10	*Taphrorychus bicolor* (Herbst, 1794)	F_1			2
11	*Xyleborinus attenuatus* (Blandford, 1894)*	F_1	m		1
12	*Xyleborinus saxesenii* (Ratzeburg, 1837)	F_1	m		2
13	*Xylosandrus germanus* (Blandford, 1894)*	F_2	m		1
	Dryophthoridae				
1	*Dryophthorus corticalis* (Paykull, 1792)	F_3	ks	16	2

*species new to the Roztoczański National Park, F_0 – accidental species, F_1 – species facultatively associated with dead wood, F_2 – species found on dead wood, but seen in a different environment, F_3 – species obligately associated with dead wood, R – rare and relict species, ks – xylophagous, m – mycetophagous, n – necrophagous, p – polyphagous, s – saprophagous, z – zoophagous, ? – unknown food preferences

Of the 104 saproxylic species (F_1–F_3), 75 (5 traps) occurred on beech and 63 (4 traps) on fir. Thirty-seven (37) species were found on both tree species (Fig. 3). Amongst the 668 saproxylic specimens collected, as many as 414 occurred on fir trees and 254 on beech.

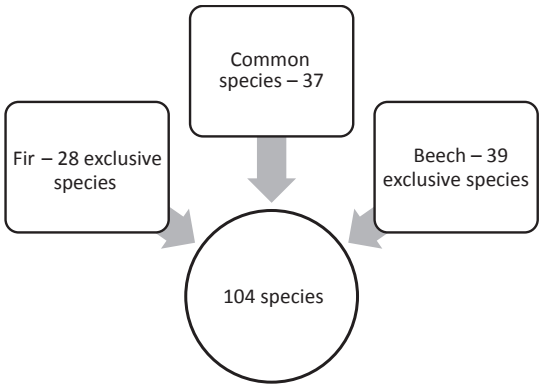

Figure 3. The number of species common and exclusive for fir and beech

In taking a closer look at the trophic groups, of note is the fact that the highest number of captured species are those associated with the fruiting bodies of fungi and decaying bark and wood (43% and 34%, respectively). Xylophagous (23% of species, 27% of individuals) and zoophagous species (23% of species, 12% of individuals) were also represented by a large group of individuals (Fig. 4).

Based on a cluster analysis, we separated two large communities of beetles. The first community includes the species colonising Bk_4, Jd_1 and Jd_3 trees, whilst the second community was divided into two smaller ones, comprised of individuals caught in the traps installed on trees: Bk_3 and Jd_4 and those from Bk_1, Bk_2, Bk_3 and Jd_2 (Fig. 5).

Beech was found to have higher values of Margalef's index of species richness and index of community fidelity. The index of community faunal value (taking into account rare and relict species) was higher for fir. The values for the index of the nature conservation value of a community were similar for beech and fir (Table 2).

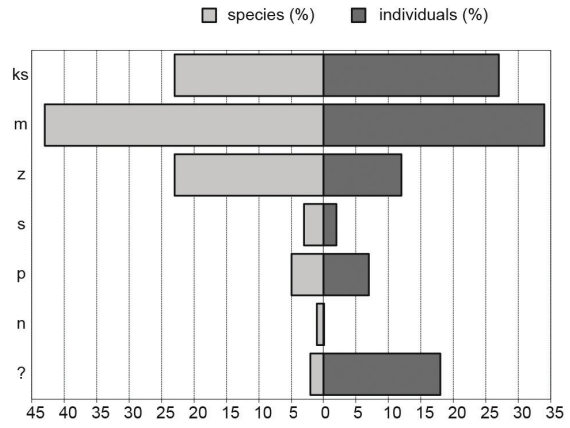

Figure 4. The proportion of species and individuals in different trophic groups: ks, xylophagous; m, mycetophagous; n, necrophagous; p, polyphagous; s, saprophagous; z, zoophagous; ?, unknown food preferences

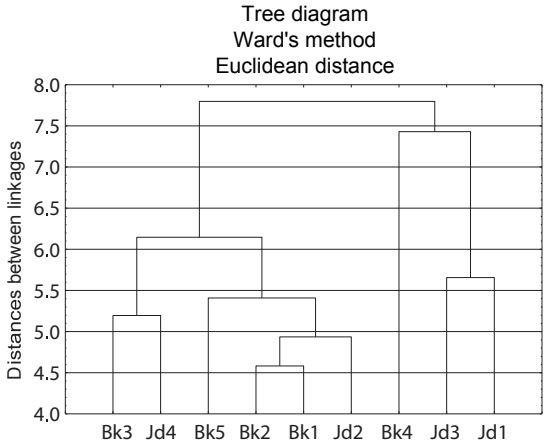

Figure 5. Faunal similarity of communities of saproxylic beetles captured on studied trees: Bk, beech; Jd, fir.

4. Discussion and conclusions

In the study, 894 Coleoptera individuals belonging to 134 species were caught. Fidelity classes F_1–F_3, corresponding to saproxylic species, were represented by 104 species and

Table 2. Faunal-ecological metrics

Metric	Fir (four traps)	Beech (five traps)	Bukowa Góra
Margalef's index of species richness (d)	24,09	30,84	36,15
Index of community fidelity (Q_{F3})	233,20	276,14	281,32
Index of community faunal value (Q_R)	116,84	96,12	120,22
Index of the nature conservation value of a community (W_{F3R})	13,23	13,64	14,17

667 specimens. Of this number, 46 species and 323 individuals are obligately associated with the wood of dead trees, which is indicative of a well-preserved primary forest. This is also reflected in the high proportion of rare and endangered species (Buchholz, Ossowska 1995), represented in the study area by 22 species and 112 specimens. It should be added that only two species of trees were analysed, additionally, with a small number of repetitions.

Amongst the saproxylic Coleoptera, many species were classified as mycetophagous, xylophagous and zoophagous forms (Fig. 4). Pawłowski (2008) reported that the most important group of forest types, in terms of trophic preferences, are insects that feed on decaying wood. The larvae develop only in an environment of dead wood. Another important group is mycetophagous, developing under decaying bark and in decaying wood, as well as in the fruiting bodies of tree fungi. Zoophagous beetles are a large and diverse group found in the wood of dead trees (Mokrzycki 2011). They are just behind cambio- and xylophagous forms found in wood at advanced stages of decay, for example, the blue ground beetle (*C. intricatus*) and *L. lepidopterus*. There is also a certain group of insects constantly present in the wood of dead trees, but their food preferences are still unknown. There were two such species in the study area – *A. brevicollis* (Bonv.) and *Epuraea neglecta* (Heer).

Of all the species recorded, as many as 52 are new additions to the recorded fauna of the Roztocze National Park. Amongst the beetles identified for the first time in the park, 16% are considered rare or threatened. This indicates that the entomofauna developing in the wood of dead trees is poorly known, which is due to the laborious methodology required and the need to involve specialists of different insect groups. Ranius and Jansson (2002) stressed that there is no single method that would provide a full and objective description of the occurrence of saproxylic beetles for which the most important factor is choosing the correct tree for the research (Ranius 2001).

Numerous studies confirm a direct relationship between the amount of dead wood and the richness of the occurrence of saproxylic species (Byk 2001; Grove, 2002; Simile et al., 2003; Maciejewski, Szafraniec 2014). Other researchers pointed to the fact that the greatest significance for the occurrence of particular species of saproxylic plants, fungi and invertebrates is not the total amount of dead wood, but rather its form and quality (Odor et al. 2006; Tikkanen et al. 2006; Hilszczański et al. 2011; Lassance et al. 2011). The characteristics of dead wood that are important for the presence of living organisms include tree species, volume, extent of decay and spatial distribution (Söderström 1988; Samuelsson et al. 1994).

Amongst those fir and beech containing decaying wood, the former proved to be more valuable in terms of fauna, despite the functioning of only four traps (Table 2). More species and individuals considered rare or endangered were captured in the traps on the fir. In contrast, beech reached a higher conservation value (W_{F3R}), which could be due to the greater number of saproxylic Coleoptera species found there and the higher number of traps (Table 2). In similar studies conducted in the Świętokrzyskie Mountains, fir had a higher index of nature conservation value than beech (Byk 2007). It should be noted that the index of the nature conservation value of both studied tree species was significantly higher in Bukowa Góra than that in the Świętokrzyskie Mountains (13.64 and 8.40 for beech; 13.23 and 9.48 for fir, respectively).

Study results show that the tree stands of the Roztocze National Park are a very important refuge for rare and endangered saproxylic beetles. Almost half of the identified beetle species is new to the fauna of the Roztocze National Park. Knowledge about invertebrates varies and depends on the taxonomic group, so research should continue in this area and the methodology of inventorying insects should be extended. In the future, this could help to explain the details of the biology and ecology of this group of insects.

P. mandibularis turned out to be an interesting species. It develops in the decaying heartwood of fallen trees. It is probably entirely dependent on the environment of old decaying trees, which are increasingly rare in Europe (Gueorguiev 2011). It is known in Poland from a few scattered locations (Kubisz et al. 2014). The capture of 14 individuals may indicate that the Roztocze National Park is a very important refuge for this species in Poland.

Conflicts of interest

The authors declare no potential conflicts of interest.

Acknowledgements and financial support

The authors would like to thank the Directorate of the Roztocze National Park for permission to conduct the research, Dr. Przemysław Stachyra for helping in organising the fieldwork and providing publications about the study area, Andrzej Melke for identifying the beetles of the *Staphylinidae* family and Krzysztof Grabski for his help with the field work.

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M.P., T.M. – preparation of the study design, data collection, performing the study, statistical analysis, interpretation of results, literature review and writing the manuscript.

Translated by: Barbara Przybylska