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Canopy leaf beetles and weevils in the Białowieża and Borecka Forests in Poland (Col., Chrysomeloidea, Curculionoidea)

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ABSTRACT. In this study we present a faunistic overview of an investigation of arboreal phytophagous beetles collected from primeval forests and managed forests of Białowieża and Borecka Forests by insecticidal knock-down in 2001 and 2002. The whole dataset is based on 122 fogging samples and on stem eclector samples from 49 trees. In the area of Białowieża Forest 78 fogging samples from common oak (*Quercus robur* L.), 28 from spruce (*Picea abies* (L.) KARST.), 13 from hornbeam (*Carpinus betulus* L.) and 3 from different trees (*Acer platanoides* L., *Populus tremula* L., *Pinus sylvestris* L.) were taken. The samples from ancient woodland, primary forest sanctuaries, and different-aged managed forest stands revealed 129 phytophagous beetle species and 24458 individuals of the families Chrysomelidae, Bruchidae, Anthribidae, Rhynchitidae, Attelabidae, Apionidae, Nanophyidae, and Curculionidae. The stem eclector catches resulted in 32 species and 7077 individuals of Chrysomelidae, Anthribidae, Apionidae and Curculionidae. In the area of Borecka Forest 11 trees were fogged (3 *Quercus robur L.,* 4 *Picea abies*, 3 *Carpinus betulus* and 1 *Tilia cordata* MILL.), resulting in 25 species and 1531 individuals. The following seven species,mainly collected by fogging, were previously not recorded from Białowieża forest: *Zeugophora frontalis, Longitarsus curtus, Cryptocephalus nitidus, Crepidodera nitidula, Bruchidius marginalis, Acanthoscelides obtectus*, and *Phaeochrotes cinctus*. Some rare species as *Cryptocephalus querceti, Polydrusus flavipes, Anthonomus pinivorax, Magdalis fuscicornis, Magdalis exarata, Rhynchaenus pilosu*s, and *Rhynchaenus hortorum* were caught in medium or large numbers indicating that they preferably occur in the canopy. Full-winged specimens of *Psylliodes cucullatus* were found for the first time. Canopy communities were dominated by the feeding generalist *Strophosoma capitatum* (47.5% of all weevils, Anthribidae excluded) and other broad-nosed weevils of the genera *Phyllobius* und *Polydrusus.* Broad-nosed weevils represented 92.1% of the total weevil catch. *Polydrusus flavipes* proved to be a characteristic species of the wet oak forest, where it was abundant mainly on old oak trees. 36% of the weevil species, but only 13% of the leaf beetle species develop on the sampled trees (*Quercus, Picea*, and *Carpinus*). The remaining species develop on other forest

trees (22% of the leaf beetles and 32% of the weevils), on herbs, low shrubs or in the open country (65% of the leaf beetles and 32% of the weevils); rarely sampled tree genera were not considered in this analysis.

KEY WORDS: Borecka, Białowieża Primeval forest, managed forest, canopy fogging, arboreal arthropods, community composition, transient species, tree specificity, Chrysomeloidea, Curculionoidea.

INTRODUCTION

The canopy of tropical trees was called the last biotic frontier in order to emphasize that this habitat harbours the most diverse terrestrial arthropod fauna on earth (ERWIN 1983). Until the early eighties of the last century the canopy was largely neglected in research. Research focussed from the beginning on tropical countries while the temperate forest canopies remained largely uninvestigated (FLOREN & SCHMIDL 2006; KÖHLER 1992). The establishment of the insecticidal knock-down technique was an important preposition to investigate arboreal arthropods. Canopy fogging allows to collect arthropods of high forest trees almost quantitatively by causing only little spatio-temporal disturbance resulting in samples of high comparability (FLOREN & SCHMIDL 2003). Just recently the method was introduced step by step in Europe (FLOREN & SCHMIDL 1999, FLOREN & GOGALA 2002, FLOREN & OTTO 2002, FLOREN & SPRICK 2007; THUNES et al. 2003).

Another obstacle of ecological research in Europe is the almost complete destruction of primary forests. Today, larger unfragmented forest areas are found only in the outlying areas of Middle Europe or in adjacent areas of Southeast Europe (e.g. in Slovakia, in Poland, Romania, Slovenia or Hungary, see KORPEL 1995). Scientists devote increasing attention to these forests in order to understand how ecosystems function that are undisturbed by human (e.g. PETERKEN 1996; TOMIAŁOJĆ & WESOLOWSKI 2004).

Our project aimed at investigating the canopy arthropod fauna of the Białowieska Primeval Forest as one of the last remaining larger lowland forests close to nature in Central Europe and to use these data as a baseline to assess the effects of management practices on arboreal arthropods. In this article we present results from two years of field work (2001 and 2002) concerning leaf beetles (Chrysomeloidea) and weevils (Curculionoidea) except bark beetles. The project aims at assessing of how arthropod communities change as a consequence of forest management practices.

METHODS

Field work was done in the Białowieża Forest (Puszcza Białowieska) at the border to East Europe in the region of Białystok close to the Byelorussian frontier (52° 30'-53° 00' N; 23° 30'- 24° 15' E). Another primary forest was included in the study, the Borecka Forest

(Puszcza Borecka) east of Giżycko in the Masurian lakeland (54° 02' N, 22° 01' E), 180 km away from the Białowieża Forest. In Białowieża four primary forest sanctuaries were investigated (Fig. 1): Leśna close to the Byelorussian border and close to the river with the same name, Starzyna, in a distance of 3 km, Lipiny near Hajnówka, and Dębowy Grąd near the village Budy. All sites are outside the strictly protected National Park, but have the status of reserves and possess a very old tree stock with most oak trees older than 300 years. Moreover, trees from managed forests of different age were sampled which were all situated in the Hajnówka forest district between Hajnówka and Białowieża and within a distance of a few kilometers of the primary forest sanctuaries.

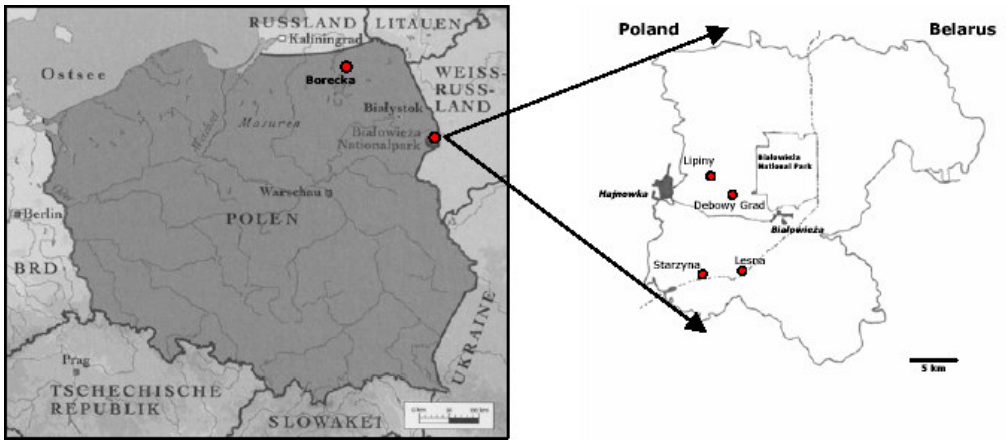

Fig. 1: Map of the investigated forests. The managed forests were all embedded in the Białowieża forest matrix.

The predominating forest types at the investigation sites were: in Leśna *Tilio-Carpinetum typicum* and *stachyetosum* as well as *Carici elongatae-Alnetum*, in Lipiny different types of *Tilio-Carpinetum* and *Pino-Quercetum*, in Dębowy Grąd *Circaeo-Alnetum*, *Tilio-Carpinetum stachyetosum* and *corydaletosum*, and in Starzyna *Peucedano-Pinetum*, *Pino-Quercetum* and *Tilio-Carpinetum calamagrostietosum* (according to FALINSKI 1986 and own observations). The sites Leśna und Dębowy Grąd have high ground water levels, and they are much more damp than Starzyna and Lipiny, the only site, where sessile oak (*Quercus petraea* (MATT.) LIEBL.) occurs.

The fogging method

One advantage of the insecticidal fogging technique is that canopy arthropods can be collected almost quantitatively and in a tree-selective way. Tree selectivity is guaranteed by the appropriate orientation of the collecting funnels beneath tree crowns. 80-90% of each crown projection area was covered by collecting sheets in order to sample most of the community. We used natural pyrethrum (ex *Tanacetum cinerariifolium* (TREVIR.) SCH.-BIP.) to collect arboreal arthropods which is highly specific to arthropods and destroyed photochemically within hours without leaving any persistent substances in the trees. The concentration of the active substance was below 1% and most arthropods affected but not collected recover within hours. Fogging was carried out from 28.6. - 8.7. 2001 and 1.6. - 19.6. 2002 in the Białowieża Forest, and on 12.6. and 13.6. 2002 in the Borecka Forest. For more technical details see literature cited above. In the Białowieża Forest area 122 trees were fogged during 2001 and 2002 (78 oaks, 28 Norway spruces, 13 hornbeams and one tree of Norway maple, pine and aspen), and 11 trees in the Borecka Forest (3 oaks, 4 Norway spruces, 3 hornbeams, 1 small-leaved lime). For a survey of tree species, age and characters of the stands at the investigation sites see Table 1.

Stem eclectors

Furthermore, 49 stem eclectors were fixed on oak trees 3-4 m above the forest floor in the Białowieża Forest. They were distributed over a large area between Hajnówka and Białowieża. These traps collect insects moving vertically along the trunks. Invertebrates climbing upwards come to a hat-shaped barrier, fitted tightly to the trunk. They are guided through a hole into a well translucent collecting box (MÜHLENBERG 1989). Stem eclectors were installed on 14.6. and 3.7. 2002 and removed on 1./2.10.2002. Eclector boxes were filled with formol (4%) and emptied in 14-day-intervals. In total, the stem eclectors have been collecting over a period of 5037 days.

Table 1: Insecticidal knock-down samples from the Białowieża Forest and the Borecka Forest**.**

Tree species	Stand characteristics	Age (years)	Number of trees
Białowieża Forest: Hajnówka forest district (72 trees)			
Carpinus betulus	Managed forest	80	**5**
Picea abies	Managed forest	8	**10**
Picea abies	Managed forest	80	**9**
Populus tremula	Managed forest	170	**1**
Quercus robur	Managed forest	30	**10**
Quercus robur	Managed forest	50	**15**
Quercus robur	Managed forest	80	**9**
Quercus robur	Managed forest	170	**9**
Quercus robur	Forest edge	200	**4**
Białowieża Forest: Dębowy Grąd			
Quercus robur	Primary forest	275	**4**
Białowieża Forest: Leśna (29 trees)			
Acer platanoides	Primary forest	135	**1**
Carpinus betulus	Primary forest	135	**6**
Picea abies	Primary forest	275	**7**
Quercus robur	Primary forest	275	**15**
Białowieża Forest: Lipiny			
Quercus robur	Primary forest	170	**6**
Białowieża Forest: Starzyna (11 trees)			
Carpinus betulus	Primary forest	135	**2**
Picea abies	Primary forest	175	**2**
Pinus sylvestris	Primary forest	250	**1**
Quercus robur	Primary forest	175	**6**
Borecka Forest (11 trees)			
Carpinus betulus	Primary forest	80	**3**
Picea abies	Primary forest	80	**4**
Quercus robur	Primary forest	150	**3**
Tilia cordata	Primary forest	100	**1**

RESULTS

Fogging

In total, 44 leaf beetle species were recorded by fogging, 43 species in the Białowieża Forest, but only 3 species in the Borecka Forest (abbreviated 43/3), 4 species of seed

beetles and of fungus weevils (Bruchidae: 4/0; Anthribidae: 4/2) and in the weevils (Rhynchitidae, Attelabidae, Apionidae, Nanophyidae, and Curculionidae), there are altogether 77 (74/20) species (Table 2).

Table 2. Phytophagous beetles (Chrysomeloidea, Curculionoidea) from the Białowieża and the Borecka Forests collected by insecticidal knock-down during 2001 and 2002. Numbers refer to species abundance. - Bia: Białowieża Forest, Bor: Borecka Forest.

	Białowieża: Primary Forest					**Białowieża: Managed forest stands**						**Bia**	**Bor**
Site	**Sta-rzy-na**	**Leśna**	**Leśna**	**Lipiny**	**Dębo-wy Grąd**	**Hajnówka forest district**							
Year of investigation	2001	2001	2002	2002	2002	2001	2001	2002	2001	2002	2002		2002
Tree ages	> 150	120-300	> 250	170	> 250	8	30	50	80	170	200		150
Tree numbers	11	23	6	6	4	10	10	15	23	10	4		11
												∑	∑
Fam. Chrysomelidae												**675**	**10**
Orsodacne cerasi (L., 1758)												**0**	**3**
Zeugophora frontalis Suffr., 1840										1		**1**	
Oulema melanopus (L., 1758)	1			1								**2**	
Cryptocephalus nitidus (L., 1758)							2	1				**3**	
Cryptocephalus punctiger Payk., 1799								2				**2**	
Cryptocephalus parvulus Müll., 1776			9					4	1	1	1	**16**	
Cryptocephalus querceti Suffr., 1848		14	8	1	2					7	1	**33**	
Cryptocephalus pusillus F., 1777		2					24		12			**38**	
Leptinotarsa decemlineata (Say, 1824)	1		2									**3**	
Chrysolina fastuosa (Scop., 1763)	1											**1**	

Plagiodera versicolora (Laich., 1781)							1						**1**	
Chrysomela tremulae F., 1787										1			**1**	
Linaeidea aenea (L., 1758)			2										**2**	**6**
Phratora laticollis (Suffr., 1851)		27	4	3	13		26	12	6	202	4		**297**	
Phratora vitellinae (L., 1758)		1											**1**	
Galerucella grisescens (Joann., 1866)			1										**1**	
Galeruca tanaceti (L., 1758)							1		3				**4**	
Luperus longicornis (F., 1781)	1	2								1			**4**	
Phyllotreta vittula (Redt., 1849)	14	13		1		1	2	1	5		1		**38**	
Phyllotreta nemorum (L., 1758)	1							2					**3**	
Phyllotreta undulata (Kutsch., 1860)		1	1					1					**3**	
Phyllotreta tetrastigma (Com., 1837)		1											**1**	
Phyllotreta dilatata Thoms., 1866		1											**1**	
Phyllotreta striolata (F., 1803)	1								1				**2**	
Phyllotreta ochripes (Curt., 1837)	1		1										**2**	
Phyllotreta atra (F., 1775)	1												**1**	
Phyllotreta nigripes (F., 1775)											1		**1**	
Aphthona euphorbiae (Schrk., 1781)		9	2	2	5			1		4	4		**27**	
Longitarsus nasturtii (F., 1792)							1						**1**	
Longitarsus parvulus (Payk., 1799)			2							1	1		**4**	**1**
Altica quercetorum Foudr., 1860		2	2					79	1		1		**85**	
Altica oleracea (L., 1758)	1	14	1				1	1	1				**19**	
Lythraria salicariae (Payk., 1800)		1	2										**3**	
Neocrepidodera ferruginea (Scop., 1763)								1	1				**2**	
Crepidodera aurea (Fourcr., 1785)	1												**1**	

Crepidodera fulvicornis (F., 1792)		5				1							**6**	
Crepidodera nitidula (L., 1758)										11			**11**	
Epitrix pubescens (Koch, 1803)		1											**1**	
Chaetocnema concinna (Marsh., 1802)	4	12			1		1	3	7				**28**	
Chaetocnema hortensis (Fourcr., 1785)						3	3						**6**	
Psylliodes affinis (Payk., 1799)		1	1										**2**	
Psylliodes napi (F., 1792)		2	1		3								**6**	
Psylliodes cucullatus (Ill., 1807)	2			1		1	1	1	1				**7**	
Cassida nebulosa L., 1758			2					1				1	**4**	
Fam. Bruchidae													**14**	**0**
Bruchus atomarius (L., 1761)										1	1		**2**	
Bruchus rufimanus Boh., 1833		2		1					5		2		**10**	
Bruchidius marginalis (F., 1777)											1		**1**	
Acanthoscelides obtectus (Say, 1831)	1												**1**	
Fam. Anthribidae													**661**	**78**
Anthribus nebulosus Forst., 1771 (*Brachytarsus nebulosus* [Forst., 1771])	108	167	76	23	10	11	1	4	59	6	74		**539**	**76**
Platystomos albinus (L., 1758) (= *Anthribus albinus* [L., 1758])				1						2	1		**4**	
Tropideres albirostris (Hbst., 1783)					1					1			**2**	
Phaeochrotes cinctus (Payk., 1800)		50	18	2	7		1	15	1	6	16		**116**	**2**
Fam. Rhynchitidae													**39**	**11**
Temnocerus nanus (Payk., 1792)							3	3	1		2		**9**	
Temnocerus tomentosus (Gyll., 1839)							1							
Involvulus cupreus (L., 1758)														
Deporaus betulae (L., 1758)							1	9		2				
Fam. Attelabidae													**97**	**0**

Attelabus nitens (Scop., 1763)		9	39		6		4	1	9	26	3	**97**	
Fam. Apionidae												**360**	**39**
Perapion curtirostre (Germ., 1817)								1				**1**	
Protapion fulvipes (Fourcr., 1785)	2	1	5	1			7	4	2	2		**24**	**29**
Protapion apricans (Hbst., 1797)		1										**1**	
Betulapion simile (Kirby, 1811)			1	3	2		11	283	23	3	7	**333**	
Oxystoma cerdo (Gerst., 1854)												**0**	**5**
Eutrichapion viciae (Payk., 1800)							1					**1**	**5**
Fam. Nanophyidae												**2**	**0**
Nanophyes marmoratus (Gze., 1777)		2										**2**	
Fam. Curculionidae												**22610**	**1393**
Otiorhynchus scaber (L., 1758)				1	2				4	1		**8**	
Phyllobius virideaeris (Laich., 1781)								5				**5**	
Phyllobius arborator (Hbst., 1797)	704	1430	419	425	8	13	98	305	122	107	138	**3769**	**17**
Phyllobius calcaratus (F., 1792)		6	4									**10**	**4**
Phyllobius argentatus (L., 1758)	84	561	172	93	40		27	62	207	636	304	**2186**	**621**
Polydrusus pallidus Gyll., 1834		7						3		2		**12**	
Polydrusus flavipes (Deg., 1775)		3062	80	42	884		1	4	4	4		**4081**	
Polydrusus pilosus Gredl., 1866								4			24	**28**	
Polydrusus tereticollis (Deg., 1775) *[= P. undatus* (F., 1781)]		7			2		1		4	19		**33**	**3**
Polydrusus mollis (Ström, 1768)												**0**	**10**
Sciaphilus asperatus (Bonsd., 1785)		1			2							**3**	
Brachysomus echinatus (Bonsd., 1785)		5			1		14		5	3	1	**29**	**1**
Brachyderes incanus (L., 1758)								1				**1**	

Strophosoma capitatum (Deg., 1775)	335	2413	278	1420	1271	12	606	1514	1934	1004	185	**10972**	**690**
Sitona lepidus Gyll., 1834		1										**1**	
Sitona macularius (Marsh., 1802)											1	**1**	
Tanysphyrus lemnae (Payk., 1792)							1					**1**	
Magdalis ruficornis (L., 1758)		1										**1**	
Magdalis fuscicornis Desbr., 1870	8	43	3	7	4		2	2	4	22	4	**99**	
Magdalis cerasi (L., 1758)	5	3		2	2			2	2	3	2	**21**	**1**
Magdalis exarata (H. Bris., 1862)	5	51	1	2	2		2	1	7	1	2	**74**	**2**
Magdalis nitida (Gyll., 1827)	12	26	1		1	4	1	1	8	1		**55**	**7**
Magdalis linearis (Gyll., 1827)								3				**3**	
Magdalis violacea (L., 1758)			1							1		**2**	
Magdalis duplicata Germ., 1819	2	1										**3**	
Hylobius pinastri (Gyll., 1813)			1	1		3						**5**	
Cossonus parallelepipedus (Hbst., 1795)		1										**1**	
Curculio venosus (Grav., 1807)	1	21	13	30	36		4	22	25	36	14	**202**	
Curculio villosus F., 1781										1		**1**	
Curculio glandium Marsh., 1802		13	10	26	6			11	18	10	3	**97**	**1**
Curculio crux F., 1776							1					**1**	
Curculio salicivorus Payk., 1792											1	**1**	
Curculio pyrrhoceras Marsh., 1802	8		1	6	4		20	72	7	22	27	**167**	**24**
Dorytomus tortrix (L., 1761)										1		**1**	
Dorytomus dejeani Faust, 1882)				2	2				3	36	3	**46**	
Dorytomus taeniatus (F., 1781)							1					**1**	
Dorytomus rufatus (Bedel, 1888)							1					**1**	
Tychius picirostris (F., 1787)	1	1	2					1	1	3		**9**	
Tychius meliloti Steph., 1831					1						1	**2**	

Anthonomus humeralis (Panz., 1795)		2											**2**	
Anthonomus pinivorax Silfv., 1977	2	9				3			9				**23**	**7**
*Brachonyx pineti (*Payk., 1792)	1							2	1				**4**	
Gymnetron villosulum Gyll., 1838								1					**1**	
Rhinusa antirrhini (Payk., 1800)							1	1					**2**	
Cionus hortulanus (Fourcr., 1785)								1					**1**	
Stereonychus fraxini (Deg., 1775)		2											**2**	
Rhynchaenus pilosus (F., 1781)		50	17	7	53		2	20	6	12	7		**174**	**3**
Rhynchaenus hortorum (F., 1792) *[= Rh. signifer* (Creutz, 1799)]		174	71	31	37			28	15	11	7		**374**	
Rhynchaenus calceatus (Germ., 1821)								1					**1**	
Rhynchaenus rusci (Hbst., 1795)		2			1			2	1				**6**	**1**
Tachyerges stigma (Germ., 1821)							1						**1**	
Isochnus populicola Silfv., 1977		1						2			1		**4**	
Rhamphus pulicarius (Hbst., 1795)					1		18	19	4	3			**45**	
Gasterocercus depressirostris (F., 1792)		3			1								**4**	
Acalles camelus (F., 1792)					1								**1**	
Acalles echinatus (Germ., 1824)		1											**1**	
Pelenomus quadrituberculatus (F., 1787)									1				**1**	
Rhinoncus castor (F., 1792)		2					1	3					**6**	
Rutidosoma fallax (Otto, 1897)		1											**1**	
Coeliodes dryados (Gmel., 1790)		5		1			2		1		1		**10**	
Coeliodes erythroleucos (Gmel., 1790)					2				3		1		**6**	
Ceutorhynchus erysimi (F., 1787)	1								2				**3**	

Ceutorhynchus sulcicollis (Payk., 1800)			**0**	**1**
Ceutorhynchus obstrictus (Marsh., 1802)		1	**1**	

In the Borecka Forest only 10 leaf beetle specimens, 78 fungus weevils and 1443 weevils were recorded; the most abundant species was *Strophosoma capitatum* with a proportion of 47.8% among the weevils. In the Białowieża Forest, we collected 675 leaf beetle specimens, 14 seed beetles, 661 fungus weevils and 23108 weevils, of which *Strophosoma capitatum* provided 10972 individuals or 47.5% of all weevils except fungus weevils. Broad-nosed weevils like *Strophosoma, Phyllobius*, and *Polydrusus* represented most specimens, namely 92.1% of all collected weevils (Anthribidae excluded).

Stem eclectors

Table 3: Beetles collected by 49 stem eclectors from oak (*Quercus robur*) in the Białowieża Forest (14.6. to 2.10. 2002).

Taxon	Number of specimens
Fam. Chrysomelidae	
Leptinotarsa decemlineata (Say, 1824)	26
Linaeidea aenea (L., 1758)	1
Phratora laticollis (Suffr., 1851)	6
Aphthona euphorbiae (Schrk., 1781)	2
Longitarsus curtus (All., 1860)	3
Longitarsus parvulus (Payk., 1799)	2
Altica quercetorum Foudr., 1860	6
Fam. Anthribidae	
Anthribus nebulosus (Forst., 1771)	9
Platystomos albinus (L., 1758)	2
Phaeochrotes cinctus (Payk., 1800)	4
Fam. Apionidae	
Betulapion simile (Kirby, 1811)	1
Ischnopterapion virens (Hbst., 1797)	1
Fam. Curculionidae	
Phyllobius arborator (Hbst., 1797)	367
Phyllobius calcaratus (F., 1792)	4
Phyllobius argentatus (L., 1758)	17
Polydrusus pallidus Gyll., 1834	1
Polydrusus flavipes (Deg., 1775)	20
Polydrusus pilosus Gredl., 1866	1
Strophosoma capitatum (Deg., 1775)	6358

Sitona griseus (F., 1775)	1
Hylobius abietis (L., 1758)	1
Hylobius pinastri (Gyll., 1813)	1
Rhyncolus ater (L., 1758)	1
Curculio venosus (Grav., 1807)	163
Curculio nucum L., 1758	1
Curculio glandium Marsh., 1802	71
Curculio pyrrhoceras Marsh., 1802	2
Dorytomus rufatus (Bed., 1888)	1
Gasterocercus depressirostris (F., 1792)	1
Stereonychus fraxini (Deg., 1775)	1
Rhynchaenus pilosus (F., 1781)	1
Rhamphus pulicarius (Hbst., 1795)	1

Stem eclectors collected altogether 32 species. This is a small part of the species spectrum of the fogging samples (Tab. 3). There are 7 leaf beetle species (46 individuals), 3 fungus weevils (15 individuals), and 22 species of weevils (7016 individuals of which 6358 [90.6%] were *Strophosoma capitatum*). 5 weevil species, collected as singletons, were not found in the fogging samples, namely *Ischnopterapion virens, Sitona griseus, Hylobius abietis, Rhyncolus ater*, and *Curculio nucum.* Furthermore, 3 specimens of the leaf beetle *Longitarsus curtus* were found only by the eclectors. Most of these species are transient species and not associated with oaks. *Rhyncolus ater* develops apart from oak also on many other trees. For a short definition of the term transient species, see explanations for figure 3.

3.1 Comments on faunistically remarkable species

As a basis for the faunistic interpretation, we used the faunal lists of the Białowieża Forest published by GUTOWSKI & JAROSZEWICZ (2001), BOROWIEC (2001), and WANAT (2001, 2003) for Chrysomeloidea and Curculionoidea. Further important informations on the occurrence and distribution of leaf beetles (incl. seed beetles) and weevils in Poland as well as in the area of the Białowieża Forest were taken from BURAKOWSKI et al. (1990, 1991, 1992) and WANAT (1994). Some of these species are not rare at all in Poland although there are only few records from the Białowieża area. The recording dates in the Borecka Forest are 12. and 13.6. 2002.

FAMILY CHRYSOMELIDAE

***Orsodacne cerasi* (LINNAEUS, 1758)**

Biology and life cycle of this species are poorly known (COX 1981). 3 specimens were fogged from *Carpinus betulus* and *Picea abies* in the Borecka Forest. *O. cerasi* is in Germany mainly found in old forests and old parks (FLOREN & SPRICK 2007). In the northern sandy lowlands of Germany the species is very rare or extinct (KÖHLER & KLAUSNITZER 1998, GÜRLICH et al. 1995). There is no record from Białowieża Forest (BURAKOWSKI et al. 1990, BOROWIEC 2001).

***Zeugophora frontalis* SUFFRIAN, 1840**

1 ex. was sampled from a 170 year-old oak forest, 16.6.2002. The occurrence of this species, developing on aspen, in the Białowieża area was not known, according to BOROWIEC (2001). WARCHAŁOWSKI (2003) does not list *Z. frontalis* in his key to European leaf beetles, but also H. Kippenberg (pers. comm.) has no doubt, that it is a valid species.

***Cryptocephalus nitidus* (LINNAEUS, 1758)**

In June 2001 and June 2002, 3 specimens were sampled in the 30 and 50 years old oak forests. The identification was also checked with the key of WARCHAŁOWSKI (2003), to exclude a possible confusion with the closely related and similarly sounding species *C. nitidulus* that is reported by BURAKOWSKI et al. (1990) from the Białowieża area.

***Cryptocephalus punctiger* PAYKULL, 1799**

In June 2002, 2 exx. were obtained from a fifty years old oak forest, 15.6. 2002.

***Cryptocephalus parvulus* MÜLLER, 1776**

16 specimens were sampled in the Leśna primary forest and in old managed forests, mainly from *Quercus robur* (15 exx.).

***Cryptocephalus querceti* SUFFRIAN, 1848**

31 of 33 exx. are from *Quercus robur*, only found in the primary forests and in the 170 year-old forests (Leśna: 16, Hajnówka forest district: 14, Lipiny: 1, Dębowy Grąd: 2). Previously, in the Białowieża Forest only 2 specimens from windfall stands were known (GUTOWSKI & KUBISZ 1995, BOROWIEC 2001).

Chrysomela tremulae FABRICIUS, 1787

We collected only 1 specimen from a 170 years old oak forest. This species develops at dry and warm sites on young aspen shoots of the herb or shrub layer and can be obtained by fogging only sporadically.

Phyllotreta tetrastigma (COMOLLI, 1837)

1 specimen was sampled from oak in the Leśna forest on 30.6.2001. This species develops in wet localities on *Cardamine* species and was only recorded near Pogorzelce before (BOROWIEC et al. 1992).

Phyllotreta dilatata THOMSON, 1866

This species, not known before from Białowieża Forest, was collected as singleton from a very old oak tree in the Leśna forest on 30.6.2001. It develops on *Rorippa amphibia* and other hygrophilous Brassicaceae.

Longitarsus curtus (ALLARD, 1860)

Stem eclectors revealed 3 exx. between 21.9. and 2.10. 2002 from old oaks. A species of the open countryside, in Poland rather widely distributed (Burakowski et al 1991). Previously not known from Białowieża Forest.

Longitarsus nasturtii (FABRICIUS, 1792)

This species was only once reported from Białowieża Forest without an exact locality (TROJAN et al. 1994). In the fogging samples we found a specimen in a 30 years old oak plantation on 8.7.2001.

Altica quercetorum FOUDRAS, 1860

From this species we received 85 exx., but it is not common, 4 specimens were found on old oaks in the Leśna Forest, and 81 in the managed forests (79 of them in the 50 years old oak forest). TROJAN et al. (1994) listed this species for the Białowieża Forest, but neither gave an exact locality nor an information on abundance.

Crepidodera nitidula (LINNAEUS, 1758)

Recorded were 11 specimens from *Populus tremula* and *Quercus robur* in a 170 years old forest, on 17.6.2002. The species develops on aspen. It is new to the Białowieża area.

***Epitrix pubescens* (KOCH, 1803)**

This species, usually not rare on *Solanum dulcamara*, was only once found in the Białowieża area until today (BOROWIEC 2001). A further specimen was fogged on 30.6.2001 from an old oak in the Leśna forest.

***Psylliodes cucullatus* (ILLIGER, 1807)**

Altogether 7 exx. from different sites (Starzyna: 2, Lipiny: 1, managed forests in the Hajnówka forest district: 4) and differently aged trees were obtained. Remarkable is the occurrence of long-winged specimens which were unknown until today. In one specimen the hind-wings could be recognized without a section. The identification keys of MOHR (1966), DOGUET (1994) and WARCHAŁOWSKI (2003) do not allow an identification of these beetles, because in all cases, the lack or the reduction of wings and of a pronounced shoulder are pre-conditions.

Family Bruchidae

***Bruchidius marginalis* (FABRICIUS, 1777)**

One specimen was fogged at a forest edge from an old oak, Hajnówka forest district, 1.6.2002. This species is new to the Białowieża area.

***Acanthoscelides obtectus* (SAY, 1831)**

In Starzyna we found 1 specimen on *Pinus sylvestris*, 28.6.2001. This seed beetle lives on *Phaseolus* (bean weevil) and was previously not recorded from the Białowieża area. It is a species of fields and gardens and not part of the typical fauna of this area.

Family Anthribidae

***Tropideres albirostris* (HERBST, 1783)**

Only known from three sites in the Białowieża Forest: Kosy Most, Park Narodowy and Oddziały (WANAT 1994). We can add two more: from Dębowy Grąd, 18.6.2002, and from a 170 years old managed oak forest, 17.6.2002, where two single specimens were collected.

***Phaeochrotes cinctus* (PAYKULL, 1800)**

The species obviously has a particular affinity to oaks (mainly branches infested by *Peniophora fungi* (J. SCHMIDL, pers. comm.); all 116 exx. from Białowieża Forest and the two from Borecka Forest were fogged from old oaks. Further 4 specimens were collected by stem eclectors. The species was previously not recorded from Białowieża Forest (WANAT 2001).

Family Curculionidae

***Polydrusus flavipes* (DEGEER, 1775)**

According to WANAT (1994), only known from Polana Białowieska. From our results, we conclude that it is a characteristic species of the damp and cool oak forest in the Białowieża Forest. In large numbers in Leśna (> 2500 exx.) and Dębowy Grąd (884 exx.), with comparatively low abundance in Lipiny (42 exx.) and rare in the managed forests (together 13 exx.), in Starzyna no record; mainly on oak, in lower numbers also on spruce (132 exx.) and hornbeam (45 exx.); stem eclectors revealed 20 exx. It seems worth mentioning that the highest number from a single oak in Leśna was 832.

***Polydrusus pilosus* GREDLER, 1866**

Mainly at a forest edge (24 exx.) on old oaks; moreover 4 specimens in a 50 years old managed oak forest. According to WANAT (1994) also mainly at forest edges or in tree groups (between Witowo and Orzeszkowo, near Gnilec and in the Polana Białowieska).

***Polydrusus mollis* (STRÖM, 1768)**

Only found in the Borecka Forest: mainly on *Carpinus betulus* (8 of 10 exx.). WANAT (1994) recorded this species in the Białowieża area only near Białowieża village (Polana Białowieska and Grudki).

***Cossonus parallelepipedus* (HERBST, 1795)**

One specimen was collected on 30.6.2001 from an old oak tree in the Leśna forest. Only 15 specimens were recorded before from the Białowieża area of this rather rare species from hollow decaying tree trunks (WANAT 1994, CHOLEWICKA-WIŚNIEWSKA 1994).

Anthonomus humeralis (PANZER, 1795)

On 30.6.2001 two specimens were fogged from a 300 years old oak in the Leśna forest. Up to now, there was only one record from the National Park area (WANAT 1994). This species develops on *Prunus species*.

Anthonomus pinivorax SILFVERBERG, 1977

Altogether 23 exx. were sampled from primary forests with spruce (Starzyna, Leśna) as well as young forests (Hajnówka forest). WANAT (1994) only knew one specimen from the area (Bokówka, NE of Orzeszkowo); the occurrence in the Białowieża Forest was reported before from KARPIŃSKI (1958). - In the Borecka Forest 7 exx. were fogged from spruce.

Magdalis fuscicornis DESBROCHERS, 1870

Sampled by fogging in a remarkable number from the whole Białowieża area: 8 exx. from Starzyna, 46 exx. from Leśna, 7 exx. from Lipiny, 4 exx. from Dębowy Grąd. The forests no older than 80 years in the Hajnówka forest revealed 6 exx., and the 170 years old stand 22; 4 more exx. from 200 years old oaks at a forest edge. This species was previously known only in one specimen from Białowieża area (PETRYSZAK & MAZUR 1981), but it is obviously more widespread on old oaks.

Magdalis exarata (H. BRISOUT, 1862)

Up to now, only 7 exx. of this species were recorded from the SW border of the Białowieża area (WANAT 1994, CHOLEWICKA-WIŚNIEWSKA 1994). Our results show, that *M. exarata* is widespread inside the Białowieża Forest. Most of the total 74 specimens were caught in Leśna (51). Two specimens were found in the Borecka Forest.

Gasterocercus depressirostris (FABRICIUS, 1792)

Four specimens were collected from old oak trees of primary forests: 3 exx. on 2.7.2001 in the Leśna forest and 1 ex. in Dębowy Grąd, 18.06.2002. A further specimen was recorded by stem eclectors from 3.-13.7.2002 on a 170 years old oak. KNUTELSKI & KUBISZ (1993) found this species first west of Narewka (also pers. comm.), and WANAT (1994) added one locality in the National Park and three in the surrounding area.

Acalles camelus (FABRICIUS, 1792)

WANAT (1994) mentions several sites from the National Park area. In Dębowy Grąd one specimen was fogged from an old oak tree (18.6. 2002*). A. camelus* as well as Acalles echinatus (GERMAR, 1824) were rarely collected by fogging and stem eclectors, indicating that these species do not climb the trees more than some decimeters. Normally, these

species live in the soil and in the leaf litter of deciduous forests, and sometimes they can be beaten from dead twigs and branches above the forest floor (see STÜBEN et al. 2003).

***Rutidosoma fallax* (OTTO, 1897)**

In Leśna one specimen was fogged from an old oak of the primary forest, 30.6.2001. This flightless species, which is monophagous on *Oxalis acetosella*, is a forest-dwelling species of the herb layer, which was only recently recorded by WANAT (2003).

***Rhynchaenus pilosus* (F., 1781)**

Astonishingly, only one specimen was recorded previously from Białowieża Forest (WANAT 1994: Polana Białowieska). The fogging samples revealed 174 exx. from nearly all study sites. One specimen came from the stem eclectors. In the Borecka Forest we found 3 exx..

***Rhynchaenus hortorum* (F., 1792) (syn. *Rhynchaenus signifer* (CREUTZ., 1799))**

PETRYSZAK & MAZUR (1981) received a single specimen near Białowieża, and WANAT (1994) collected 4 exx. in the same area (Polana Białowieska). As shown by the fogging samples the species is common on oak: 374 exx. were found in all study sites except the 8 year-old spruce plantation. Interestingly, another jumping weevil from oak, *Rhynchaenus quercus* (L., 1758), rather common elsewhere and also recorded from the Białowieża area, has not been recorded during this study.

***Rhynchaenus calceatus* (GERMAR, 1821)**

One specimen of this rare jumping weevil species from birch was recorded on an oak tree in the Hajnówka forest district in a 50 year-old forest, 15.6.2002. Previously also only 1 specimen was known from an adjacent area, recorded by WANAT (1994) SW Hajnówka, near Bokówka.

3.2 Composition of the phytophagous beetle communities of the canopy

The faunistic analysis shows that many species collected by fogging do not develop in the canopy. Figure 2 shows that only 13% of all leaf beetle species (6 species) and 36% of all weevil species (28 species) are associated with the tree from which they were collected. Another 22% of the leaf beetle species (10 species) and 32% of the weevil species (24 species) develop on other species of trees belonging to the arboreal fauna. 65% of the leaf beetles (30 species) and 32% of the weevils (24 species) are transient species, developing in the herb layer or in adjacent biotopes.

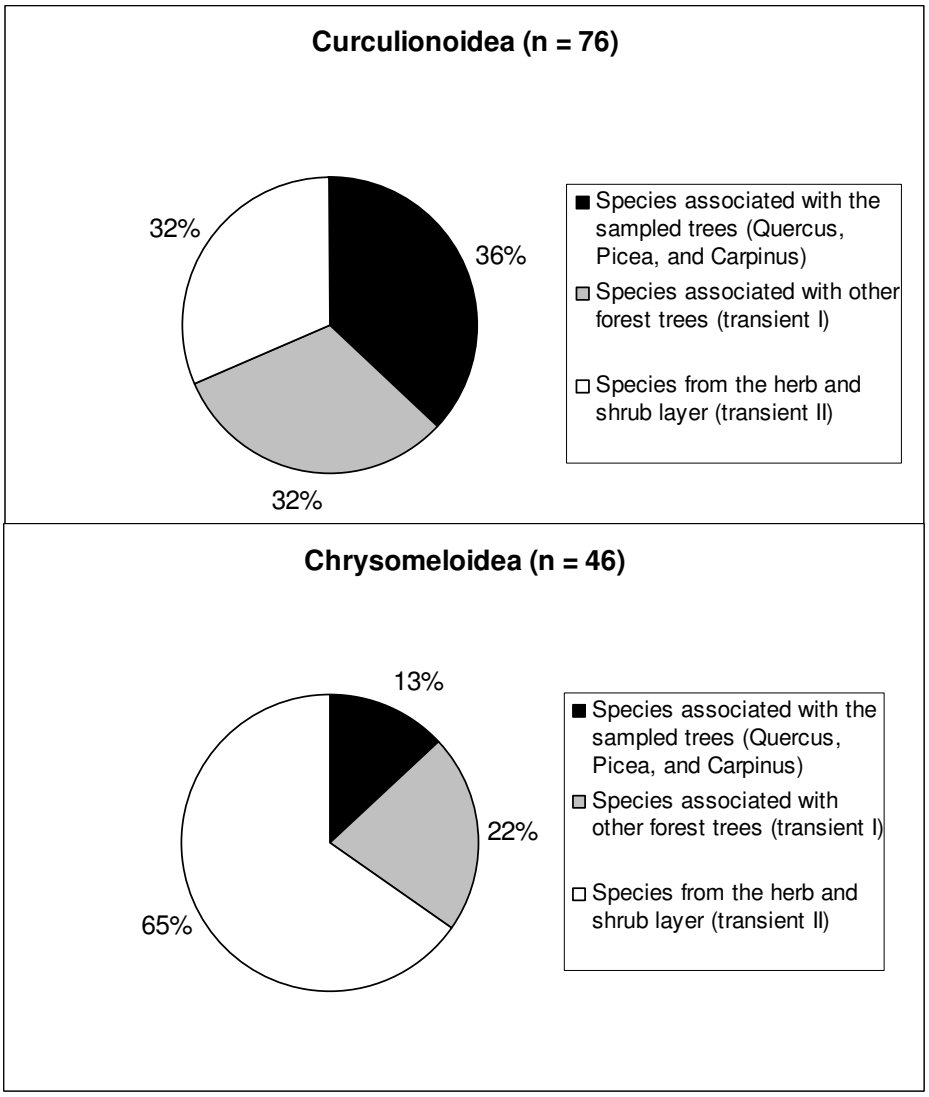

Fig. 2. Species assemblages of leaf beetles and weevils as derived from insecticidal knock-down samples from common oak, spruce, and hornbeam in the Białowieża Forest. Not considered are *Acer platanoides, Pinus sylvestris* and *Populus tremula*, which were fogged only once.

In respect to individuals, weevils were clearly dominating. Most arboreal specimens belong to the group of polyphagous broad-nosed weevils (mainly *Strophosoma capitatum, Phyllobius arborator, Phyllobius argentatus*, and *Polydrusus flavipes*). A relatively small number of leaf beetles were collected from the trees. Numbers of host plant-associated specimens were similar to those of the herb and shrub layer (transient species II) while numbers of non-associated arboreal specimens were even lower (Tab. 4). In respect to species numbers, host plant-associated arboreal weevils, transient I- and transient II species, were sampled in similar numbers. In contrast, in leaf beetles transient II species represented 65% of the total - three times more than transients from other than the focal trees and five times more than associated arboreal weevil species (Fig. 2).

Table 4. Number of Chrysomeloidea and Curculionoidea collected in 119 fogging samples from oak, spruce, and hornbeam (see text).

Chrysomeloidea	**Number**	**Curculionoidea**	**Number**
Specimens associated with *Quercus, Picea*, and *Carpinus*	**177**	Specimens associated with *Quercus, Picea,* and *Carpinus*	**22616**
Specimens associated with other forest trees	**130**	Specimens associated with other forest trees	**480**
Specimens associated with herb and shrub layer	**178**	Specimens associated with herb and shrub layer	**107**

Due to the high number of transient species the combined species accumulation curve is still steep (Fig. 3). Based on the faunistic analysis, however, the accumulation curves show clear differences for 1. arboreal species associated with their host plants, 2. arboreal species associated with other trees (Transient I), and 3. species associated with the ground vegetation (Transient II). While the flat curve computed for all phytophagous beetles collected from oak, hornbeam, and spruce indicates representative sampling of the associated fauna, the curves for both groups of transient species are still increasing.

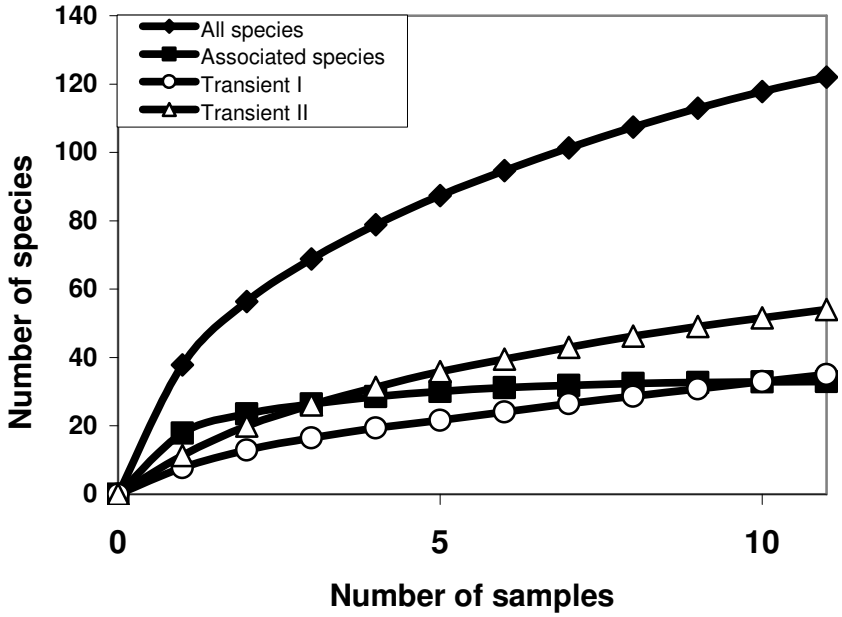

Fig. 3. Species accumulation curves for phytophagous beetles (Chrysomeloidea, Curculionoidea) collected by insecticidal knock-down in four primary forest plots and five managed forests in the Białowieża Forest. Data were shuffled 500 times to remove the effect of sample order. Associated species = phytophagous beetles associated with the studied trees. Transient I = arboreal species from non-focus trees. Transient II = species from the ground vegetation.

DISCUSSION

As shown by the analysis, insecticidal knock-down samples give a reliable picture of the diversity, structure, and composition of arboreal phytophagous beetles on *Quercus*, *Carpinus*, and *Picea*. The appropriateness of the fogging method is based on the high efficiency of the natural pyrethrum, which allows collecting free-living arthropods almost completely. This has also been described for other groups of arthropods but not yet on such a comprehensive database (e.g. FLOREN & GOGALA 2002; FLOREN & SPRICK 2007). Numerous species were recorded for the first time and the distribution of many species previously known to occur mostly as singletons or in low numbers were shown to be widespread or locally abundant, e.g. *Altica quercetorum, Phaeochrotes cinctus, Anthonomus pinivorax*, *Magdalis exarata*, *M. fuscicornis*, *Rhynchaenus hortorum* and *R. pilosus* as well as some species of *Cryptocephalus*. Due to their autecological requirements

these species are usually underrepresented in beating- and sweep net samples. Furthermore, species of *Curculio*, which usually live in acorns and acorn galls, are collected in larger numbers by fogging as also *Anthribus nebulosus* and *Attelabus nitens*. Medium and high abundances indicate that the canopy is their preferred habitat.

Although we collected also many transient species associated with other species of trees or with plants from the herb layer, their numbers always remained strikingly low. Both autecological knowledge and abundance data allowed us to separate transients from the tree-associated species community (see also FLOREN & GOGALA 2002; FLOREN & SPRICK 2007, HORSTMANN & FLOREN 2006). Using autecological information, the high number of phytophagous beetles could be reduced considerably and representative sampling was achieved. In contrast to the fogging, which collected 129 species, the stem eclectors collected only 32 species. Six of these species had not been recorded by fogging; five were singletons and only the three specimens of *Longitarsus curtus* represent a new record. Surprisingly the introduced species, *Leptinotarsa decemlineata*, which lives on potato and - less abundant - in wet forests on *Solanum dulcamara* (Solanaceae) was the most common leaf beetle in the stem eclectors, indicating its large dispersal power. A more thorough analysis of the stem eclector data is currently been carried out (see ERDMANN et al. 2006).

The arboreal Chrysomelidae and Curculionidae

Canopy fogging allowed us to get a view of the arboreal community of phytophagous beetles which would otherwise be hardly possible. A prominent result was the dominance of the broad-nosed polyphagous weevils (mainly of the genera *Phyllobius, Polydrusus* and *Strophosoma*), which are known to occur in the herb layer where they deposit their eggs and climb the trees for maturity feeding. *Strophosoma capitatum* alone represented almost half of all weevils. For many of the polyphagous individuals it is not absolutely sure whether they really had developed on the trees from which they were sampled. They were considered part of the tree-specific community in this analysis, however. On the other hand, other widely distributed broad-nosed weevils were found only in low numbers, like *Phyllobius calcaratus, Polydrusus pallidus* and *P. tereticollis*. The predominance of arboreal Curculionidae is evident (Fig. 2, Tab. 4). Obviously, the leaf beetles are more adopted to open forests and forest edges like *Altica quercetorum* or species of *Cryptocephalus* which mainly occur in dry or in damp and riparian forests. Most *Cryptocephalus* species are rather habitat than plant species specialists. The most abundant species associated with *Populus, Phratora laticollis,* was frequently collected as transient species from oak and spruce (e.g. on 30% of all oaks), and rarely from *Carpinus*.

Endophytic species and species of tree trunks are only collected accidentally by fogging, as for example *Cossonus parallelepipedus*. The high abundance of *Betulapion simile* in three samples from the 50 year-old oak forest, which represents 80.2% of the total catch, is a consequence of the admixture of the forest with birch trees. Remarkable is the record of the rare species *Anthonomus humeralis*, which develops on *Prunus* (Rosaceae), as

well as the repeated recording of *Magdalis cerasi* from oak, the latter is known to live on Rosaceae (trees and shrubs), too.

Although most of the collected beetles are associated with *Quercus* - as are most arthropods in general (see FLOREN & SCHMIDL 2006), the canopy oak fauna remains comparatively little investigated until today. A detailed analysis (but not based on insecticidal knock-down samples) has been published only for the beetle fauna of *Pinus* (CHOLEWICKA-WIŚNIEWSKA 1994). The large importance of *Quercus* for phytophagous beetles is clearly reflected by the high proportion, i.e. 27.2% of associated species, among them many specialists and rare species. The rare polyphagous *Polydrusus flavipes* is also associated with *Salix* indicating a preference of more humid habitats (DIECKMANN 1980). Seven species, of which three are specialists, live on *Picea* while there are no feeding specialists among Chrysomelidae and Curculionidae on *Carpinus* trees in Central Europe.

The proportion of non-arboreal species was rather large, representing 30 Chrysomeloidea species (including all Bruchidae) and 24 species of Curculionoidea. These species occur in various habitats, like the herb layer of forests (e.g. *Rutidosoma fallax*), nitrogen-rich forest edges or shorelines with tall herbs (e.g. *Nanophyes marmoratus, Phyllotreta dilatata, P. ochripes, P. tetrastigma, Psylliodes napi*), meadows and roadsides (e.g. *Tychius picirostris*), gardens (e.g. *Acanthoscelides obtectus*), dry forest edges or nitrogen-poor, dry and sandy grasslands (e.g. *Bruchidius marginalis, Rhinoncus castor*, *Tychius meliloti*). They probably enter the forest for aestivation or hibernation or they were collected from the canopy during their dispersal flights. *Phyllotreta dilatata, Epitrix pubescens, Longitarsus nasturtii* or *Rutidosoma fallax* were only little known in the area. Remarkable is the finding of *Longitarsus parvulus* although there were no *Linum* fields in the surroundings (M. WANAT, pers. information and own observations).

The first record of individuals of full-winged *Psylliodes cucullatus* is of general interest. Hitherto, this species was considered unable to fly. Flight unability was even used as a main character for the species identification.

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