JOURNAL OF FOREST SCIENCE, *49*, 2003 (4): 148–158

Hymenoptera (Aculeata) in birch stands of the air-polluted area of Northern Bohemia

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ABSTRACT: The Hymenoptera (Aculeata) fauna was studied in birch stands (*Betula pendula* Roth) of colder areas of Northern Bohemia using the method of Moericke's yellow traps. Altogether 159 species were trapped; the most important were *Andrena lappona, Vespula vulgaris, Halictus* sp., *Trypoxylon minus* and *Vespula rufa.* Only 12.7% of the species are widely spread in this ecosystem type. In 1990–1994 and in 1995–1999 we compared the abundance of the fauna and discovered that many species of the families Apidae and Sphecidae receded from the birch stands due to changing site conditions (light, weed infestation).

Keywords: Hymenoptera; Aculeata; *Betula pendula*; Moericke's yellow traps; Northern Bohemia

Birch (*Betula pendula* Roth) stands have been a substitute forest community for dead spruce stands in the air-polluted area of Northern Bohemia since 1980. The fauna of this area has been the object of long-term investigations in the Děčín Sandstone Uplands. In this area we collected 861 species of moths (KULA 1997a); in addition, the crown fauna of birch includes 119 species of caterpillars (KULA 1997b) and 71 species of bugs (KULA 1999). The epigeal fauna consists of a great range of rove beetles (KULA 1991), ground beetles (KULA 1992) and spiders (KULA 1997d). The method of Moericke's yellow traps is very efficient for capturing dipterans and hymenopterans and enabled to document as many as 175 species of hoverflies (syrphids) (KULA 1997c; KULA, SCHOLZ 1995; KULA, LÁSKA 1997).

The Hymenoptera (Aculeata) are a very numerous group of insects. The fauna of Bohemia counts 838 species (PÁDR 1989) that play an important role not only as pollinators but also in particular as a component of the spectrum of natural enemies of pests and regulators of the equilibrium in forest ecosystems. Spider wasps (Pompiloidea) and digger wasps (Sphecoidea) are predators, and ruby wasps (Chrysidoidea), bethylid wasps (Bethyloidea) are parasitoids that frequently escape attention although they are important.

The attention of the majority of authors was focused on warmer localities of Bohemia that have a greater and more interesting range of fauna (BALTHASAR 1954, 1972; KOCOUREK 1966), in contrast to localities where the climate is colder and more humid (TYRNER 1988, 1995).

The objective of the present study is to document the abundance and importance of the Aculeata fauna in birch stands.

MATERIAL AND METHODS

The Hymenoptera (Aculeata) fauna was collected in three birch (*Betula pendula* Roth) stands in the Děčín Sandstone Uplands (DSU) – forest district Sněžník (FD Sněžník) using the method of Moericke's yellow traps (diameter 23 cm, depth 8 cm). The yellow traps were placed inside the stand in two parallel rows 50 m apart, alternatively placed low and high above the ground (0.3 and 1.3 m, respectively). The medium was 1% formaldehyde, which prevented algae to grow and reduced the attractiveness of the captured insects for the birds, and a wetting agent. The low and high traps were controlled separately in 7-day intervals in the period from 15 April to 15 October 1990–1999.

This study was supported by Grant Research Project 434100005 from Ministry of Education, Youth and Sports of the Czech Republic and VaV/830/3/00 funded by Ministry of the Environment of the Czech Republic and by the following firms and companies: SCA Packaging in Jílové, Netex and Alusuisse in Děčín, District Offices in Děčín, Setuza and Trmice Thermal Power Plant in Ústí nad Labem, ČEZ Praha, Čížkovice Lafarge Cement Works, North-Bohemian Mines in Chomutov, Dieter Bussmann in Ústí nad Labem.

P. Tyrner carried out the determinations of the collected material; J. Straka determined some of the species of the family Pompilidae, and for this we render our sincere thanks. The material was preserved in 70% ethanol and is stored in the depositaries of the Faculty of Forestry and Wood Technology of Mendel University of Agriculture and Forestry in Brno, the prepared part (300 ex) is stored in P. Tyrner's collection (Litvínov).

A larger part of the area of Sněžník forest district (14°04´ E, 50°46´ N), a part of the Děčín Sandstone Uplands that links up with the eastern part of the Krušné hory Mts. (Northern Bohemia), is situated on an upland plateau at an altitude of 450–700 m, mountainous climate, annual temperatures 6–7°C, annual sum of precipitation 700–800 mm, vegetation period 110–120 days (average daily temperatures higher than 15°C). The area has been affected by air-pollutants for a long period. One of the main pollutants was SO_2 (in 1969–1987 the annual concentrations of SO_2 exceeded 60 μg/m^3) (TŮMA 1988).

Investigations were carried out in three birch stands of the 1st age class (0–20 years) (Tisá, Letadlo "A", Vlčák). The birch stands have a different altitude, exposure, degree of weed infestation, type of soil preparation before the establishment of stands by seeding or planting, class of air pollution hazard (A) by long-term load of more than 60 μg/m^3 SO_2 per year, spruce longevity 20 years or (B) the same long-term load of SO_2, better ecological conditions, spruce longevity 20–40 years.

1. Letadlo "A" locality (A). The birch stand was established in 1983 without soil preparation, with an admixture of planted larch and blue spruce; closed; locally dense. The stand is situated on a south-eastern long, warm, stony slope (altitude of 440–500 m), full-area weed infestation with *Avenella flexuosa* (L.) Pirl., *Calamagrostis villosa* (Chaix.) Gmel. and *Vaccinium myrtillus* L. Area of air pollution hazard, degree B, acidic spruce-beech forest type. Wrong tending practices resulted in slow birch regeneration and increased the stand density.
2. Tisá locality (T). The birch stand was established in 1980 by planting after full-area bulldozer preparation and is situated on the upland plateau at an altitude of 600 m, in the area of air pollution hazard, degree A, in the acidic spruce-beech forest type. After the stand closed, tending was carried out (1993). Degree of weed infestation: 100% (*A. flexuosa* 20%, *C. villosa* 70%, *Calluna vulgaris* (L.) Hull. 10%).
3. Vlčák locality (V). The birch stand was established in 1980 by seeding without previous soil preparation on a moderate north-western slope (altitude of 450 m); area of air pollution hazard, degree B, acidic spruce-beech forest type; stand with locally dense growth where full-area tending was carried out in 1995; 100% herb cover with *A. flexuosa, C. villosa* and *Carex brizoides* L.

RESULTS AND DISCUSSION

In 1990–1999 we collected 9,529 specimens of 159 species in the birch stands; *Andrena lapponica* (14.34%), *Vespula vulgaris* (18.72%) and genus *Halictus* (30.13%) were eudominant. There were no dominant species, but *Trypoxylon minus* (4.17%) and *V. rufa* (2.38%) had a subdominant status. Eight species were classified to the category of receding species (Table 1). The fauna in the spruce stands was not so abundant (only 102 species) and the representation of some species was different (KULA, TYRNER 2000).

The species diversity in the localities with birch stands was considerably different. Only 66 species were captured in Vlčák locality; in the 5-year periods we compared (1990–1994 and 1995–1999) we saw only a slight decrease from 49 species to 42, and we discovered that a half of the species (i.e. 33) appeared in both studied periods. The Aculeata fauna of the birch stands of Tisá locality consisted of 91 species, the numbers slightly decreasing from 66 species to 61, but only 34 species (i.e. 37.4%) were trapped repeatedly in the second 5-year period. The most abundant fauna was discovered at the warmest site with higher diversity of woody species inside the stand and in the surroundings. Out of the total 159 species, only 141 species were captured in the first half of the investigations; in the following 5-year period it was by 19 species less, in spite of the fact that this area is the most stable because 87 species were common to both periods (i.e. 61.7%).

The bee *Andrena lapponica* belongs to the most numerous genus *Andrena*; it makes its nests in the surface layers of soil, very frequently among the vegetation and is not particular about the substrate quality. In the period of investigations it was a eudominant species, with the exception of 1993 (3.6%), 1995 (6.9%) and 1998 (8.8%); every 2nd to 3rd year the culmination in dominance followed and immediately after it its abundance greatly declined. Even though the absolute captures were the highest in Tisá and Letadlo "A" localities, its dominance in the Aculeata fauna was balanced, with the exception of 1995–1999 in the Tisá stand (Table 1). Since this species is heliophilic, it appeared in the closed spruce stands only as a receding species (1.92%) (KULA, TYRNER 2000). The abundance of this species is also limited by the amount of nutrient plants (*Vaccinium* sp.) available in birch stands.

Out of the 24 species of the genus *Andrena,* three species (*A. nitida, A. subopaca* and *A. clarkella*) receded from the biotope; in 1990–1994 *A. clarkella* was a subdominant species in Tisá locality (2.68%). In spruce stands the spectrum of this genus was limited to 17 species, the abundance of *A. fucata* and *A. nitida* being higher (KULA, TYRNER 2000). As a receding species *Andrena bicolor* reached a dominant status in 1996 and 1999 (7.3% and 7.9%, respectively).

The status of bees of the genus *Halictus* that make their nests especially in sandy and loess soil, in sand, even in the compact soil of roads, among the Apocrita fauna, was permanently eudominant with frequent culminations (1992, 1994, 1997, 1999). In the stand of Tisá locality they made up more than a half of the Aculeata fauna (53.83%). In the second half of the 1990s they generally receded

Table 1. Summary of the abundance of the Aculeata specimens in birch stands captured in Moericke's yellow traps (1990–1999)

Locality	Vlčák				Tisá				Letadlo "A"				Total	
	1990–1994		1995–1999		1990–1994		1995–1999		1990–1994		1995–1999		1990–1999	
Species	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	Sum	(%)
Agenioideus cinctellus (SPINOLA, 1808)									9	0.27			9	0.09
Ammophila sabulosa (LINNAEUS, 1758)									1	0.03			1	0.01
Ancistrocerus nigricornis (CURTIS, 1826)	8	1.68	3	0.88	13	0.54	0.00	0.00	68	2.04	7	0.42	99	1.04
Ancistrocerus parietinus (LINNAEUS, 1761)		0.00	1	0.29		0.00				0.00	1	0.06	2	0.02
Ancistrocerus trifasciatus (MÜLLER, 1776)	1	0.21	3	0.88		0.00	0.00	0.00	2	0.06	6	0.36	12	0.13
Andrena apicata SMITH, 1847		0.00		0.00		0.00			1	0.03		0.00	1	0.01
Andrena bicolor FABRICIUS, 1775	14	2.94	6	1.75	51	2.14	39	2.98	38	1.14	41	2.44	189	1.98
Andrena carantonica PÉREZ, 1902		0.00		0.00	3	0.13		0.00	17	0.51		0.00	20	0.21
Andrena clarkella (KIRBY, 1802)	3	0.63		0.00	64	2.68	2	0.15	4	0.12	8	0.48	81	0.85
Andrena denticulata (KIRBY, 1802)		0.00		0.00		0.00		0.00	1	0.03	2	0.12	3	0.03
Andrena flavipes PANZER, 1799	3	0.63	2	0.58	1	0.04		0.00	15	0.45	13	0.78	34	0.36
Andrena fucata SMITH, 1847	5	1.05	1	0.29	5	0.21	4	0.31	17	0.51	16	0.95	48	0.50
Andrena fulva (MÜLLER, 1766)		0.00		0.00		0.00	3	0.23		0.00		0.00	3	0.03
Andrena gravida IMHOFF, 1832		0.00		0.00		0.00		0.00	3	0.09	6	0.36	9	0.09
Andrena haemorrhoa (FABRICIUS, 1781)	1	0.21		0.00	6	0.25	8	0.61	15	0.45	2	0.12	32	0.34
Andrena helvola (LINNAEUS, 1758)		0.00	1	0.29		0.00		0.00	1	0.03		0.00	2	0.02
Andrena humilis IMHOFF, 1832		0.00		0.00		0.00		0.00	1	0.03	1	0.06	2	0.02
Andrena chrysosceles (KIRBY, 1802)		0.00		0.00		0.00		0.00	4	0.12		0.00	4	0.04
Andrena lapponica ZETTERSTEDT, 1838	75	15.72	44	12.87	341	14.29	264	20.15	432	12.95	210	12.52	1,366	14.34
Andrena minutula (KIRBY, 1802)		0.00	3	0.88	3	0.13	4	0.31	2	0.06	12	0.72	24	0.25
Andrena minutuloides PERKINS, 1914		0.00	4	1.17	1	0.04	2	0.15	5	0.15	5	0.30	17	0.18
Andrena nigroaenea (KIRBY, 1802)		0.00		0.00		0.00		0.00	5	0.15	2	0.12	7	0.07
Andrena nitida (MÜLLER, 1776)	3	0.63	1	0.29	26	1.09	6	0.46	57	1.71	41	2.44	134	1.41
Andrena ovatula (KIRBY, 1802)		0.00	1	0.29		0.00		0.00	5	0.15	2	0.12	8	0.08
Andrena pandellei PÉREZ, 1895		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Andrena ruficrus NYLANDER, 1848		0.00	1	0.29	6	0.25	2	0.15		0.00	1	0.06	10	0.10
Andrena subopaca NYLANDER, 1848	13	2.73	1	0.29	8	0.34	8	0.61	25	0.75	2	0.12	57	0.60
Andrena varians (KIRBY, 1802)	2	0.42		0.00		0.00	3	0.23	1	0.03		0.00	6	0.06

Locality	Vlčák				Tisá				Letadlo "A"				Total	
	1990–1994		1995–1999		1990–1994		1995–1999		1990–1994		1995–1999		1990–1999	
Species	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	Sum	(%)
Andrena wilkella (KIRBY, 1802)		0.00		0.00		0.00		0.00	2	0.06	1	0.06	3	0.03
Anoplius infuscatus (VAN DER LINDEN, 1827)		0.00		0.00		0.00		0.00	1	0.03	1	0.06	2	0.02
Anoplius nigerrimus (SCOPOLI, 1763)	3	0.63		0.00		0.00		0.00	4	0.12		0.00	7	0.07
Anoplius tenuicornis (TOURNIER, 1889)		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Anoplius viaticus viaticus (LINNAEUS, 1758)		0.00		0.00		0.00	1	0.08		0.00	2	0.12	3	0.03
Anthidium scapulare LATREILLE, 1809		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Apis mellifera LINNAEUS, 1758		0.00	2	0.58	3	0.13		0.00	10	0.30	2	0.12	17	0.18
Argogorytes mystaceus (LINNAEUS, 1761)		0.00		0.00	1	0.04	1	0.08		0.00		0.00	2	0.02
Caliadurgus fasciattelus (SPINOLA, 1808)		0.00		0.00		0.00	1	0.08		0.00		0.00	1	0.01
Cerceris rybyensis (LINNAEUS, 1771)		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Cleptes semiauratus (LINNAEUS, 1761)		0.00	19	5.56		0.00	9	0.69	6	0.18	28	1.67	62	0.65
Crabro scutellatus (SCHEVEN, 1781)		0.00		0.00	4	0.17		0.00		0.00		0.00	4	0.04
Crossocerus annulipes (LEPELETIER & BRULLÉ, 1834)	16	3.35		0.00	8	0.34		0.00	27	0.81	3	0.18	54	0.57
Crossocerus assimilis (F. SMITH, 1856)		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Crossocerus barbipes (DAHLBOM, 1854)	1	0.21	1	0.29		0.00	1	0.08	8	0.24	10	0.60	21	0.22
Crossocerus binotatus LEPELETIER & BRULLÉ, 1834		0.00		0.00		0.00	2	0.15		0.00		0.00	2	0.02
Crossocerus capitosus (SHUCKARD, 1837)	4	0.84		0.00	1	0.04		0.00	28	0.84		0.00	33	0.35
Crossocerus cetratus (SHUCKARD, 1837)		0.00	1	0.29	1	0.04	2	0.15	3	0.09	2	0.12	9	0.09
Crossocerus cinxius (DAHLBOM, 1838)	1	0.21		0.00		0.00		0.00	5	0.15		0.00	6	0.06
Crossocerus dimidiatus (FABRICIUS, 1781)	3	0.63	2	0.58		0.00		0.00	2	0.06	1	0.06	8	0.08
Crossocerus distinguendus (A. MORAWITZ, 1866)		0.00		0.00	2	0.08	3	0.23	1	0.03	1	0.06	7	0.07
Crossocerus leucostomus (LINNAEUS, 1758)	5	1.05		0.00	2	0.08	1	0.08	11	0.33	10	0.60	29	0.30
Crossocerus megacephalus (ROSSI, 1790)	4	0.84		0.00	3	0.13	2	0.15	12	0.36	11	0.66	32	0.34
Crossocerus nigritus LEPELETIER & BRULLÉ, 1834		0.00		0.00	1	0.04	1	0.08		0.00	1	0.06	3	0.03
Crossocerus ovalis LEPELETIER & BRULLÉ, 1834		0.00		0.00	1	0.04		0.00		0.00		0.00	1	0.01
Crossocerus pusillus LEPELETIER & BRULLÉ, 1834	25	5.24	12	3.51	34	1.42	6	0.46	11	0.33		0.00	88	0.92

Locality	Vlčák				Tisá				Letadlo "A"				Total	
	1990–1994		1995–1999		1990–1994		1995–1999		1990–1994		1995–1999		1990–1999	
Species	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	Sum	(%)
Dipogon subintermedius (MAGRETTI, 1866)		0.00		0.00	1	0.04		0.00	3	0.09		0.00	4	0.04
Dolichovespula adulterina (BUYSSON, 1905)		0.00		0.00		0.00		0.00	1	0.03	1	0.06	2	0.02
Dolichovespula ingrica (BIRULA, 1931)		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Dolichovespula media (RETZIUS, 1783)		0.00	26	7.60		0.00	2	0.15	1	0.03	1	0.06	30	0.31
Dolichovespula norvegica (FABRICIUS, 1793)	3	0.63	2	0.58	1	0.04	5	0.38	10	0.30	4	0.24	25	0.26
Dolichovespula saxonica (FABRICIUS, 1793)	9	1.89	5	1.46	7	0.29	5	0.38	31	0.93	25	1.49	82	0.86
Dolichovespula sylvestris (SCOPOLI, 1763)	1	0.21		0.00		0.00		0.00	3	0.09		0.00	4	0.04
Ectemnius borealis (ZETTERSTEDT, 1838)	8	1.68		0.00	28	1.17	1	0.08	34	1.02	13	0.78	84	0.88
Ectemnius cavifrons (THOMSON, 1870)	1	0.21		0.00		0.00	1	0.08		0.00		0.00	2	0.02
Ectemnius continuus (FABRICIUS, 1804)		0.00		0.00	1	0.04		0.00	9	0.27	6	0.36	16	0.17
Ectemnius dives (LEPELETIER & BRULLÉ, 1834)	1	0.21		0.00		0.00		0.00	4	0.12	1	0.06	6	0.06
Ectemnius guttatus (VAN DER LINDEN, 1829)		0.00		0.00	2	0.08		0.00	2	0.06	5	0.30	9	0.09
Ectemnius lapidarius (PANZER, 1804)	1	0.21		0.00	2	0.08		0.00		0.00	1	0.06	4	0.04
Ectemnius rubicola (DUFOUR & PERRIS, 1840)		0.00		0.00		0.00		0.00	2	0.06	1	0.06	3	0.03
Ectemnius ruficornis (ZETTERSTEDT, 1838)	5	1.05	1	0.29	8	0.34		0.00	52	1.56	24	1.43	90	0.94
Entomognathus brevis (VAN DER LINDEN, 1829)		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
*Eucera longicornis (*LINNAEUS, 1758*)*		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Eumenes pedunculatus (PANZER, 1799)		0.00		0.00		0.00		0.00	2	0.06		0.00	2	0.02
Euodynerus notatus (JURINE, 1807)		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Evagetes alamannicus (BLÜTHGEN, 1944)		0.00		0.00		0.00		0.00		0.00	2	0.12	2	0.02
Halictus rubicundus (CHRIST, 1791)		0.00	1	0.29	26	1.09	6	0.46	13	0.39	5	0.30	51	0.54
Halictus sp.	44	9.22	24	7.02	1,368	57.31	622	47.48	584	17.51	178	10.61	2,820	29.59
Heriades truncorum (LINNAEUS, 1758)		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Homonotus sanguinolentus (FABRICIUS, 1793)		0.00		0.00		0.00		0.00	2	0.06		0.00	2	2.02
Hylaeus communis NYLANDER, 1852		0.00		0.00	1	0.04	1	0.08	4	0.12		0.00	6	0.06
Hylaeus confusus NYLANDER, 1852	1	0.21	1	0.29		0.00		0.00	10	0.30	2	0.12	14	0.15
Hylaeus cornutus CURTIS, 1831		0.00		0.00	8	0.34	3	0.23	1	0.03	1	0.06	13	0.14
Chelostoma florisomne (LINNAEUS, 1758)		0.00		0.00	2	0.08		0.00	5	0.15	3	0.18	10	0.10

Locality	Vlčák				Tisá				Letadlo "A"				Total	
	1990–1994		1995–1999		1990–1994		1995–1999		1990–1994		1995–1999		1990–1999	
Species	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	Sum	(%)
Chelostoma rapunculi (LEPELETIER, 1841)		0.00		0.00		0.00		0.00		0.00	4	0.24	4	0.04
Chrysis angustula SCHENCK, 1856		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Chrysis ignita LINNAEUS, 1761		0.00	1	0.29		0.00	1	0.08		0.00	1	0.06	3	0.03
Lestica clypeata (SCHREBER, 1759)		0.00		0.00		0.00		0.00	3	0.09	1	0.06	4	0.04
Lindenius albilabris (FABRICIUS, 1793)		0.00		0.00	11	0.46		0.00	3	0.09		0.00	14	0.15
Macropis fulvipes (FABRICIUS, 1804)		0.00		0.00	2	0.08	2	0.15	1	0.03		0.00	5	0.05
Megachile alpicola ALFKEN, 1924		0.00		0.00	1	0.04		0.00	1	0.03		0.00	2	0.02
Megachile lapponica THOMSON, 1872		0.00		0.00	1	0.04		0.00		0.00		0.00	1	0.01
Megachile nigriventris SCHENCK, 1870		0.00		0.00		0.00	1	0.08		0.00		0.00	1	0.01
Melecta albifrons FÖRSTER, 1771		0.00		0.00		0.00		0.00	3	0.09		0.00	3	0.03
Mellinus arvensis (LINNAEUS, 1758)		0.00		0.00	29	1.21	1	0.08	4	0.12	1	0.06	35	0.37
Mimumesa dahlbomi (WESMAEL, 1852)		0.00		0.00		0.00	2	0.15	30	0.90	14	0.83	46	0.48
Myrmosa atra PANZER, 1801		0.00		0.00		0.00		0.00	2	0.06		0.00	2	0.02
Nomada fabriciana (LINNAEUS, 1767)		0.00		0.00		0.00	1	0.08	7	0.21	6	0.36	14	0.15
Nomada flava PANZER, 1798		0.00		0.00		0.00		0.00	2	0.06		0.00	2	0.02
Nomada flavoguttata (KIRBY, 1802)		0.00		0.00	1	0.04		0.00	7	0.21	3	0.18	11	0.12
Nomada fucata PANZER, 1798		0.00		0.00		0.00	1	0.08	4	0.12	3	0.18	8	0.08
Nomada goodeniana (KIRBY, 1802)		0.00		0.00	1	0.04		0.00	3	0.09	3	0.18	7	0.07
Nomada leucophtalma (KIRBY, 1802)	1	0.21	1	0.29	119	4.99	24	1.83	8	0.24	7	0.42	160	1.68
Nomada marshamella (KIRBY, 1802)		0.00		0.00	1	0.04		0.00	24	0.72	4	0.24	29	0.30
Nomada panzeri LEPELETIER, 1841		0.00		0.00		0.00	2	0.15	1	0.03	3	0.18	6	0.06
Nomada ruficornis (LINNAEUS, 1758)		0.00		0.00	3	0.13	3	0.23	2	0.06	1	0.06	9	0.09
Nomada signata JURINE, 1807		0.00		0.00		0.00	1	0.08		0.00		0.00	1	0.01
Nomada symphyti STOECKHERT, 1930		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Nysson spinosus (FOERSTER, 1771)	1	0.21	1	0.29	17	0.71	83	6.34	36	1.08	35	2.09	173	1.82
Nysson trimaculatus (ROSSI, 1790)		0.00		0.00		0.00		0.00	2	0.06		0.00	2	0.02
Odynerus spinipes (LINNAEUS, 1758)		0.00		0.00	1	0.04		0.00	1	0.03	1	0.06	3	0.03
Omalus aeneus (FABRICIUS, 1787)		0.00	1	0.29		0.00		0.00		0.00	1	0.06	2	0.02

Locality	Vlčák				Tisá				Letadlo "A"				Total	
	1990–1994		1995–1999		1990–1994		1995–1999		1990–1994		1995–1999		1990–1999	
Species	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	Sum	(%)
Omalus biaccinctus BUYSSON, 1891		0.00		0.00		0.00		0.00		0.00	2	0.12	2	0.02
Osmia claviventris THOMSON, 1872		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Osmia nigriventris (ZETTERSTEDT, 1838)		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Osmia rufa (LINNAEUS, 1758)		0.00		0.00	3	0.13		0.00	21	0.63	6	0.36	30	0.31
Osmia uncinata GERSTAECKER, 1869		0.00		0.00		0.00		0.00	2	0.06	1	0.06	3	0.03
Oxybelus uniglumis (LINNAEUS, 1758)		0.00		0.00	1	0.04	1	0.08		0.00		0.00	2	0.02
Panurgus banksianus (KIRBY, 1802)		0.00		0.00	1	0.04		0.00	2	0.06	1	0.06	4	0.04
Panurgus calcaratus (SCOPOLI, 1763)		0.00		0.00		0.00		0.00	1	0.03	2	0.12	3	0.03
Passaloecus borealis DAHLBOM, 1845	2	0.42		0.00		0.00	1	0.08	18	0.54	6	0.36	27	0.28
Passaloecus brevilabris WOLF, 1958		0.00		0.00		0.00		0.00	6	0.18		0.00	6	0.06
Passaloecus clypealis FAESTER, 1947		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Passaloecus corniger SHUCKARD, 1837	6	1.26		0.00		0.00		0.00	6	0.18	5	0.30	17	0.18
Passaloecus eremita KOHL, 1893		0.00		0.00		0.00		0.00	1	0.03	1	0.06	2	0.02
Passaloecus gracilis (CURTIS, 1834)		0.00		0.00		0.00		0.00		0.00	2	0.12	2	0.02
Passaloecus insignis (VAN DER LINDEN, 1829)	5	1.05	9	2.63		0.00		0.00	18	0.54	4	0.24	36	0.38
Passaloecus monilicornis DAHLBOM, 1844	16	3.35	1	0.29		0.00	2	0.15	15	0.45		0.00	34	0.36
Passaloecus singularis DAHLBOM, 1844	5	1.05	1	0.29		0.00	1	0.08	6	0.18		0.00	13	0.14
Pemphredon inornata SAY, 1824	16	3.35		0.00	22	0.92	13	0.99	81	2.43	17	1.01	149	1.56
Pemphredon lethifer (SHUCKARD, 1837)		0.00		0.00		0.00	8	0.61	1	0.03	6	0.36	15	0.16
Pemphredon lugens DAHLBOM, 1842	1	0.21		0.00		0.00		0.00	5	0.15	1	0.06	7	0.07
Pemphredon lugubris (FABRICIUS, 1793)	17	3.56	1	0.29	11	0.46	3	0.23	99	2.97	14	0.83	145	1.52
Pemphredon montana DAHLBOM, 1845		0.00		0.00	1	0.04	2	0.15	6	0.18	5	0.30	14	0.15
Pemphredon morio VAN DER LINDEN, 1829		0.00		0.00	2	0.08		0.00	7	0.21	2	0.12	11	0.12
Pemphredon rugifer DAHLBOM, 1843	1	0.21		0.00	1	0.04		0.00	2	0.06	2	0.12	6	0.06
Polistes nimpha (CHRIST, 1791)		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Priocnemis exaltata (FABRICIUS, 1776)		0.00		0.00		0.00		0.00	4	0.12	3	0.18	7	0.07
Priocnemis fennica HAUPT, 1926		0.00	1	0.29		0.00		0.00	2	0.06		0.00	3	0.03
Priocnemis perturbator (HARRIS, 1780)		0.00	2	0.58		0.00	1	0.08	1	0.03	1	0.06	5	0.05

Locality	Vlčák				Tisá				Letadlo "A"				Total	
	1990–1994		1995–1999		1990–1994		1995–1999		1990–1994		1995–1999		1990–1999	
Species	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	Sum	(%)
Priocnemis schiodtei HAUPT, 1926		0.00		0.00		0.00	1	0.08	1	0.03	2	0.12	4	0.04
Psenulus fuscipennis (DAHLBOM, 1843)		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Psenulus pallipes (PANZER, 1797)		0.00		0.00	1	0.04		0.00		0.00		0.00	1	0.01
Pseudomalus violaceus (SCOPOLI, 1763)		0.00		0.00		0.00	1	0.08		0.00		0.00	1	0.01
Rhopalum clavipes (LINNAEUS, 1758)		0.00		0.00		0.00	7	0.53		0.00		0.00	7	0.07
Rhopalum coarctatum (SCOPOLI, 1763)	1	0.21		0.00		0.00		0.00		0.00		0.00	1	0.01
Sphecodes ephippius (LINNAEUS, 1767)		0.00		0.00		0.00		0.00		0.00	1	0.06	1	0.01
Sphecodes miniatus HAGENS, 1882	1	0.21		0.00	1	0.04	2	0.15	5	0.15		0.00	9	0.09
Stigmus solskyi A. MORAWITZ, 1864	2	0.42	2	0.58		0.00		0.00		0.00		0.00	4	0.04
Symmorphus bifasciatus (LINNAEUS, 1761)		0.00		0.00	2	0.08		0.00	1	0.03		0.00	3	0.03
Symmorphus crassicornis (PANZER, 1798)		0.00	1	0.29		0.00		0.00		0.00		0.00	1	0.01
Tachysphex unicolor (PANZER, 1809)		0.00		0.00		0.00		0.00	1	0.03		0.00	1	0.01
Trichrysis cyanea (LINNAEUS, 1761)	2	0.42		0.00		0.00		0.00	1	0.03	10	0.60	13	0.14
Trypoxylon attenuatum SMITH, 1851		0.00		0.00	1	0.04		0.00	1	0.03		0.00	2	0.02
Trypoxylon clavicerum LEPELETIER & SERVILLE, 1825	35	7.34		0.00	7	0.29	1	0.08	32	0.96	25	1.49	100	1.05
Trypoxylon figulus (LINNAEUS, 1758)	2	0.42		0.00		0.00		0.00	6	0.18	1	0.06	9	0.09
Trypoxylon minus DE BEAUMONT, 1945	25	5.24	1	0.29	24	1.01	3	0.23	263	7.88	81	4.83	397	4.17
Vespula adulterina		0.00		0.00		0.00		0.00	1	0.03	1	0.06	2	0.02
Vespula germanica (FABRICIUS, 1793)		0.00	1	0.29		0.00		0.00		0.00	1	0.06	2	0.02
Vespula rufa (LINNAEUS, 1758)	8	1.68	39	11.40	16	0.67	35	2.67	48	1.44	81	4.83	227	2.38
Vespula vulgaris (LINNAEUS, 1758)	66	13.84	110	32.16	62	2.60	85	6.49	887	26.59	574	34.23	1,784	18.72
	477	100	342	100	2,387	100	1,310	100	3,336	100	1,677	100	9,529	100

from birch stands to 41.3% of their original abundance, which could be related to the overall weed infestation of the stands. In Tisá locality, in particular, the weeds were destroyed in the early 1990s by full-area bulldozer soil preparation resulting in cleared loamy earth banks. Weed regeneration was gradual, it reached full-area coverage in the second half of the 1990s and caused the recession of specimens of this genus. The most frequent sources of feed for species of the genus *Halictus* are flowers of the various species of *Asteraceae*.

Out of the 11 species of the genus *Nomada* the occurrence of *N. leucophtalma* is very interesting because in 1990–1994 its abundance was remarkably high in Tisá locality (4.99%), but it was very sporadic in spruce stands (KULA, TYRNER 2000). The host of this parasitoid is *Andrena lapponica* and the fluctuation in the dominance of both species is clearly correlated. In terms of the total abundance we observed that the most abundant species of the genus *Andrena* was *A. lapponica* (1,531 ex in total) and of the genus *Nomada* the species *N. leucophtalma* (161 ex).

The *Ancistrocerus nigricornis* species makes their nests in tree stems in the galleries of wood-destroying insects. They prey on small larvae of butterflies, but also on lar-

vae of beetles, especially of the family *Chrysomelidae.* They preferred Letadlo "A" locality where its status was dominant in the first half of the 1990s, but in the following period it disappeared from the stands, similarly like the willow leaf beetle (*Lochmaea capreae* L.) (KULA 1988, 1994).

Cleptes semiauratus is an important parasitoid of the sawfly *Pachynematus scutellatus* (Htg.) and is not a typical insect of birch stands; however it was not monitored in birch stands until the second half of the 1990s, similarly like in spruce stands, as a response to the increased abundance of sawflies.

Digger wasps make up an important part of the Aculeata fauna (17.13%) counting 64 species. In forest biotopes the prevailing species were xylophile and rubicole (98.27%) as compared to the terrestrial species (1.73%). Species of the genera *Passaloecus*, *Trypoxylon* and *Rhopalum* make their nests in the wood in the finished galleries of wood-destroying insects while species of the genera *Crossocerus* and *Ectemnius* complete the galleries in the wood with their mouth organs.

The spectrum of digger wasps of the genus *Crossocerus* in birch and spruce stands is very broad, but more of these predators were found in birch stands, which is related to the greater diversity of available feed. Similarly like the most abundant *C. pusillus,* the species *C. annulipes* and *C. capitosus* disappeared from the biotope, and species of the genus *Ectemnius*, particularly *E. ruficornis* and *E. borealis* receded. *Trypoxylon minus* was a sub-dominant species of birch stands (4.17%) and its abundance declined from 1990 (14.4%) to 1994 (1.7%) with slight culmination in 1996 (4.5%) and following continuous recession, accompanied by *T. clavicerum*. The status of the receding species of the genus *Pemphredon* (*P. inornata, P. lugubris*) confirms the general recession of digger wasps in the investigated birch stands (Table 1). The decreasing numbers of Sphecidae species are an indubitable consequence of the succession particularly of woody vegetation, increasing the degree of coverage and canopy closure of birch, thereby decreasing insolation and changing the microclimate towards lower temperatures and higher humidity. With the exception of an extreme increase in the abundance of *Nysson spinosus* in Tisá locality the situation in the studied period was balanced. It is interesting that its hosts of the genus *Gorytes* (*G. laticinctus*, *G. quadrifasciatus*) were not monitored in the area, so we cannot exclude that there are some other hitherto not determined hosts, or maybe the yellow traps are not attractive for them.

Sphecidae are an important component of the entomofauna with a wide range of feed demands; the dominant species of their feed are considered to be harmful in terms of forest management (Aphididae and other Homoptera, Diptera, Heteroptera, Lepidoptera, to a lesser extent Coleoptera).

If wasps are a typical component of the Aculeata fauna in spruce stands (KULA, TYRNER 2000), then *Vespula rufa* reached high culmination values of dominance in 1993, 1995 and 1998 (i.e. 44%, 41% and 39,7%) while in the other years its dominance was very low (1–6.9%). It was most abundant in Letadlo "A" locality (29.14%) while the Tisá stand (4%) appeared to be entirely unattractive. *Dolichovespula saxonica* was more abundant in the warmer locality Letadlo "A" (Table 1).

In terms of the frequency of abundance in the investigated decade 26% of the species were monitored once, 21% twice, 14% three times and we can consider only 12.7% of the species as widely spread with 9–10-year repeated incidence (KULA, TYRNER 2000).

When we compare the periods of 1990–1994 (n_1) and 1995–1999 (n_2), the total abundance $\underline{n}$ of the studied species decreased to 72% of the original numbers ($n_1 = 477$, $n_2 = 342$) in Vlčák locality, to 55% ($n_1 = 2{,}387$, $n_2 = 1{,}310$) in Tisá locality and to 50% ($n_1 = 3{,}336$, $n_2 = 1{,}677$) in Letadlo locality.

CONCLUSION

In birch stands we captured 159 species; *Andrena lappona, Vespula vulgaris* and *Halictus* sp. were eudominant, and *Trypoxylon minus* and *Vespula rufa* were subdominant. Only 12.7% of the monitored species can be indicated as widely spread in this type of ecosystem.

The cause of recession of the majority of specimens of the Hymenoptera (Aculeata) families is the development of site conditions, reduction of disturbances, succession of the stand creating a crown canopy resulting in reduced insolation and changes in the microclimate towards lower temperatures and higher humidity, weed infestation with grass communities where *Calamagrostis* sp. are dominant, reduction of the abundance of some pests as sources of feed caused by the increased stability of the stands.

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Received for publication January 30, 2003
Accepted after corrections February 24, 2003

Hymenoptera (Aculeata) porostů břízy imisní oblasti severních Čech

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ABSTRAKT: Fauna Hymenoptera (Aculeata) byla studována v chladnější oblasti severních Čech v porostech břízy *Betula pendula* Roth metodou Moerickeho žlutých misek. Ve spektru 159 druhů měly nejvýznamnější postavení druhy *Andrena lappona, Vespula vulgaris, Halictus* sp., *Trypoxylon minus, Vespula rufa.* Pouze 12,7 % druhů lze označit za obecně rozšířené v tomto typu ekosystému. Ze srovnání výskytu v letech 1990–1994 a 1995–1999 vyplývá ústup řady druhů z čeledi Apidae, Sphecidae ze sledovaných březových porostů v důsledku měnících se stanovištních podmínek (světlostní poměry, zabuřenění).

Klíčová slova: Hymenoptera; Aculeata; *Betula pendula*; Moerickeho žluté misky; severní Čechy

Fauna Čech zahrnuje 838 druhů žahadlovitých (PÁDR 1989), které sehrávají významnou roli nejen jako opylovači, ale především jako součást spektra přirozených nepřátel škůdců a regulátorů rovnováhy v lesních ekosystémech. Hrabalky (Pompiloidea), kutilky (Sphecoidea) jsou predátory a zlatěnky (Chrysidoidea), hbitěnky (Bethyloidea) jsou parazitoidy, kteří přes významné postavení často unikají pozornosti. Cílem příspěvku je doložit faunu žahadlovitých (Aculeata) v porostech břízy a její význam.

Faunistické sběry blanokřídlých (Aculeata) se uskutečnily na území Děčínské pískovcové vrchoviny, Lesní správa Sněžník (severní Čechy) v porostech břízy *Betula pendula* Roth metodou Moerickeho žlutých misek v letech 1990–1999. Žluté misky byly situovány uvnitř porostu ve dvou souběžných liniích 50 m vzdálených, kde se střídala nízká (0,3 m) a vysoká (1,3 m) poloha umístění misky nad zemí.

V letech 1990–1999 bylo zachyceno v porostech břízy 9 529 jedinců 159 druhů, z nichž se k eudominantním řadila *Andrena lapponica* (14,34 %), *Vespula vulgaris* (18,72 %) a nedeterminovaný rod *Halictus* (30,13 %). Významnější subdominantní postavení měl *Trypoxylon minus* (4,17 %) a *Vespula rufa* (2,38 %). Osm druhů se řadilo do kategorie recedentních zástupců (tab. 1). Z celkového počtu 159 druhů bylo 141 druhů zachyceno v první polovině sledovaného období a pouze 120 druhů v navazujícím pětiletém období, přesto je možné označit tuto oblast za stabilní, protože hodnocené periody měly 61,7 % druhů společných.

Včela *Andrena lapponica* přísluší k nejpočetnějšímu rodu, jehož druhy hnízdí v povrchových vrstvách půdy často mezi vegetací bez zvláštních nároků na kvalitu substrátu. Byla eudominantním zástupcem ve sledovaném období s výjimkou r. 1993 (3,6 %), 1995 (6,9 %), 1998 (8,8 %) s kulminací ve dvouletém až tříletém intervalu.

Ze 24 druhů r. *Andrena* jsme u tří (*A. nitida, A. subopaca* a *A. clarkella*) zaznamenali celkový ústup z biotopu.

Včely rodu *Halictus,* které hnízdí hlavně v písčité a spražové půdě, písku, dokonce i v udusané hlíně cest, se projevovaly permanentním eudominantním zastoupením ve fauně štíhlopasých s četnějšími kulminacemi (1992, 1994, 1997, 1999). S narůstajícím zabuřeněním porostů ve druhé polovině devadesátých let z porostů břízy obecně ustupuje.

Z jedenácti zástupců rodu *Nomada* je zajímavý výskyt parazitoida *N. leucophtalma* u *Andrena lapponica,* přičemž kolísání dominance obou druhů je ve zřetelné korelaci.

Ancistrocerus nigricornis vytváří hnízda v chodbách dřevokazného hmyzu ve kmenech stromů. Loví drobnější housenky motýlů, ale také larvy brouků, zvláště čeledi Chrysomelidae. Obecně mizel z porostů břízy stejně jako klesal výskyt bázlivce vrbového (*Lochmaea capreae* L.) (KULA 1988, 1994).

Cleptes semiauratus, který je významným parazitoidem pilatky *Pachynematus scutellatus* (Htg.), není typickým zástupcem pro porosty břízy, ale stejně jako ve smrkových porostech byl zde zaznamenán až ve druhé polovině devadesátých let jako odezva na zvýšený výskyt pilatek.

Kutilky tvoří významnou část spektra Aculeata (17,13 %) se 64 druhy. V lesních biotopech převládaly xylofilní a rubikolní druhy (98,27 %) proti terestrickým (1,73 %).

Kutilky rodu *Crossocerus* se vyznačovaly širokým spektrem v porostech břízy i smrku, ale početnější byli tito predátoři v porostech břízy, což souvisí s vyšší diverzitou potravní nabídky. Stejně jako nejhojnější *C. pusillus,* tak i *C. annulipes, C. capitosus* ze sledovaného biotopu mizeli. Rovněž zástupci rodu *Ectemnius,* zvláště *E. ruficornis* a *E. borealis,* ustupovali. *Trypoxylon minus* byl subdominantním zástupcem porostů břízy (4,17 %), jeho výskyt klesal od r. 1990 (14,4 %) až do r. 1994 (1,7 %) s mírnou kulminací v r. 1996 (4,5 %) a navazujícím kontinuálním ústupem. Byl doprovázen druhem *T. clavicerum.*

Sphecidae jsou významnou složkou entomofauny se širokým spektrem potravních nároků, přičemž v jejich potravě dominují druhy, které jsou z hlediska lesního hospodářství pokládány za škodlivé (Aphididae a jiná Homoptera, Diptera, Heteroptera, Lepidoptera, méně Coleoptera).

Vývoj stanovištních podmínek, snížení disturbancí, sukcese porostu s vytvářením korunového zápoje, jehož důsledkem je snížení insolace a změny mikroklimatu směrem k nižším teplotám a zvýšení vlhkosti, zabuřenění travními společenstvy s dominantní *Calamagrostis* sp., pokles v zastoupení některých škůdců jako zdroje potravy v důsledku zvýšení stability porostů jsou příčinou obecného ústupu většiny zástupců zkoumaných čeledí Hymenoptera (Aculeata).

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