

Neuroptera, Raphidioptera and Mecoptera assemblages inhabiting young spruce (*Picea abies*) forests: dominance structure and seasonal activity patterns

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ABSTRACT: Neuropteroid insects (Neuroptera, Raphidioptera) and scorpion flies (Mecoptera) were studied in six young spruce forest localities in the eastern part of the Czech Republic during years 2005 and 2006. Twenty-seven species of lacewings, four species of snake flies and four species of scorpion flies were found using the Malaise traps. Consequently, the seasonal flight activity of the seven most abundant species (*Chrysopa perla*, *Hemerobius pini*, *Hemerobius humulinus*, *Dichrostigma flavipes*, *Phaeostigma notata*, *Panorpa communis* and *Panorpa germanica*) is discussed.

Keywords: Malaise traps; Neuroptera; Raphidioptera; Mecoptera; seasonal flight activity; faunistics; Czech Republic

The research of neuropteroid insects (Neuroptera and Raphidioptera) was carried very intensively in the Czech Republic during the last 25 years. The distribution of individual species was observed especially by ZELENÝ (1984a,b, 1986, 1988, 1995, 2004, 2005a,b) and BEZDĚK et al. (1997) in Bohemia and CHLÁDEK (1995a), CHLÁDEK and ZELENÝ (1995), ŠEVČÍK (1995a, 1997, 1998, 1999a, 2003), ŠEVČÍK and HUDEČEK (1995), HOLUŠA and VIDLIČKA (2002) in Moravia. Summarization of all relevant data on the occurrence of Neuroptera species in the Czech Republic and Slovakia was presented by JEDLIČKA et al. (2004).

Until recently scorpion flies (Mecoptera) in the Czech Republic (including Moravia) were studied by CHLÁDEK (1985a,b, 1995b), ŠEVČÍK (1995b, 1999b), ŠEVČÍK and HUDEČEK (1994), TAJOVSKÝ and LAUTERER (1986) and ZELENÝ (2005c).

The flight activity of neuropteroid insects was studied by ZELENÝ (1984a,b) in one locality of Bohemia and later, a series of papers including localities in Slovakia and Moravia was published by VIDLIČKA (1994, 1995, 1998) and HOLUŠA and VIDLIČKA (2002). Similar researches were conducted by SZENTKIRÁLYI (1992, 1997), SZENTKIRÁLYI and KAZINCZY (2002), SZENTKIRÁLYI et al. (1995) and VAS et al. (2001) in Hungary.

Only several authors (MARTINEK 1960; BEZDĚK et al. 1997; HOLUŠA, VIDLIČKA 2002) mention data about Neuroptera, Raphidioptera and Mecoptera from spruce forest.

Our study is focused mainly on following problems. (i) What species spectrum of Neuroptera, Raphidioptera and Mecoptera occurs in young planted spruce forests? (ii) Which species of the studied insect orders are typical for such localities?

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(iii) What are the flight activity patterns of dominant species in young spruce forests?

MATERIAL AND METHODS

The study area is situated in the eastern part of the Czech Republic. The study was carried out in the industrially affected region (Ostravská pánev Plateau) with forest coverage 9–20% (dominance of Norway spruce, *Picea abies*, 30–50%) and in the Nízký Jeseník Hills (forest coverage 70%, dominance of Norway spruce 67.8%) (ČULEK 1996). The Norway spruce dominates in both studied regions, however other tree species as larch (*Larix* sp.), beech (*Fagus* sp.), pine (*Pinus* sp.), oak (*Quercus* sp.), lime (*Tilia* sp.), birch (*Betula* sp.) are also present. Woods form a heterogenic mosaic of differently aged spruce forests.

The neuropteroid insects (Neuroptera, Raphidioptera) and scorpion flies (Mecoptera) were collected by Malaise traps of TOWNES (1972) type (modified and made by f. Entomologické pomôcky, Bratislava, RNDr. O. Šauša). The Malaise trap is a passive, non-powered and continuously operating tent-like trap. Its height is 2 m and collecting surface is approximately 6 m². Collecting sheets are black and a covering sheet is white. The trap is anchored to the ground by ropes and metal hooks. During 2005–2006, one trap was placed in each of six localities (Kyjovice: 49°49'30.17"N, 18°3'4.38"E, 390 m a.s.l.; Pustá Polom: 49°51'38.05"N, 18°0'16.99"E, 430 m a.s.l.; Podvihov: 49°51'36.47"N, 17°58'46.72"E, 460 m a.s.l.; Lesní Albrechtice: 49°48'21.09"N, 17°53'4.78"E, 460 m a.s.l.; Skřípov: 49°48'39.08"N, 17°52'59.02"E, 480 m a.s.l.; Paskov: 49°42'43.34"N, 18°16'45.7"E, 270 m a.s.l.) in very young spruce forests (10–20-year-old). All Malaise traps were installed in small forest clearings, minimally 30 m inwards the forest. The forest clearings are covered mainly by rough reedgrass (*Calamagrostis arundinacea*) and shrubs like bird cherry (*Padus racemosa*) are growing there occasionally too. The traps were exposed from the beginning of April to the end of October. From April to July, they were emptied every second or third day and from August to October, they were emptied monthly (J. Holuša leg.).

Figs. 1a–f display only the time period in which selected species were recorded.

RESULTS AND DISCUSSION

Altogether nearly 2,000 specimens from the orders Neuroptera, Raphidioptera and Mecoptera including 35 species of 7 families were collected

during a two-year research (2005–2006). All data regarding species richness and species dominance detected in each locality are presented in Table 1 (Neuroptera), Table 2 (Raphidioptera) and Table 3 (Mecoptera). Considering our research took place only in spruce forests, the number of species found is very high. In total, 78 species of Neuroptera (JEDLIČKA et al. 2004) were previously recorded in Moravia what means that 27 species found (Table 1) represent 35% of the entire species richness.

All studied localities can be divided into two groups according to the species frequency what is obvious mainly in Neuroptera. The highest species richness was ascertained in the villages Lesní Albrechtice and Skřípov (18, resp. 17 species of Neuroptera) and a slightly lower number was found in the village Podvihov (14 species). The second group includes the localities Kyjovice, Pustá Polom and Paskov (9, 8, resp. 7 species). When we add next two species of Neuroptera which were found in the locality Paskov in 1998 (HOLUŠA, VIDLIČKA 2002), a total of nine species is known from this locality. The higher species composition could be a result of the spruce forest decline caused by drought and infestation by honey fungus. By comparison, other localities are covered with much closer and denser spruce forests as in the surroundings of Skřípov.

Localities Lesní Albrechtice and Skřípov. Species *Chrysopa perla* and *Hemerobius humulinus* were very abundant in both localities. Species *Chrysoperla carnea* s.l. was abundant only in these localities. Species *Nineta flava*, *Nineta pallida*, *Chrysotropia ciliata*, *Chrysopa pallens*, *Hemerobius stigma*, *Wesmaelius nervosus*, *Drepanopteryx phalaenoides*, *Coniopteryx pygmaea* and *Myrmeleon formicarius* did not occur in other surveyed areas. Several of them live sparsely in coniferous forests. *Hemerobius atrifrons* is associated with European larch (*Larix decidua*) (ASPÖCK et al. 1980). The rare snake fly species *Inocellia crassicornis*, which distribution data for Silesia and Northern Moravia regions were summarized by ŠEVČÍK (1995a), was collected in Lesní Albrechtice.

Locality Kyjovice. Euryoecic species *Chrysopa perla*, *Hemerobius humulinus* and *Micromus variegatus* are very abundant in coniferous and deciduous forests (ASPÖCK et al. 1980). *Hemerobius pini*, typical for pine trees (*Pinus* sp.) (ASPÖCK et al. 1980), was also numerous in this locality. The Siberian faunistic elements predominated in this locality. Regarding snake flies (Raphidioptera), the most abundant species were typical for pine and spruce forests (*Dichrostigma flavipes*, *Phaeostigma notata*) (ASPÖCK et al. 1980).

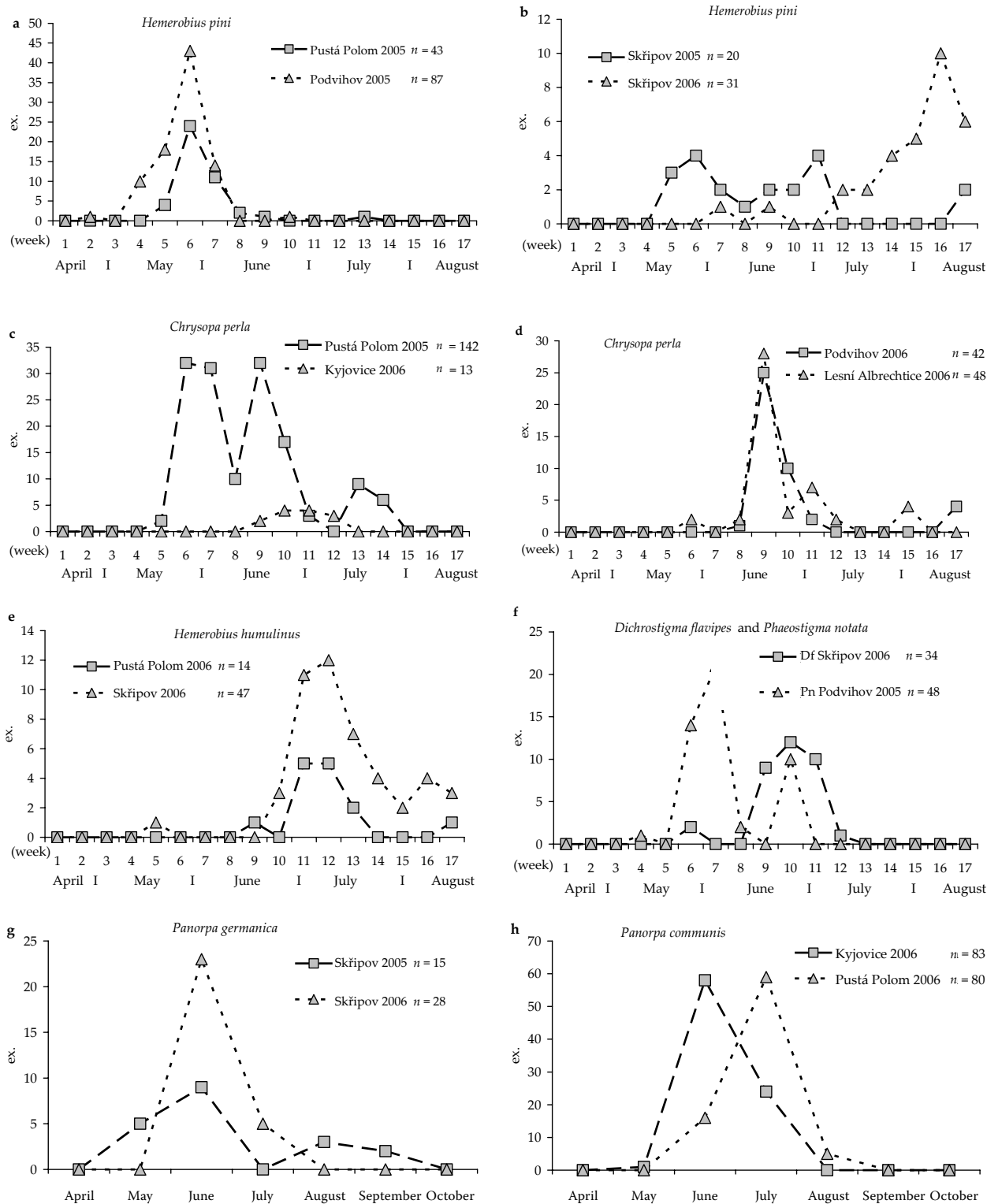


Fig. 1. Flight activity of selected dominant species of Neuroptera, Raphidioptera and Mecoptera on Malaise-trapping sites

Locality Pustá Polom. Species *Chrysopa perla*, *Hemerobius humulinus* and *Hemerobius pini* predominated. Species *Micromus angulatus*, which occur mainly on low vegetation in warmer localities (Aspöck et al. 1980), was very abundant here. The rare species *Conwentzia pineticola* associated

with coniferous forests, living mainly on pine trees (ZELENÝ 1961), was trapped here too. Only a few localities with occurrence of this species have been published from Moravia (ZELENÝ 1995; ŠEVČÍK 1997, 2003). Snake fly *Xanthostigma xanthostigma* is predominantly associated with pines (*Pinus*),

Table 1. List of recorded Neuroptera species and their dominance distribution (%)

Neuroptera	Kyjovice		Pustá Polom		Podvihov		Lesní Albrechtice		Skřipov		Paskov	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Chrysopidae												
<i>Nineta</i> Navás, 1912												
– <i>flava</i> (Scopoli, 1763)							2.5					
– <i>pallida</i> (Schneider, 1846)							1.2		2.8			
<i>Chrysotropia</i> Navás, 1911												
– <i>ciliata</i> (Wesmael, 1841)								1.2				
<i>Chrysopa</i> Leach, 1815												
– <i>pallens</i> (Rambur, 1838)								3.5		7.0		
– <i>perla</i> (Linnaeus, 1758)	79.5	26.5	74.3	35.7	27.3	33.6	32.1	56.5	28.2	16.8	20.0	33.3
<i>Dichochrysa</i> Yang, 1991												
– <i>flavifrons</i> (Brauer, 1850)						0.8						
– <i>prasina</i> (Burmeister, 1839)					0.7	0.8				0.7		
– <i>ventralis</i> (Curtis, 1834)		2.0	0.5			2.4	1.2	2.4			26.7	16.7
<i>Peyerimhoffina</i> Lacroix, 1920												
– <i>gracilis</i> (Schneider, 1851)						0.8	2.5		7.0	3.5		
<i>Chrysoperla</i> Steinmann, 1964												
– <i>carnea</i> s.l. (Stephens, 1836)	15.4		1.1	7.1	2.2	9.6	21.0	9.4	15.5	9.8		16.7
Hemerobiidae												
<i>Hemerobius</i> Linnaeus, 1758												
– <i>humulinus</i> Linnaeus, 1758		22.5		20.0	0.7	7.2		10.6		32.9	6.7	16.7
– <i>stigma</i> Stephens, 1836									1.4	0.7		
– <i>pini</i> Stephens, 1836		14.3	22.5	10.0	62.6	19.2	22.2	7.1	39.4	21.7	26.7	16.7
– <i>atrifrons</i> McLachlan, 1868							2.5					
– <i>nitidulus</i> Fabricius, 1777					0.7	0.8						
– <i>micans</i> Olivier, 1792		2.0			0.7	1.6	2.5			2.1		
– <i>lutescens</i> Fabricius, 1793					0.7	0.8						
<i>Wesmaelius</i> Kruger, 1922												
– <i>nervosus</i> (Fabricius, 1793)											0.7	
– <i>quadrifasciatus</i> (Reuter, 1894)		8.2							2.8	1.4		
– <i>subnebulosus</i> (Stephens, 1836)					0.7	1.6		2.4	1.4	0.7	6.7	
<i>Drepanepteryx</i> Leach, 1815												
– <i>phalaenoides</i> (Linnaeus, 1758)							1.2		1.4			
<i>Micromus</i> Rambur, 1842												
– <i>variegatus</i> (Fabricius, 1793)	5.1	20.4		2.9	2.9	8.8	6.2	3.5			6.7	
– <i>angulatus</i> (Stephens, 1836)		4.1	1.6	22.9	0.7	12.0	3.7	2.4				
Coniopterygidae												
<i>Coniopteryx</i> Curtis, 1834												
– <i>pygmaea</i> Enderlein, 1906								1.2		0.7		
<i>Conwentzia</i> Enderlein, 1905												
– <i>pineticola</i> Enderlein, 1905				1.4						0.7		
<i>Semidalis</i> Enderlein, 1905												
– <i>aleyrodiformis</i> (Stephens, 1836)							1.2				6.7	
Myrmeleontidae Latreille, 1802												
<i>Myrmeleon</i> Linnaeus, 1767												
– <i>formicarius</i> Linnaeus, 1767										0.7		
Number of species	3	8	5	7	11	14	13	11	9	15	7	5
Number of individuals	39	49	191	70	139	125	81	85	71	143	15	6
Total number of species	9		8		14		18		17		7	
Total number of individuals	88		261		264		166		214		21	

Table 2. List of recorded Raphidioptera species and their dominance distribution (%)

Raphidioptera	Kyjovice		Pustá Polom		Podvihov		Lesní Albrechtice		Skřipov		Paskov	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Raphidiidae												
<i>Xanthostigma xanthostigma</i> (Schummel, 1832)	6.2	–	5.3	100	1.3	37.8	–	7.1	2.8	–	100	66.7
<i>Dichrostigma flavipes</i> (Stein, 1863)	50.0	100	63.1	–	34.7	53.3	82.6	78.6	68.6	89.5	–	–
<i>Phaeostigma notata</i> (Fabricius, 1781)	43.8		31.6	–	64.0	8.9	17.4	7.1	28.6	10.5	–	33.3
Inocellidae												
<i>Inocellia crassicornis</i> (Schummel, 1832)	–	–	–	–	–	–	–	7.1	–	–	–	–
Number of species	3	1	3	1	3	3	2	4	3	2	1	2
Number of individuals	16	12	19	2	75	45	23	14	35	38	1	3
Total number of species	3		3		3		4		3		2	
Total number of individuals	28		21		120		37		73		4	

spruces and oaks (*Quercus*) (ASPÖCK et al. 1980; ŠEVČÍK 1995a).

Locality Podvihov. The species *Hemerobius pini* and *Chrysopa perla* were typical. An occurrence of two xerothermous species, *Dichochrysa flavifrons* and *Micromus angulatus*, is very interesting. *Dichochrysa flavifrons* occurs in deciduous forests only sporadically (recorded in silver fir forest and pine forest – SZENTKIRÁLYI 2001). *Micromus angulatus* was also in spruce forest in the High Tatras Mts. (unpublished data) however its eudominant representation in spruce forest is not typical. A very similar representation of this species detected SZENTKIRÁLYI (2001) in pine forest in Hungary.

Locality Paskov. Only euryoecic species occurred in this locality, though in a low abundance. In the same locality, the flight activity of Neuroptera was recorded almost five times higher during a previous research (HOLUŠA, VIDLIČKA 2002). The actual low value was probably caused by an unsuitable trap location.

The frequency of some species allowed studying their seasonal flight activity. Species *Hemerobius pini* (Figs. 1a,b) began to appear in the mid of April. The occurrence increases at the end of May what corresponds with the observation of HOLUŠA and VIDLIČKA (2002) in spruce forests of Paskovský les and Kabátice in 1998. The second peak was re-

Table 3. List of recorded Mecoptera species and their dominance distribution (%)

Mecoptera	Kyjovice		Pustá Polom		Podvihov		Lesní Albrechtice		Skřipov		Paskov	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Panorpidae												
<i>Panorpa</i> Linnaeus, 1758												
– <i>communis</i> Linnaeus, 1758	33.9	52.2	54.5	70.2	27.5	44.1	44.1	34.3	17.5	20.0	38.1	16.7
– <i>vulgaris</i> Omhoff, Labram, 1845	27.1	22.7	15.2	12.3	42.5	39.7	11.8	28.6	7.0	5.0	14.3	–
– <i>germanica</i> Linnaeus, 1758	3.4	9.4	3.0	13.1	22.5	14.7	44.1	37.1	66.7	70.0	38.1	66.6
– <i>alpina</i> Rambur, 1842	35.6	15.7	27.3	4.4	7.5	1.5	–	–	8.8	5.0	9.5	16.7
Number of species	4	4	4	4	4	4	3	3	4	4	4	3
Number of individuals	59	159	33	114	40	68	34	35	57	40	21	6
Total number of species	4		4		4		3		4		4	
Total number of individuals	218		147		108		69		97		27	

corded in July (Skřipov 2005) or in August (Skřipov 2006). ZELENÝ (1984a) noticed a high abundance of this species in Prague in September. In the investigated areas, no flight activity of this species was recorded in September.

Chrysopa perla was active from the end of May to the mid of August. The activities in Pustá Polom, Podvihov and Lesní Albrechtice (Figs. 1c,d) reached the peak in the mid of June. Females occurred mainly in July and at the end of season. VIDLIČKA (1994) recorded the peak of the activity in the mid of May in Ivanka pri Dunaji (Slovakia), but this locality is markedly xerothermous with deciduous trees. HOLUŠA and VIDLIČKA (2002) observed the peak of its activity in spruce forests of Paskovský les and Loucký les at the end of May in 1998. The delay of its flight activity in highlands, compared to lowlands, is in accordance with results of SZENTKIRÁLYI (1997).

Hemerobius humulinus (Fig. 1e) is a common species in the Czech Republic, having probably two generations and regularly occurring in coniferous trees. We recorded this species from the mid of May to the mid of August with the peak of its activity at the beginning of July.

The flight activity of snake fly *Phaeostigma notata* was very short, from May to June, with the highest activity at the beginning of June (Fig. 1f). A similar pattern of flight activity was found in *Dichrostigma flavipes*, but its activity peaked at the end of June (Fig. 1f). The males prevailed in the trap collections in both species during the whole season.

Panorpa communis was the most abundant Mecoptera species in spruce forests. Its flight activity increased from the end of May to the end of July, then decreased considerably (Fig. 1h). A very similar pattern of flight activity was recorded in *Panorpa germanica* (Fig. 1g). The ratio of females increased at the end of season in both species.

Based on our results (Table 1), we can specify some typical species associated with spruce trees (regular representation in all or nearly all investigated areas, dominant representation at least in one studied area): *Chrysopa perla*, *Dichochrysa ventralis*, *Chrysoperla carnea* s.l., *Hemerobius humulinus*, *Hemerobius pini*, *Wesmaelius subnebulosus*, *Micromus variegatus* and *Micromus angulatus*.

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Společenstva Neuroptera, Raphidioptera a Mecoptera mladých smrkových (*Picea abies*) lesů: struktura dominance a sezonní aktivita

ABSTRAKT: Síťokřídlý hmyz (Neuroptera, Raphidioptera) a srpice (Mecoptera) šesti lokalit umístěných v mladých smrkových porostech ve východní části České republiky jsme studovali v letech 2005 a 2006. Bylo zjištěno 27 druhů zlatooček, denivek, bělotek a mravkolvů, čtyři druhy dlouhošijek a čtyři druhy srpic. V článku se diskutuje o letové aktivitě sedmi nejpočetnějších druhů (*Chrysopa perla*, *Hemerobius pini*, *Hemerobius humulinus*, *Dichrostigma flavipes*, *Phaeostigma notata*, *Panorpa communis* a *Panorpa germanica*).

Klíčová slova: Malaiseho lapač; Neuroptera; Raphidioptera; Mecoptera; sezonní letová aktivita; faunistika; Česká republika

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