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Geometridae (Insecta: Lepidoptera) in stands of substitute species with the dominant position of birch

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ABSTRACT: The species spectrum of Geometridae, their seasonal and population dynamics and importance for the stability of birch stands in the air-polluted area of the Krušné hory Mts. was derived from a light trap [224 species of imagoes, particularly *Cabera pusaria* (L.), and *Cyclophora albipunctata* (Hufn.)] and the method of shaking off from birch crowns [52 species of larvae, particularly *C. pusaria* (L.), *Operophtera fagata* (Scharp.), *Alcis repandata* (L.), *Biston betularius* (L.), and *C. albipunctata* (Hufn.)]. *O. fagata* (Scharp.) has an economic importance for birch stands and newly established beech stands. Thanks to the uneven time of hatching moths of an eudominant species *C. pusaria* (L.) the danger of defoliation of birch stands in summer is reduced in spite of the species gradation potential.

Keywords: larvae; *Betula pendula*; Krušné hory Mts.; method of shaking off; light catcher; Geometridae

Fauna of moths the species spectrum and numerical proportion of which are affected by meso- and microclimatic conditions (altitude, aspect) and woody and herbaceous undergrowth are the organic component of forest ecosystems. Through the effect of anthropogenic air pollution, faunistic-poor spruce stands in the eastern Krušné hory Mts. have died being replaced by stands of substitute species with the high proportion of birch *Betula pendula* Roth and heavy weed infestation. Newly created site conditions generally increased faunistic diversity. In the spectrum of caught moths, it is possible to note a number of important phytophagous pests (Kula 1997b).

Birch ranks among species with the broad spectrum of phytophages where larvae show a dominant position. Reiprich (2001) mentions 367 species of butterfly and moths larvae (15 monophages) related to birch in Slovakia. Kutenkova (1986) corroborated food relationships to birch in 107 species of moths in the Karelian region. The author considers *Orgyia antiqua* (L.) and *Epirrita autumnata* (Bork.) to be potential pests. Gninenko (1999) ranks *Ptilodon capucina* (L.), *Biston betularius* (L.), *Ochropacha duplaris* (L.), *Hypomecis punctinalis* (Scop.), *Leucodonta bicoloria* (Den. et Schiff.) and *Acronicta leporina* (L.) among pests endangering birch. Flerov (1954) considers *Operophtera brumata* (L.) *Erannis defoliaria* (Cl.) and *Biston stratarius* (Hufn.) to be an important component of the crown fauna of birch. In Scandinavia in regions beyond the Arctic Circle, *E. autumnata* (Bork.) undergoes periodical gradations on *Betula tortuosa* Ledeb. causing complete defoliations (Eidmann 1964). Čihař (1978) rank loopers *B. betularius* (L.) and *Geometra papilionaria* (L.) among important pests of birch. *Erannis defoliaria* (Cl.), larvae of which are less numerous but exhibit higher food requirements than winter moth causes often complete defoliation in case of gradation. The fact is supported by damage

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to mountain ash and birch (1980, Forest Enterprise Janov in the Krušné hory Mts. – 3,000 ha and Forest Enterprise Děčín – 500 ha) which was eliminated by aerial spraying of stands (Badalík 1988). Koch (1989) mentions 131 species, 60 of which from the family Geometridae. Kula (1988a) ranked also *Cabera pusaria* (L.) among the spectrum of ten most important larvae on birch.

Phenology of the occurrence of larvae of moths related to birch changes during the year and it is possible to specify certain successions which overlap (Kula 1997a).

With respect to the extent of caught loopers (imagoes, larvae) the aim of the paper is to define their species spectrum, seasonal and population dynamics and importance for the stability of birch stands.

METHODS AND MATERIAL

The collection of crown fauna was carried out in the area of Forest Enterprise Děčín (formerly Sněžník) in the period 1986–2004 using the method of shaking off insect in six stands of *B. pendula* Roth aged 5–15 years. In each of the stands, in total 5 trees were shaken off on a cloth 2 × 2 m in a 14-day interval in a period from 1 April to 31 October. Trees for shaking off were randomly selected in a stand in such a way the trees not to repeat in two subsequent terms and thus the representation of larvae the development of which exceeded 14 days not to be affected. Shaken off individuals were killed and preserved in 75% ethanol creating a mixed sample for the stand. Larvae were determined by Dr. J. Patočka (Zvolen).

The trapping of moths was carried out by means of a light catcher Minnesota with a RVL 250 W vacuum tube and daily inspection from 1989 to 2004 (1 April–30 October). The catcher was placed in the zone of originally maximum threat by air pollution (at an altitude of 570 m). It was hung 3.5 m above the ground in a young stand of birch and in the vicinity of the catcher, full-grown trees of birch, larch, spruce, oak, ash, linden, alder and a pine thicket occurred. In the herb layer, *Calamagrostis villosa* Gmel. and *Senecio* sp. predominated with 100% cover.

The moths species were determined in cooperation with Dr. M. Králíček (Mendel University of Agriculture and Forestry Brno), V. Elsner (Museum of SE Moravia, Zlín), J. Spružina and J. Černý (Ústí nad Labem). The nomenclature of Laštůvka and Liška (2005) was used. Dominance was classified using five classes: eudominant > 10%, dominant 5–10%, subdominant 2–5%, receding 1–2%, subreceding up to 1% (Losos et al. 1984).

Description of the area under study

The area is part of the region of Forest Enterprise Děčín (northern Bohemia, 14°04´E, 50°46´N, number of the square of network faunistic mapping 5250) in the past for a long time exposed to SO_2 concentrations exceeding 60 μg/m^3. It is characterized by cold mountain climate (mean annual temperature 6°C, total annual precipitation 800 mm, the length of a growing season 110–120 days, altitude 450–700 m) occurring in the actual medium air pollution load. Spruce stands died on large areas in 1979 being then replaced by stands with the dominant proportion of birch (*B. pendula* Roth). The crown fauna was studied in six stands of birch.

The description of stands with permanent research plots (shaking off)

- Locality **Vlčák** – stand 144 A_1 with *Betula* sp. 50%, *Fagus sylvatica* L. 10%, *Picea abies* (Karst.) 10%, *Picea pungens* Engelm. 10%, *Larix decidua* Mill. 10% and *Quercus rubra* L. 10%. The birch stand was established by sowing in 1980, tending measures were carried out in 1995. NW aspect, gentle slope (5°), altitude 450 m, zone of air pollution threat B, forest type 6K4. Undergrowth species: *Avenella flexuosa* (L.) Pirl., *Calamagrostis villosa* (Chaix) Gmel., *Carex brizoides* L., *Trientalis europea* L. etc., cover 100%.
- Locality **Kristin Hrádek** – stand 209 D_1 with the dominance of *Betula* sp. (60%), other tree species 5–20% (*P. pungens* Engelm., *F. sylvatica* L., *L. decidua* Mill. and *Pinus sylvestris* L.). The stand was established by sowing (1980), altitude 500 m, plain, zone of air pollution threat A, forest type 6K4. Continuous herb layer of *C. villosa*, to a lesser extent *A. flexuosa* (L.), *Vaccinium myrtillus* L., *Polygonatum verticillatum* (L.) All.
- Locality **Sněžník** – stand 245 A_1, *Betula* sp. 40% (sowing in 1979, tending measures in 1993), *Sorbus aucuparia* L. 20% and *L. decidua* Mill. 40%. S aspect, slope (5°) with boulders (15–20%), altitude 560–570 m, zone of air pollution threat B, forest type 6K1, undergrowth *A. flexuosa* (L.), *C. villosa* (Chaix) Gmel., *Rubus idaeus* L. (90%).
- Locality **Tisá** – stand 239 E_1, *Betula* sp. planted in 1980 after bulldozer preparation of soil, tending measures in 1993. Plain, altitude 600 m, zone of air pollution threat A, forest type 6K4. Undergrowth

Table 1. Loopers of the crown fauna of birch, their phenology and seasonal dynamics (Forest Enterprise Děčín, method of shaking off, 1986–2004)

Species	Localities								Phenology					1986–1988	1989–1991	1992–1994	1995–1997	1998–2000	2001–2003	2004
	V	A	KH	O	S	T	Sum	(%)	A	B	C	D	E							
Aethalura punctulata (Den. & Schiff., 1775)	16	14	17	30	26	16	119	1.48		5	33	76	5	12	2	27	41	11	19	7
Agriopis aurantiaria (Hübner, 1799)	53	20	111	41	72	36	333	4.14	1	294	22	16		22	7	38	28	41	96	101
Agriopis marginaria (Fabricius, 1776)	5	1	10		8	1	25	0.31		18	4	3		13		8	1	2	1	
Alcis bastelbergeri (Hirschke, 1908)	10	3	13	4	2	5	37	0.46	2	5	7	11	12		5	7	6	8	11	
Alcis repandata (Linnaeus, 1758)	11	17	14	13	26	35	116	1.44	7	20	27	35	27	10	10	34	9	10	38	5
Alsophila aescularia (Den. & Schiff., 1775)		1		1		1	3	0.04		1	2					1		2		
Apocheima pilosarium (Den. & Schiff., 1775)	8	2	15	2	8	16	51	0.63		45	6			3	6	22	2	3	10	5
Archiearis parthenias (Linnaeus, 1761)	9	5	13	8	18	4	57	0.71		30	21	6		8	8	19	2	7	7	6
Ascotis selenaria (Den. & Schiff., 1775)			1			1	2	0.02				2			2					
Asthena albulata (Hufnagel, 1767)			2	1	2	1	6	0.07				5	1		2		1		3	
Biston betularius (Linnaeus, 1758)	33	23	27	31	30	22	166	2.06			1	140	25	21	28	24	48	15	21	9
Biston stratarius (Hufnagel, 1767)	5				2		7	0.09			6	1			2	1		1	3	
Boarmia indet.	3	3		1	1		8	0.10			4	1	3	4	3	1				
Cabera exanthemata (Scopoli, 1763)			1		8		9	0.11				9			9					
Cabera pusaria (Linnaeus, 1758)	602	397	790	427	570	594	3,380	41.99		8	92	2,886	394	666	631	524	829	291	398	45
Campaea margaritata (Linnaeus, 1767)	40	6	48	27	45	55	221	2.75	9	17	2	122	71	5	7	21	52	48	78	10
Cleora cinctaria (Den. & Schiff., 1775)			1				1	0.01			1				1					
Colotois pennaria (Linnaeus, 1761)	9	1	10	2	3	4	29	0.36		28		1		4		7	4	1	9	4
Crocallis elinguaria (Linnaeus, 1758)	2	2			2		6	0.07		6					1	3				2
Cyclophora albipunctata (Hufnagel, 1767)	155	134	215	91	113	107	815	10.13		16	185	493	121		19	82	422	130	131	31
Cyclophora pendularia (Clerck, 1759)					1		1	0.01					1	1						
Cyclophora punctaria (Linnaeus, 1758)	8	4	17	8	11		48	0.60			7	34	7			1	18	14	9	6
Cyclophora indet.	8	7	19	5	6	9	54	0.67		1	37	8	8	4	5	45				
Ectropis crepuscularia (Den. & Schiff., 1775)	1	2	1			2	6	0.07			1	5		1	1	1	1			2
Ennomos alniarius (Linnaeus, 1758)				3	1		4	0.05			2	2				1	2	1		
Ennomos autumnarius (Werneburg, 1859)				1	1		2	0.02			1	1							2	
Ennomos erosarius (Den. & Schiff., 1775)	1	1				1	3	0.04			1	2		1				1	1	
Ennomos quercinarius (Hufnagel, 1767)	1			1	1		3	0.04			2	1				1	1	1		

Table 1 to be continued

Species	Localities								Phenology					1986–1988	1989–1991	1992–1994	1995–1997	1998–2000	2001–2003	2004
	V	A	KH	O	S	T	Sum	(%)	A	B	C	D	E							
Ennomos indet.				2			2	0.02		1	1								1	1
Epirrita autumnata (Borkhausen, 1794)	5	12	3	19	19	13	71	0.88		43	18	10		11	9	4	3	27	11	6
Epirrita dilutata (Den. & Schiff., 1775)	1	1	5	1	4		12	0.15		7	4	1		3	1		1	5	2	
Epirrita christyi (Allen, 1906)		1	1		1		3	0.04		2			1		2					1
Epirrita indet.	2	1					3	0.04		3					2	1				
Erannis defoliaria (Clerck, 1759)	2	6	6		8	9	31	0.39		30	1			8	2	5	3	4	2	7
Euchoeca nebulata (Scopoli, 1763)		1		1			2	0.02			1	1						2		
Eupithecia exiguata (Hübner, 1813)					2	1	3	0.04					3	3						
Eupithecia indet.		1		2	1		4	0.05			2	2		2	1	1				
Geometra papilionaria (Linnaeus, 1758)	3	2	1	4	4	2	16	0.20	5	6	1	4		1	1	7	2	5		
Geometridae indet.	9	4	8	1	2	7	31	0.39	1	4	9	14	3	4	10	8	7	2		
Hemithea aestivaria (Hübner, 1799)				1			1	0.01				1				1				
Hydriomena furcata (Thunberg, 1784)	3	4	1	5	3		16	0.20		16						16				
Hypomecis punctinalis (Scopoli, 1763)	8	5	3	2	4	8	30	0.37			9	17	4	2		8	9	2	3	6
Chiasmia alternata (Den. & Schiff., 1775)				1			1	0.01				1							1	
Chiasmia brunneata (Thunberg, 1784)		1	1			1	3	0.04		3						3				
Chiasmia notata (Linnaeus, 1758)	21	8	41	19	13	37	139	1.73		6	44	57	32			40	17	31	43	8
Chiasmia signaria (Hübner, 1809)			3				3	0.04				3							3	
Chiasmia indet.	1	1		1	1	6	10	0.12			7	2	1		1	1			8	
Chloroclysta siterata (Hufnagel, 1767)	3	2	2	3	1	2	13	0.16				11	2			2	4	6	1	
Idaea indet.					1		1	0.01				1								1
Jodis lactearia (Linnaeus, 1758)	4	10	3	2	5	4	28	0.35				25	3		1	4	14	9		
Lycia hirtaria (Clerck, 1759)	14	11	30	19	10	24	108	1.34		21	69	18		7	6	6	51	16	22	
Lycia pomonaria (Hübner, 1790)	2	5	3		1		11	0.14		1	10			2		9				
Operophtera brumata (Linnaeus, 1758)	18	13	23	27	28	9	118	1.47		115	3			42	3	11	32	3	19	8
Operophtera fagata (Scharfenberg, 1805)	276	120	346	417	220	388	1,767	21.95		1,759	7	1		37	105	717	184	66	473	185
Paradarisa consonaria (Hübner, 1799)					2		2	0.02	1	1						1	1			
Parectropis similaria (Hufnagel, 1767)	9	9	23	9	8	11	69	0.86			10	41	18		20	32	9	6	2	
Peribatodes rhomboidarius (Den. & Schiff., 1775)	7	7	1	6		1	22	0.27				15	7		15		7			

Table 1 to be continued

Species	Localities								Phenology					1986 1988	1989– 1991	1992– 1994	1995– 1997	1998– 2000	2001– 2003	2004
	V	A	KH	O	S	T	Sum	(%)	A	B	C	D	E							
Plagodis dolabraria (Linnaeus, 1767)						1	1	0.01				1					1			
Plagodis pulveraria (Linnaeus, 1758)			1				1	0.01				1					1			
Selenia dentaria (Fabricius, 1775)					2	5	7	0.09			4	2	1		1		2	3	1	
Selenia indet.	1	2	2		1	2	8	0.10		2	4	2		5	1	2				
Total	1,369	870	1,832	1,239	1,298	1,441	8,049	100.00	26	2,514	668	4,091	750	902	930	1,747	1,815	774	1,429	456

Localities: V – Vlčák, A – Letadlo, KH – Kristin Hrádek, O – Ostrov, S - Sněžník, T – Tisá

Phenology: A – early spring 15. 3.–30. 4., B – spring 1. 5.–10. 6., C – summer 11. 6.–15. 8., D – late summer 16. 8.–15. 9., E – autumnal 16. 9.–31. 10.

synusia *A. flexuosa* (L.) 20%, *C. villosa* (Chaix) Gmel. 70%, *Calluna vulgaris* (L.) Hull., *V. myrtillus* L.

– Locality **Ostrov** – stand 238 C_1 *Betula* sp. established in 1979, tending measures in 1992. N aspect, zone of air pollution threat A, altitude 550 m, forest type 6K8, dominant *Pteridium aquilinum* (L.) Kuhn and *A. flexuosa* (L.) are replaced by *C. villosa* (Chaix) Gmel. in open stand margins.
– Locality **Letadlo A** – stand 257 B_1 *Betula* sp. (1983) tending measures in 1993, SE slope (7°), altitude 440–500 m, decreased weed infestation [65–85% – *A. flexuosa* (L.), *C. villosa* (Chaix) Gmel., *Oxalis acetosella* (L.), *V. myrtillus* L.], boulder ground (15–25%), zone of air pollution threat B, forest type 6K4.

RESULTS

The crown fauna of birch loopers consisted of 52 species. *Cabera pusaria* (L.) (42%), *Operophtera fagata* (Scharp.) (22%) and *Cyclophora albipunctata* (Hufn.) (10.1%) showed eudominant position while *Agriopis aurantiaria* (Hübn.) (4.1%), *Campaea margaritata* (L.) (2.8%), *Biston betularius* (L.) (2.1%) occurred as subdominant species (Table 1).

The stand of birch in the Kristin Hrádek locality was subject to the greatest attack due to the higher percentage of eudominant and subdominant species. Decreased occurrence of loopers was noted in the stand Letadlo (Table 1). Faunistic diversity was defined by 32–39 species in particular localities partial preferences being noted in some species for certain localities. *C. pusaria* (L.), *A. aurantiaria* (Hübn.), *C. albipunctata* (Hufn.), *Chiasmia notata* (L.) showed increased proportion in the stand K. Hrádek while *O. fagata* (Scharp.) dominated in stands Ostrov and Tisá (Table 1).

In an early spring aspect, only 6 species were caught. The highest degree of threat is related to the spring aspect (26 species). Ten species of them is characterized by culmination in the period, e.g. *O. fagata* (Scharp.), *A. aurantiaria* (Hübn.) and *O. brumata* (L.). Although a summer aspect with 34 species shows high species diversity, only *Lycia hirtaria* (Cl.) exhibits culmination during this aspect. The highest diversity (39 species) in the late summer aspect is related to the culmination period of the occurrence of eight species of loopers, e.g. *C. pusaria* (L.), *B. betularius* (L.), *C. albipunctata* (Hufn.). In an autumn aspect (18 species), particularly the late summer aspect subsides. Loopers *Alcis repandata* (L.) and *Alcis bastelbergeri* (Hirschke) (Table 1) can be ranked among species with long-term occurrence and without marked culmination.

Most loopers were caught in crowns of birch trees in 1992–1994 and 1995–1997. In the spectrum of loopers, population dynamics occurred only in *A. aurantiaria* (Hübn.) (a species actively increasing population dynamics), *C. pusaria* (L.) (culmination period 1995–1997, actually in low population density), *C. albipunctata* (Hufn.) (evident culmination 1995–1997), *O. fagata* (Scharp.) (culmination in 1992–1994 and 2001–2003, actually in the gradation stage) (Table 1).

The spectrum of loopers caught by a light catcher (224 species, 49,934 specimens) corroborated the species richness of the family. However, only 24 species were represented by more than 1%.

Table 2. Loopers from stands of substitute species with the dominant position of birch (Sněžník, light trap, 1989–2003)

Species	1989–1991		1992–1994		1995–1997		1998–2000		2001–2003		1986–2003	
	N	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
Cabera pusaria (Linnaeus, 1758)	234	8.98	1,195	17.93	1,833	20.67	1,222	14.52	2,053	8.78	6,537	13.09
Alcis repandata (Linnaeus, 1758)	42	1.61	392	5.88	527	5.94	470	5.58	2,934	12.55	4,365	8.74
Biston betularius (Linnaeus, 1758)	813	31.19	771	11.57	388	4.38	655	7.78	883	3.78	3,510	7.03
Chiasmia notata (Linnaeus, 1758)	19	0.73	402	6.03	260	2.93	162	1.92	1,330	5.69	2,173	4.35
Idaea aversata (Linnaeus, 1758)	22	0.84	160	2.40	240	2.71	340	4.04	1,217	5.21	1,979	3.96
Campaea margaritata (Linnaeus, 1758)	21	0.81	130	1.95	176	1.98	319	3.79	1,129	4.83	1,775	3.55
Cyclophora pendularia (Clerck, 1759)	0	0.00	0	0.00	602	6.79	308	3.66	801	3.43	1,711	3.43
Xanthorhoe montanata (Den. & Schiff., 1775)	72	2.76	139	2.09	222	2.50	458	5.44	735	3.14	1,626	3.26
Chiasmia liturata (Clerck, 1759)	20	0.77	262	3.93	16	0.18	125	1.48	1,186	5.07	1,609	3.22
Lomaspilis marginata (Linnaeus, 1758)	47	1.80	380	5.70	366	4.13	275	3.27	329	1.41	1,397	2.80
Lycia hirtaria (Clerck, 1759)	20	0.77	175	2.63	353	3.98	386	4.59	434	1.86	1,368	2.74
Cyclophora albipunctata (Hufnagel, 1767)	38	1.46	280	4.20	909	10.25	3	0.04	0.00	0.00	1,230	2.46
Euphyia unangulata (Haworth, 1809)	7	0.27	1	0.02	2	0.02	47	0.56	865	3.70	922	1.85
Xanthorhoe ferrugata (Clerck, 1759)	36	1.38	62	0.93	112	1.26	81	0.96	611	2.61	902	1.81
Chiasmia clathrata (Linnaeus, 1758)	50	1.92	301	4.52	203	2.29	76	0.90	267	1.14	897	1.80
Eupithecia lariciata (Freyer, 1842)	8	0.31	0	0.00	0	0.00	123	1.46	689	2.95	820	1.64
Aplocera praeformata (Hübner, 1826)	46	1.76	70	1.05	157	1.77	288	3.42	241	1.03	802	1.61
Aethalura punctulata (Den. & Schiff., 1775)	1	0.04	41	0.62	179	2.02	248	2.95	146	0.62	615	1.23
Idaea deversaria (Her.-Sch., 1847)	28	1.07	64	0.96	157	1.77	34	0.40	293	1.25	576	1.15
Xanthorhoe spadicearia (Den. & Schiff., 1775)	120	4.60	138	2.07	74	0.83	115	1.37	125	0.53	572	1.15
Hydriomena impluviata (Den. & Schiff., 1775)	18	0.69	1	0.02	9	0.10	52	0.62	446	1.91	526	1.05
Ennomos alniarius (Linnaeus, 1758)	70	2.69	47	0.71	71	0.80	159	1.89	174	0.74	521	1.04
Xanthorhoe designata (Hufnagel, 1767)	51	1.96	16	0.24	49	0.55	49	0.58	339	1.45	504	1.01
Lomographa temerata (Den. & Schiff., 1775)	2	0.08	95	1.43	33	0.37	156	1.85	217	0.93	503	1.01
Sum of individuals	2,607	100	6,664	100	8,867	100	8,418	100	23,378	100	49,934	100
Individuals < 1% in total	2,478	22.17	1,144	17.17	1,477	16.66	2,046	24.31	15,842	24.99	12,494	25.02
Sum of species	107		122		135		131		177		224	
Species < 1% in total	86		102		113		110		155		200	

N – number, (%) – dominance

Table 3. Phenology of the occurrence of imagoes of the family Geometridae (Sněžník, light trap, 1989–2003)

Species	A	Species	B	Species	C	Species	D	Species	E
Lycia hirtaria	54.28	*Cabera pusaria*	7.97	*Cabera pusaria*	17.88	*Cyclophora albipunctata*	12.75	*Colotois pennaria*	21.38
Biston stratarius	14.22	*Chiasmia notata*	7.48	*Alcis repandata*	15.12	*Cabera pusaria*	11.10	*Epirrita dilutata*	13.96
Aethalura punctulata	7.93	*Lycia hirtaria*	6.60	*Biston betularius*	9.89	*Chiasmia notata*	6.36	*Ennomos alniarius*	10.12
Alsophila aescularia	2.99	*Cyclophora albipunctata*	6.36	*Campaea margaritata*	6.77	*Idaea aversata*	6.07	*Operophtera fagata*	8.07
Ectropis crepuscularia	2.67	*Aethalura punctulata*	4.99	*Xanthorhoe montanata*	5.79	*Alcis repandata*	5.48	*Thera variata*	7.43
Total	1,273	*Biston betularius*	4.85	*Idaea aversata*	4.45	*Biston betularius*	5.27	*Epirrita autumnata*	6.40
Sum of species	45	*Lomaspilis marginata*	4.84	*Chiasmia liturata*	3.78	*Xanthorhoe ferrugata*	4.27	*Agriopis aurantiaria*	3.84
		Odontopera bidentata	4.27	*Lomaspilis marginata*	3.34	*Aplocera praeformata*	3.69	*Campaea margaritata*	3.46
		Chiasmia liturata	3.38	*Eupithecia lariciata*	2.13	*Ennomos alniarius*	2.77	*Thera obeliscata*	2.94
		Lomographa temerata	3.25	*Euphyia unangulata*	2.01	*Chiasmia liturata*	2.74	*Operophtera brumata*	2.82
		Xanthorhoe montanata	2.95	Total	22,038	*Xanthorhoe spadicearia*	2.64	*Cabera pusaria*	2.30
		Euphyia unangulata	2.81	Sum of species	158	*Chiasmia clathrata*	2.46	Total	781
		Chiasmia clathrata	2.63			*Hydriomena impluviata*	2.05	Sum of species	52
		Petrophora chlorosata	2.20			Total	15,890		
		Electrophaes corylata	2.19			Sum of species	168		
		Thera obeliscata	2.01						
		Total	9,952						
		Sum of species	130						

Phenology: A – early spring 15. 3.–30. 4., B – spring 1. 5.–10. 6., C – summer 11. 6.–15. 8., D – late summer 16. 8.–15. 9., E – autumnal 16. 9.–31. 10.

C. pusaria (L.) showed eudominant position (13.1%), three dominant species [*A. repandata* (L.), *B. betularius* (L.) and *C. albipunctata* (Hufn.)] are accompanied by seven subdominant and 12 receding species (Table 2). During the period under study, the species spectrum increases from 107 species (1989–1991) to 177 species (2001–2003) and similarly, it is possible to characterize an increase in the total catching of moths from 2,607 specimens (1989–1991) to 23,378 specimens (2001–2003) (Table 2).

Because it is not possible to eliminate the impact of weather conditions on the absolute number of caught moths in the catcher even after unifying into a three-year period, population dynamics was evaluated by changes in dominance. The dominance of *C. pusaria* (L.) increases to a culmination value 20.67% (1995–1997) and subsequently decreases in the same trend. A species *C. albipunctata* (Hufn.) can be characterized in the same way. *Xanthorhoe montanata* (Den. et Schiff.) (1998–2000), *L. hirtaria* (Cl.), *Chiasmia clathrata* (L.) and *Aplocera praeformata* (Hbn.) showed the only marked increase in the studied period. *A. repandata* (L.), *Idaea aversata* (L.), *Campaea margaritata* (L.) and *Euphyia unangulata* (Haw.) rank among species where we can note a continually increasing proportion in the species spectrum. Recently, an increased occurrence appears in *Eupithecia lariciata* (Frey.). In the area under study, the proportion of *B. betularius* (L.) and *Lomaspilis marginata* (L.) decreases (after culmination in 1992–1994), *Xanthorhoe spadicearia* (Den. et Schiff.). Species *Ch. notata* (L.) and *Ch. liturata* (Cl.) (Table 2) can be characterized by two

marked culminations within the studied period. Sporadically, subdominant occurrence was noted in species classified as subreceding (*Eulithis populata* (L.), *Euchoeca nebulata* (Scop.) and *Idaea rusticata* (Den. et Schiff.).

Seasonal aspects are significantly differentiated not only by the spectrum of species but also by the extent of catching. The early spring period is relatively poor in species with the dominant occurrence of *L. hirtaria* (Cl.) (54.3%) and *B. stratarius* (Hufn.) (14.2%). From the spring aspect with 130 species the species diversity increases to 158 (summer aspect) and 168 (late summer aspect). Characteristic species for the period are *C. pusaria* (L.) and *B. betularius* (L.) and the spring and summer generation of *C. albipunctata* (Hufn.). The species diversity of an autumn aspect (52) is affected by the subsiding late summer aspect and by typical autumn species the catching of which is decreased in consequence of apterous females and not recorded November activity (Table 3). The seasonal dynamics results in the relatively numerous proportion of species with two generations [*Ch. notata* (L.), *C. albipunctata* (Hufn.), *Xanthorhoe ferrugata* (Cl.), *Xanthorhoe spadicearia* (Den. et Schiff.)] and *Ecliptopera silaceata* (Den. et Schiff.) the second generation being more numerous.

DISCUSSION

In the fauna of moths of the CR (3,374 species), Geometridae create the third most numerous family (395) after Noctuidae (478) and Tortricidae (470) (Laštůvka, Liška 2005). Under conditions of Forest Enterprise Děčín (formerly Sněžník), a direct food relationship was proved to birch in 52 species of loopers and 224 species of imagoes were caught by a light catcher. The broad spectrum indicates that a food offer as compared with spruce monocultures is very rich affecting faunistic diversity. Important pests of seeds and fruits (*Eupithecia* spp.) and phytophages with the gradation potential (*Operophtera*, *Ennomos*, *Selenia*, *Bupalus*, *Semiothisa*, *Poecilopsis*) rank among members of the family. Based on harmfulness, it is possible to classify the group of loopers developing on birch into species (1) which can gradate separately and cause defoliation [*O. fagata* (Scharp.), *O. brumata* (L.), *E. defoliaria* (Cl.), *B. betularius* (L.), *C. pusaria* (L.)], (2) which do not gradate in such a way to cause heavy feeding or defoliation but create important part of the complex of larvae damaging assimilatory organs [*C. albipunctata* (Hufn.) etc.], (3) which occur individually in the balanced numerical condition with low abundance and negligible economic importance (Kula 1997a).

The eudominant position of *C. pusaria* (L.) in crowns of birch was also corroborated by catching of larvae. It refers to an important summer species of Geometridae imagoes of which hatch irregularly and, therefore, larvae occur from the summer to the autumn aspect in crowns of birch. High total amounts of caught larvae have not become evident in single defoliation yet but in the increasing loss of leaf area which can negatively affect maturation of shoots and their subsequent winter killing similarly as in *Lochmaea capreae* L. (Kula 1988b).

O. fagata (Scharp.) occurring as an eudominant species in the crown fauna of birch is mentioned as an important pest only by Voolma (2000) in birch stands of Estonia and by Kula (1997a) in the Krušné hory Mts. If Šrot and Skuhravý (1988) and Badalík (1988) describe the gradation of *E. defolia-ria* (Cl.) and *O. brumata* (L.) in the eastern Krušné hory Mts. including the Děčín Upland it is interesting that during the period 1986–2004, *O. brumata* (L.) was receding in the crown fauna and *E. defoliaria* (Cl.) was subreceding. According to Tikkanen et al. (1998), *O. brumata* (L.) in Fennoscandia prefers *Prunus padus* (L.) and *Sorbus aucuparia* (L.) while *Alnus incana* (L.) and *Betula pubescens* (Ehrh.) show decreased attack. Effects of air pollution stress on the growth of larvae of *E. autumnata* (Bork.) were not proved in case of wet deposition of sulphur and nitrogen (Suomela, Neuvonen 1997). Under conditions of heavy air pollution impact the species does not find suitable conditions but at the content of Cu/Ni 20 to 30 μg/g in leaves the density of larvae increases (Ruohomaki et al. 1996). The differentiated occurrence in the studied localities was not related to any site factor. Populations of *O. fagata* (Scharp.) on birch can cause defoliation in a spring aspect also on beech which is significantly represented in the present regeneration of forest stands in the Krušné hory Mts.

The amount of caught insect by a light catcher does not differentiate the three species mentioned above because their late activity was not recorded by the light catcher. The inspection of eggs in not used but according to the degree of defoliation population density showed in the increased damage to assimilatory tissues (1995, 2000, 2004) particularly in old stands (Kula 2005) where ovipositing females prefer the lower third of crowns (Buchta et al. 2004). In the complex of free-feeding larvae, the studied regions of the eastern Krušné hory Mts. are differentiated by the increasing value of defoliation (Klášterec–Janov–Litvínov–Sněžník 3.3–3.2–5.6–11.4%) (Kula 2005).

The dominant position of *C. albipunctata* (Hufn.) in stands of birch is not noted in literature but with respect to the supposed low consumption of the larvae it is not possible to expect damage to stands by the species. However, it is an organic component of the summer and late summer aspect. The dominant position of imagoes of *B. betularius* (L.) which is characterized by industrial melanism demonstrates that the gradation occurrence of larvae related to defoliation in stands of birch out of the studied region (www.protec.forest.ru/win-1251/pests/leaf/013.htm) does not show adequate proportion of larvae (2,000 eggs/♀) in the crown fauna of birch in relation to the abundance and fertility of moths. Therefore, it is not possible to exclude the use of another species in addition to birch.

CONCLUSION

The fauna of Geometridae of the region of Forest Enterprise Děčín consisted of 52 species of larvae from crowns of birch trees caught by the method of shaking off and 224 species of imagoes caught by a light catcher. A decisive proportion in the crown fauna showed larvae of *Cabera pusaria* (L.), *Operophtera fagata* (Scharp.) and *Cyclophora abipunctata* and in caught imagoes the highest dominance showed *C. pusaria* (L.), *Alcis repandata* (L.), *Biston betularius* (L.) and *C. albipunctata* (Hufn.). A direct relationship was not determined between the numerical proportion of imagoes of *B. betularius* (L.) and *A. repandata* (L.) and their larvae in the crown fauna. *O. fagata* (Scharp.) shows economic importance for birch stands and subsequently for the regeneration of beech stands. *C. pusaria* (L.) is characterized by a gradation potential but owing to the non-uniform time of hatching the occurrence of larvae in tree crowns is differentiated. Summer defoliation can seriously affect maturation of shoots and their winter killing. Seasonal dynamics demonstrated the occurrence of some species with two generations. Based on population dynamics it is possible to derive repeated culmination for *O. fagata* (Scharp.), *C. pusaria* (L.), *A. aurantiaria* (Hübn.) and *C. albipunctata* (Hufn.).

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Píďalkovití (Geometridae, Lepidoptera) v porostech náhradních dřevin s dominantním postavením břízy

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ABSTRAKT: Druhové spektrum píďalek (Geometridae), jejich sezonní a populační dynamika a význam pro stabilitu porostů břízy v imisní oblasti Krušných hor byl odvozen ze světelného lapače [224 druhů imag, zvláště *Cabera pusaria* (L.) a *Cyclophora albipunctata* (Hufn.)] a metody sklepávání z korun bříz [52 druhů housenek, zvláště *C. pusaria* (L.), *Operophtera fagata* (Scharp.), *Alcis repandata* (L.), *Biston betularius* (L.), *C. albipunctata* (Hufn.)]. Hospodářský význam pro porosty břízy a nově zakládané bukové porosty má *O. fagata* (Scharp.). Nejednotnou dobou líhnutí motýlů eudominantního druhu *C. pusaria* (L.) se zmírňuje nebezpečí defoliace porostů břízy i přes její gradační potenciál.

Klíčová slova: housenky; *Betula pendula*; Krušné hory; metoda sklepávání; světelný lapač; Geometridae

Bříza se řadí k dřevinám se širokým spektrem fytofágů, z nichž housenky mají dominantní postavení. Reiprich (2001) na Slovensku zaznamenal 367 druhů motýlů, jejichž housenky jsou potravně vázány na břízu. Koch (1989) uvádí 131 druhů, z toho 60 z čeledi Geometridae. Píďalka *Erannis defoliaria* (Cl.) často působí při přemnožení holožíry. Tuto skutečnost potvrzuje napadení porostů jeřábu a břízy v Krušných horách (Badalík 1988).

Cílem příspěvku je vzhledem k rozsahu zachycených druhů píďalek (imag, housenek) vymezit jejich druhové spektrum, sezonní a populační dynamiku a význam pro stabilitu porostů břízy.

Odchyt motýlů byl prováděn v letech 1989–2004 (1. 4.–30. 10.) pomocí světelného lapače Minnesota s výbojkou RVL 250 W a denní kontrolou. Lapač byl umístěn v pásmu původně maximálního ohrožení imisemi (570 m n. m.). Byl zavěšen 3,5 m nad úrovní terénu v mladém porostu břízy, v jehož okolí se nacházely vzrostlé stromy břízy, modřínu, smrku, dubu, jasanu, lípy, olše a borová mlazina. V bylinném podrostu se 100% pokryvností převažovala *Calamagrostis villosa* Gmel. a *Senecio* sp.

Sledovaná oblast je součástí území LS Děčín (severní Čechy, 14°04´ vých. délky, 50°46´ sev. šířky, číslo čtverce síťového faunistického mapování 5250), v minulosti dlouhodobě vystavená koncentracím SO_2 převyšujícím 60 μg/m^3. Je charakterizována chladným horským klimatem (průměrná roční teplota 6 °C, úhrnné roční srážky 800 mm, délka vegetační doby 110–120 dní, nadmořská výška 450–700 m) v aktuální střední imisní zátěži.

Faunu píďalkovitých tvoří 52 druhů housenek z korun bříz ulovených metodou sklepávání a 224 druhů imag (Geometridae) zachycených světelným lapačem na území LS Děčín.

Rozhodující zastoupení v korunové fauně zaznamenaly housenky *Cabera pusaria* (L.), *Operophtera fagata* (Scharp.), *Cyclophora albipunctata* (Hufn.) a ze zachycených imag nejvyšší dominanci měly druhy *C. pusaria* (L.), *Alcis repandata* (L.), *Biston betularius* (L.) a *C. albipunctata* (Hufn.).

Nebyla stanovena přímá vazba v početním zastoupení imag druhu *B. betularius* (L.), *A. repandata* (L.) s jejich housenkami v korunové fauně.

Hospodářský význam pro porosty břízy a následné období při obnově bukových porostů má *O. fagata* (Scharp.).

C. pusaria (L.) se vyznačuje gradačním potenciálem, ale v důsledku nejednotné doby líhnutí motýlů je výskyt housenek v korunách stromů diferencovaný. Letní defoliace může ovlivnit vyzrávání letorostů a jejich zimní vymrzání.

Sezonní dynamika potvrdila výskyt několika druhů se dvěmi generacemi. Z populační dynamiky lze odvodit opakování kulminací pro *O. fagata* (Scharp.), *C. pusaria* (L.), *A. aurantiaria* (Hübn.) a *C. albipunctata* (Hufn.).

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