

Caterpillars of Lepidoptera in crowns of mountain ash (*Sorbus aucuparia* L.) in the Ore Mountains

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Abstract

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Mountain ash (*Sorbus aucuparia* L.) is an important substitute tree species in stands in the Ore Mountains loaded with air-pollution. Among 84 caterpillar species (Lepidoptera) obtained by the method of shaking off from mountain ash crowns in 2008, the highest abundance was found in the species *Campaea margaritata* (L.), *Venusia cambrica* Curtis, *Opisthograptis luteolata* (L.) and *Hedya nubiferana* (Haw.). The species diversity increased with altitude without showing preferences for individual species. In the early spring aspect (31 species), there were most abundant *Hedya nubiferana*, *H. pruniana* (Hbn.) and *Trachycera advenella* (Zincken); in the spring aspect (57 species) *Agriopsis aurantiaria* (Hbn.) and *Alsophila aescularia* (Den. et Schiff.); in the summer aspect (55 species) *V. cambrica*; in the late summer aspect (23 species) *O. luteolata* and *C. margaritata*; in the autumnal aspect (11 species) *C. margaritata*. Damage to the mountain ash berries ranged from 21.3 to 94.1%, and it was caused by *Argyresthia conjugella* (Zell.). Moths of the species hatched in the gradation years at the of effective temperatures about 900 °C.

Keywords

insect-pests, Lepidoptera larvae, Ore Mts (Erzgebirge Mts), phenology, *Sorbus aucuparia* L.

Introduction

In the air-polluted higher situated locations of the Krušné hory Mts (Ore Mountains), the mountain ash (*Sorbus aucuparia* L.) has become an important "accessory" in stands of substitute species (3,130 ha) growing in seriously disturbed site conditions (BALCAR et al., 2008). The species, relatively resistant to sulphur dioxide, grows fast and creates the local environment with leaf litter improving soil conditions, although not as effectively as birch (*Betula* sp.) (KUBELKA et al., 1992; ULBRICHOVÁ and PODRÁZSKÝ, 2002). The high attractiveness of this woody plant for forest animals is, however, a disadvantage (browsing, deer barking and winter browsing) for the plant itself (EIBERLE and BU-

CHER, 1989; SLOUP et al., 2008). The damaged, weakened trees are exposed to subsequent attack by fungal pathogens, eg *Stereum rugosum* Pers. and *Pholiota squarrosa* Kumm. (JANČAŘÍK, 1999).

As for phytophages, heavy defoliation of mountain ash is caused by *Gonionema quinquepunctata* (Fabr.) (URBAN, 1998; KULA, 1999). The species *Lochmaea crataegi* (Forst.) (SCHMIDT 1989), *Strophosomus melanogrammum* (Forst.), *Phyllobius arborator* (Herbst) (URBAN 1999, KULA and ŠIMON, 2007) and *Eriophyes pyri* (Pagenstecher) (KULA et al., 2007) are important pests of the crown fauna. *Agilus mendax* Mnnh. and *Saperda scalaris* (L.) (KANGAS, 1942) cause a serious damage to this woody plant.

A relatively broad spectrum of Lepidoptera caterpillars (148) is related to mountain ash by feeding on. Out of them, only *Stigmella hahniella* (Wörz) is considered to be a monophage of this species (REIPRICH, 2001). *Operopthera brumata* (L.) with outbreaks in the boreal region of Fennoscandinavia attacked primarily *Prunus padus* L. and *S. aucuparia* (90% defoliation); on the other hand, *Alnus incana* (L.) Moench., *Betula pubescens* (Ehrh.) were attacked much less severely (25% defoliation) (TIKKANEN et al. in contrast to 1998). In the Northern Sweden, caterpillars of *Epirrita autumnata* (Borkh.) feed on mountain ash leaves (NEUVONEN et al., 1987). IVINSKIS et al. (1991) observed an important population of *Aporia crataegi* (L.) on *Sorbus* sp. and *Salix* sp. in forest stands.

KLINKOWSKI and NOLTE (1951) classified *H. nubiferana* [syn. *Argyroploce variegana* (Hbn.)] and *Spilonota* [syn. *Tmetocera*] *ocellana* (Den. et Schiff.) as pests of fruits of mountain ash growing in the vicinity of orchards. According to NAGY (1977), *Cydia pomonella* (L.) attacked not only fruits of apple trees (0.6–26%) in orchards but also wild-growing *Malus sylvestris* Mill., *Sorbus torminalis* (L.) and *S. semiincisa* Borbás. Nevertheless, KRÍSTEK et al. (1992) mention that *Argyresthia conjugella* (Zell.) is the most important pest of mountain ash fruits.

The aim of this paper is to provide an overview on the fauna of caterpillars developing on mountain ash in forest stands in the air-polluted area of the Eastern Ore Mountains.

Methods and the area of monitoring

Caterpillars were shaken off from crowns of trees aged 15–60 years, by means of hammer blows (4 kg) on the tree stem. Two pieces of canvas 2 × 2 m in size were placed under the crown projection. The caught individuals were killed and conserved in 75% ethanol. The caterpillars were sampled at 31 localities situated at altitudes from 496 to 870 m (Table 1). At the time of the first sampling (7/5/2008), the degree of mountain ash foliage development differentiated according to the location (from stands with unfolding leaves to fully unfolded stands). A phenological shift was noted in the degree of flower development (27/5), and subsequently in the formation of rowanberries (14/6) (Table 2). The majority of localities were affected by cold weather, which was probably the cause of unpollinated flowers. The area of monitoring includes 31 localities situated from the Děčínská vrchovina Upland (N 50°47'40", E 14°07'55") (localities 1–3) to the Mount St. Sebastian in the Ore Mountains (N 50°30'41", E 13°16'21") (localities 4–31) (Table 1). Seven control samplings were carried out monthly: two in May and the other five from June 14 to October 15, 2008.

The phenology of flight activities of the selected species of butterflies was determined using a Minnesota light trap with RVL 250 W discharge lamp situated in the Sněžník locality (cadastral area Jilové – Sněžník, 14°04' E, 50°46' N, faunistic square 5250), altitude 570 m asl, daily inspection (1/4–30/10/1989–2007)

Table 1. List of the study localities and phenological characteristics of mountain ash trees in these localities (Ore Mountains, 2008)

Locality	Altitude	Location		Breaking buds [%]	Foliage		Flowers	Fruits	Phenology category
		N	E		Created leaves [%]	Crown foliage [%]			
				7. 5. 2008			27. 5. 2008	14. 6. 2008	
1	713	50°47'40"	14°05'55"	10	90	90	PUB	PVP	B
2	598	50°47'03"	14°05'17"	0	100	90	PUB	PV	A
3	526	50°47'59"	14°01'10"	0	100	100	K-100%	PV	A
4	672	50°45'38"	13°58'28"	60	40	30	PUB	PVP	B
5	734	50°45'05"	13°57'16"	20	80	70	PUB	PVP	B
6	703	50°45'11"	13°54'51"	0	100	90	PUB	PVP	B
7	756	50°44'02"	13°54'21"	70	30	40	PUB	PV+20% O	B
8	762	50°42'32"	13°51'04"	30	70	70	PUB	PVP	B
9	770	50°43'16"	13°49'56"	30	70	70	PUB	PV	B
10	868	50°43'36"	13°45'44"	90	10	10	PUT	PV+20% O	C
11	832	50°41'51"	13°43'20"	50	50	40	PUT	PVP	B
12	862	50°42'16"	13°41'31"	90	10	10	PUT	100% O	C
13	782	50°41'49"	13°37'03"	90	10	10	PUT	100% O	C
14	664	50°41'45"	13°34'03"	80	20	20	PUB	PV+50% O	C
15	800	50°41'31"	13°38'32"	90	10	10	PUB	PV+50% O	C

Table 1. Continued

Locality	Altitude	Location		Breaking buds [%]	Foliage		Flowers	Fruits	Phenology category
		N	E		Created leaves [%]	Crown foliage [%]			
					7. 5. 2008		27. 5. 2008	14. 6. 2008	
16	863	50°39'17"	13°38'37"	90	10	10	PUT	*	B
17	742	50°38'08"	13°36'54"	0	100	90	*	*	A
18	496	50°37'05"	13°37'19"	0	100	100	K-100%	PVV	A
19	855	50°33'18"	13°23'03"	80	20	15	PUT	PV+50% O	C
20	810	50°32'59"	13°23'16"	20	80	60	PUT	PVP	B
21	722	50°32'40"	13°23'51"	0	100	90	K-100%	PVP	A
22	870	50°34'50"	13°25'33"	90	10	5	PUT	100% O	C
23	821	50°34'54"	13°24'47"	40	60	40	PUT	100% O	C
24	800	50°33'35"	13°24'25"	80	20	70	PUT	PVP	B
25	798	50°33'01"	13°24'07"	0	100	90	PUB	PVP	B
26	562	50°31'58"	13°23'44"	0	100	90	*	*	A
27	686	50°32'05"	13°21'44"	20	80	80	K-50%	PVP	B
28	714	50°34'40"	13°18'12"	90	10	10	PUB	PVP	B
29	842	50°31'28"	13°14'09"	70	30	25	PUB	100% O	C
30	837	50°30'41"	13°16'21"	40	60	50	PUB	PVP	B
31	745	50°28'38"	13°16'35"	50	50	40	K-30%	PVP	B

PUT – closed flowers, dark flower-buds; PUB – closed flowers, white flower-buds; K – fully developed flowers; * – undetected
 PV – created fruit, undamaged; PVP – created fruit, damaged; O – not set established fruit, fading away; PVV – large fruits
 A – early onset of leaf unfolding and fading away; B – standard; C – delayed leaf unfolding and fading away

Table 2. Health condition of rowanberries in the period of their maturity (Ore Mountains, 2008)

Locality	Fructification	No. of examined fruits	No. of caterpillar-infested fruits	Proportion of caterpillar-infested fruits [%]	No. of rot-attacked fruits	No. of dry fruits	No. of healthy fruits
1	Sporadic	85	42	49.41	15	4	24
2	Low	114	73	64.04	5	5	31
3	Medium	69	20	28.99	7	7	35
4	Sporadic	94	78	82.98	4	8	4
5	Sporadic	84	79	94.05	2	2	1
6	Low	79	59	74.68	2	11	7
7	Sporadic	90	68	75.56	8	9	5
8–17	No occur						
18	Heavy	88	19	21.59	5		64
19–23	No occur						
24	Sporadic	80	69	86.25	5	6	0
25–27	No occur						
28	Sporadic	98	80	81.63	6	4	8
29	No occur						
30	Low	91	78	85.71	3	6	4
31	Low	95	79	83.16	6		10

(KULA 2007). The Sørensen index of species similarity and equitability was calculated according to LOSOS et al. (1984). A dendrogram was created according to the method of Ward (STATSOFT, 2007) based on a quantitative-qualitative evaluation.

The caterpillars were determined by Jan Patočka, the nomenclature is given according to LAŠTŮVKA and LIŠKA (2007).

Results and discussion

Species composition of the caterpillar communities

In total, 84 species of caterpillars were determined on mountain ash. REIPRICH (2001) mentions only 38 of them. During the growing season, altogether 15–35 species of caterpillars were noted in the particular localities. According to the index of species similarity, there is a high conformity (>70%) between stands 18 and 2–12; on the contrary, very low between stands 25 and 2–4, 8–12, 15–18 (<25%). The equitability is relatively high (0.83–0.94), the species diversity index is balanced similarly (2.31–3.26). The dendrogram created by using the Ward method (Fig 1) consists of four sections representing relatively distant stands in locations situated at medium-altitudes (20–4), Eastern part of the Ore Mountains (24–6), higher and medium locations (29–10) and the Děčínská vrchovina Upland (5–1). By the frequency, *Campaea margaritata*, *Venusia cambrica* and *Opisthograptis luteolata* can be assigned to the generally distributed species of the Děčínská vrchovina Upland and the Eastern Ore Mountains (Table 3).

V. cambrica showing a eudominant proportion (11.2%) was accompanied by three dominant species: *Hedya nubiferana* (8.52%), *C. margaritata* (6.17%) and *O. luteolata* (5.5%). In the studied area, species diversity increased with increasing altitude: from 61 species (496–700 m asl) to 78 species (701–870 m asl). Nevertheless, we did not observe preferences to altitudinal zones in the particular species (Table 3).

In the early spring aspect, 31 species were recorded with the dominant position of *H. nubiferana* (33.1%), *Hedya pruniana* (22.8%) and *Trachycera advenella* (9.5%). In the spring aspect, 57 species of caterpillars occurred; the highest proportion of them showed Geometridae, namely *Agriopsis aurantiaria* (10.8%), *Alsophila aescularia* (10.3%) accompanied by *Orthosia gothica*, *Ypsolopha horridella* and *Pandemis cerasana*. In total, 55 species of caterpillars characterized the summer aspect in crowns of mountain ash, with the very marked position of *V. cambrica* (35.5%). In the late summer aspect, the species diversity decreased (23 species); the most important position showed Geometridae *O. luteolata* (27.1%), *C. margaritata* (14.3%), *Eupithecia* sp. and *Biston betularia* (L.). Although the autumnal aspect included 11 species, *C. margaritata* predominated in the mountain ash crown and its all-season abundance culminated there (Table 4).

Eudominant and dominant species

Venusia cambrica Curtis. Caterpillars of this species were generally distributed across the studied area (97% stands), being dominant in the mountain ash crown

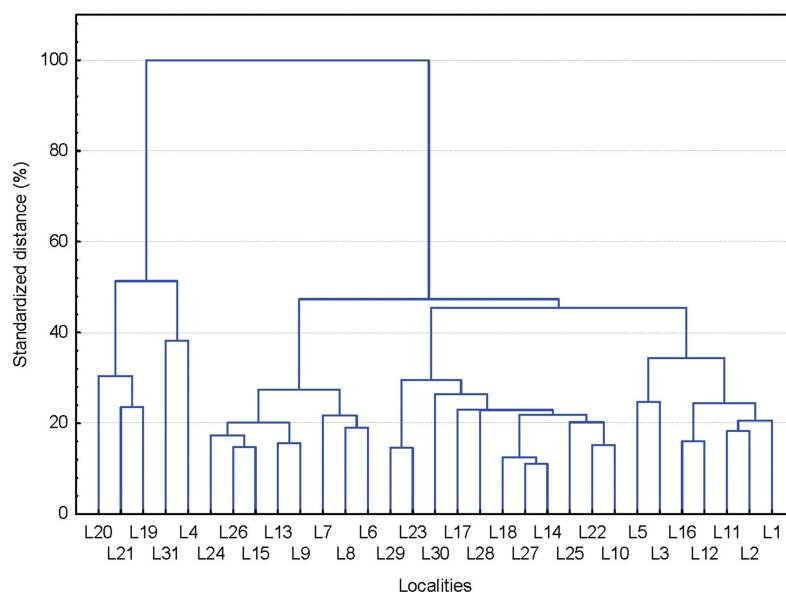


Fig 1. Dendrogram showing the similarity between samples of caterpillars collected from mountain ash in the Eastern part of the Ore Mountains (L1–L31: localities 1–31)

Table 3. Dominance (D) of abundant species of Lepidoptera caterpillars obtained from mountain ash crowns in two altitudinal zones and their frequency over the study area (Ore Mountains, 2008)

Species	Altitude [m]		Frequency [%]
	496–700 D [%]	701–870 D [%]	
<i>Campaea margaritata</i> (L.)	5.66	6.35	96.77
<i>Venusia cambrica</i> Curtis	12.42	10.76	96.77
<i>Opisthograptis luteolata</i> (L.)	3.62	6.18	90.00
<i>Hedya nubiferana</i> (Haw.)	10.69	7.73	86.67
<i>Agriopsis aurantiaria</i> (Hbn.)	5.66	3.78	83.33
<i>Chiasmia alternata</i> (Den. & Schiff.)	3.30	2.29	80.00
<i>Ypsolopha horridella</i> (Tr.)	2.04	3.09	80.00
<i>Orthosia gothica</i> (L.)	2.04	3.84	76.67
<i>Pandemis cerasana</i> (Hbn.)	3.14	3.26	73.33
<i>Alsophila aescularia</i> (Den. & Schiff.)	2.52	4.18	70.00
<i>Hedya pruniana</i> (Hbn.)	3.93	5.21	66.67
<i>Lycia hirtaria</i> (Cl.)	2.20	2.40	66.67
<i>Operophtera brumata</i> (L.)	3.46	2.06	66.67
<i>Trachycera advenella</i> (Zinck.)	4.40	3.21	60.00

Table 4. Total number of caterpillars obtained from mountain ash crowns in the 31 study localities in the Ore Mountains corresponding to the five aspects of the growing season 2008 Aspect: ČJ (early spring until 10/5), J (spring 11/5–20/6), L (summer 21/6–15/8), PL (late summer 16/8–15/9), P (autumnal 16/9–30/10)

Aspects	ČJ	J	L	PL	P	Sum	
Species/Aggregate trapping	N	N	N	N	N	N	%
<i>Acleris</i> sp.	0	3	0	1	0	4	0.17
<i>Acronicta leporina</i> (L.)	0	0	1	0	0	1	0.04
<i>Acronicta psi</i> (L.)	0	0	1	1	1	3	0.13
<i>Acronicta strigosa</i> (Den. & Schiff.)	0	0	13	0	0	13	0.55
<i>Acronicta tridens</i> (Den. & Schiff.)	0	0	2	0	0	2	0.08
<i>Agriopsis aurantiaria</i> (Hbn.)	11	89	2	0	0	102	4.28
<i>Agriopsis marginaria</i> (Fabr.)	0	2	0	0	0	2	0.08
<i>Alcis repandata</i> (L.)	4	16	1	1	4	26	1.09
<i>Allophyes oxyacanthae</i> (L.)	13	26	0	0	0	39	1.64
<i>Alsophila aescularia</i> (Den. & Schiff.)	0	85	4	0	0	89	3.73
<i>Apocheima pedarium</i> (Fabr.)	0	7	0	0	0	7	0.29
Arctiidae g. sp.	0	1	0	0	0	1	0.04
<i>Argyresthia conjugella</i> (Zell.)	0	0	0	0	3	3	0.13
<i>Archips crataeganus</i> (Hbn.)	0	40	0	0	0	40	1.68
<i>Archips podanus</i> (Scop.)	2	4	0	0	0	6	0.25
<i>Archips xylosteanus</i> (L.)	0	7	0	0	0	7	0.29
<i>Atolmis rubricollis</i> (L.)	1	1	17	13	0	32	1.34
<i>Biston betularia</i> (L.)	0	0	11	16	3	30	1.26
<i>Calliteara pudibunda</i> (L.)	0	0	2	0	0	2	0.08
<i>Campaea margaritata</i> (L.)	16	5	22	35	69	147	6.17
<i>Cleora cinctaria</i> (Den. & Schiff.)	0	1	5	1	0	7	0.29
<i>Colocasia coryli</i> (L.)	0	0	4	0	0	4	0.17

Table 4. Continued

Aspects	ČJ	J	L	PL	P	Sum	
Species/Aggregate trapping	N	N	N	N	N	N	%
<i>Colotis pennaria</i> (L.)	0	13	0	0	0	13	0.55
<i>Conistra vaccinii</i> (L.)	0	3	0	0	0	3	0.13
<i>Cosmia trapezina</i> (L.)	0	4	0	0	0	4	0.17
<i>Cydia janthinana</i> (Dup.)	0	0	0	0	1	1	0.04
<i>Cydia</i> sp.	0	0	4	1	0	5	0.21
<i>Dahlica</i> sp.	0	0	3	15	11	29	1.22
<i>Diloba caeruleocephala</i> (L.)	1	4	0	0	0	5	0.21
<i>Diurnea fagella</i> (Den. & Schiff.)	0	0	2	1	0	3	0.13
<i>Dryobotodes eremita</i> (Fabr.)	0	0	1	0	0	1	0.04
<i>Ectropis crepuscularia</i> (Den. & Schiff.)	0	0	21	3	0	24	1.01
<i>Eilema deplana</i> (Esp.)	1	3	1	1	0	6	0.25
<i>Eilema lurideolum</i> (Zinck.)	1	0	0	0	0	1	0.04
<i>Electrophaes corylata</i> (Th.)	1	0	5	16	0	22	0.92
<i>Epirrita autumnata</i> (Borkh.)	0	0	1	0	0	1	0.04
<i>Epirrita dilutata</i> (Den. & Schiff.)	2	12	1	0	0	15	0.63
<i>Erannis defoliaria</i> (Cl.)	1	11	0	0	0	12	0.50
<i>Eulia ministrana</i> (L.)	0	0	2	9	0	11	0.46
<i>Eupithecia</i> sp.	0	0	31	20	0	51	2.14
<i>Eupsilia transversa</i> (Hufn.)	0	1	0	0	0	1	0.04
Gelechiidae g. sp.	0	1	0	0	0	1	0.04
Geometridae g. sp.	1	12	2	0	0	15	0.63
<i>Hedya nubiferana</i> (Haw.)	161	42	0	0	0	203	8.52
<i>Hedya pruniana</i> (Hbn.)	111	5	0	0	0	116	4.87
<i>Hypomecis punctinalis</i> (Scop.)	0	0	3	3	0	6	0.25
<i>Chiasmia alternata</i> (Den. & Schiff.)	0	15	40	5	1	61	2.56
<i>Chiasmia notata</i> (L.)	0	0	0	0	1	1	0.04
<i>Chlorochysta siterata</i> (Hufn.)	0	0	8	1	0	9	0.38
<i>Choristoneura hebenstreitella</i> (Müll.)	0	4	2	0	0	6	0.25
<i>Jodis lactearia</i> (L.)	0	0	8	0	0	8	0.34
<i>Lamprosticta culta</i> (Den. & Schiff.)	0	0	1	5	3	9	0.38
<i>Lasiocampa quercus</i> (L.)	1	1	0	3	0	5	0.21
<i>Lithosia quadra</i> (L.)	0	2	2	0	0	4	0.17
<i>Lycia hirtaria</i> (Cl.)	0	4	52	0	0	56	2.35
<i>Lycia pomonaria</i> (Hbn.)	0	6	5	0	0	11	0.46
<i>Malacosoma neustria</i> (L.)	11	0	0	0	0	11	0.46
<i>Neosphaleroptera nubilana</i> (Hbn.)	0	1	0	0	0	1	0.04
Noctuidae g. sp.	1	3	13	4	1	22	0.92
<i>Nola cucullatella</i> (L.)	3	8	1	0	0	12	0.50
<i>Odontopera bidentata</i> (Cl.)	0	0	7	5	0	12	0.50
<i>Ochropacha duplaris</i> (L.)	0	0	1	0	0	1	0.04
<i>Operophtera brumata</i> (L.)	18	40	0	0	0	58	2.43
<i>Operophtera fagata</i> (Scharf.)	5	6	0	0	0	11	0.46
<i>Opisthograptis luteolata</i> (L.)	2	0	61	66	2	131	5.50
<i>Orgyia antiqua</i> (L.)	0	3	8	2	0	13	0.55
<i>Orthosia cerasi</i> (Fabr.)	0	30	14	0	0	44	1.85

Table 4. Continued

Aspects	ČJ	J	L	PL	P	Sum	
Species/Aggregate trapping	N	N	N	N	N	N	%
<i>Orthosia gothica</i> (L.)	0	73	7	0	0	80	3.36
<i>Orthosia incerta</i> (Hufn.)	0	8	18	0	0	26	1.09
<i>Orthosia</i> sp.	6	9	0	0	0	15	0.63
<i>Orthotaenia undulana</i> (Den. & Schiff.)	32	1	0	0	0	33	1.38
<i>Pandemis cerasana</i> (Hbn.)	26	47	4	0	0	77	3.23
<i>Pandemis cinnamomeana</i> (Tr.)	0	1	0	0	0	1	0.04
<i>Pandemis corylana</i> (Fabr.)	0	3	0	0	0	3	0.13
<i>Pandemis heparana</i> (Den. & Schiff.)	0	0	9	0	0	9	0.38
<i>Paraswammerdamia lutarea</i> (Haw.)	0	18	0	1	1	20	0.84
<i>Parectropis similaria</i> (Hufn.)	0	0	21	0	0	21	0.88
<i>Peribatodes rhomboidarius</i> (Den. & Schiff.)	0	0	10	3	0	13	0.55
<i>Phalera bucephala</i> (L.)	0	0	2	0	0	2	0.08
<i>Plagodis pulveraria</i> (L.)	0	0	2	0	0	2	0.08
<i>Poecilocampa populi</i> (L.)	0	1	0	0	0	1	0.04
<i>Psyche casta</i> Pallas	0	1	0	0	0	1	0.04
<i>Ptilodon capucina</i> (L.)	0	0	1	0	0	1	0.04
<i>Recurvaria leucatella</i> (Cl.)	0	13	0	0	0	13	0.55
<i>Recurvaria nanella</i> (Den. & Schiff.)	3	7	0	0	0	10	0.42
<i>Semioscopis steinkellneriana</i> (Den. & Schiff.)	1	0	1	3	0	5	0.21
<i>Spilonota ocellana</i> (Den. & Schiff.)	2	2	0	0	0	4	0.17
<i>Swammerdamia compunctella</i> (Herr.-Schäff.)	0	1	0	0	0	1	0.04
Tortricidae g. sp.	1	15	4	0	1	21	0.88
<i>Trachycera advenella</i> (Zinck.)	46	38	0	0	0	84	3.52
<i>Trichiura crataegi</i> (L.)	1	0	0	0	0	1	0.04
<i>Trichosea ludifica</i> (L.)	0	0	3	0	0	3	0.13
<i>Venusia cambrica</i> Curtis	0	1	257	9	0	267	11.20
<i>Ypsolopha horridella</i> (Tr.)	0	66	1	0	0	67	2.81
Total	486	826	725	244	102	2,383	100.0

fauna. The adults were not trapped into light traps (KULA, 2007). This mountain species, mentioned by EBERT et al. (2001) at locations 800–1250 m asl, was caught in the Ore Mountains at altitudes 500–900 m asl, the most abundant being in the lowest situated localities. It is considered as a monophage on mountain ash (EBERT et al., 2001, also according to our results), although some authors admit that this species also feed on birch as an additional nutritive plant (WARNECKE, 1943) or on shrub layer (LANGE, 1920). Data on its development on *Vaccinium myrtillus* L. are not to take with full confidence (VORBRODT, 1914). RASPÉ et al. (2000) specified caterpillar feeding to August. According to our results obtained by trapping on mountain ash, the main occurrence of caterpillars was recorded in the period July–August, with sporadic finds in mid-June and

culmination at the beginning of August; the occurrence lasted up to the beginning of September (Fig 2B).

Hedya nubiferana (Haw.). Although this species is considered as a polyphage on various broadleaved species (KENNEL 1908, RAZOWSKI 2001), according to our experience, it only lives on trees of the family Rosaceae. According to the above mentioned authors, caterpillars (after wintering) feed on flowers, developing buds and leaves, from April to May. In our case they created the most important component of the mountain ash crown fauna, particularly in the spring aspect, with a sporadic occurrence in May (Fig 2A). In spite of differences in the foliage of mountain ash in the early spring aspect – from sparse foliated stands to fully foliated stands, the dominance of *Hedya nubiferana* caterpillars was relatively balanced (35.5–34.3–30.2%). They

were found in 87% monitored stands. According to the quoted authors, imagoes occur from July to August. They were very abundant in the light trap (June – beginning of September) and showed another peak in July–mid-August with a maximum of 123 individuals/night (5/8/2003). Population dynamics (1989–2007) was differentiated, and after culmination in 2003 it retreated.

Hedya pruniana (Hbn.). Its caterpillars live on various broadleaved species mainly of the family Rosaceae. It winters, and in early spring occurs in crowns of trees and shrubs (KENNEL, 1908; RAZOWSKI, 2001; REIPRICH, 2001). In our case the species usually occurred on mountain ash (proved on 67% localities), which is remarkable, because, according to the experience of the second author, in other regions of Bohemia and Slovakia it occurred, almost exclusively on the genus *Prunus*. It showed an increased abundance in localities 19 and 20 (area of Boleboř – Kalek). In the spring aspect, caterpillars approached the dominance of *H. nubiferana* (Fig 2A). In stands with the early start of leaf unfolding, the population dominance was markedly lower (17.2%)

than in stands with the standard course (24.7%) and delayed flushing (28%). In some years, the imagoes in the light trap were less numerous than *H. nubiferana*. It occurred from mid-May to August, without an evident culmination, nevertheless, with a more compact proportion to the end of June.

Campaea margaritata (L.). It is a generally distributed species reaching the medium-altitude locations (BERGMANN, 1955). It occurs in one or two generations. Two generations usually occur in warmer regions and years (CELTON, 1936; PATOČKA et al., 1999; EBERT et al., 2003). Its caterpillars are polyphagous on broadleaved species, preferring the family of Fagaceae (PATOČKA et al., 1999). The moth flies from mid-May to mid-October (EBERT et al., 2003); in case of two generations, in mid-May, and then from August to October.

We detected caterpillars in 97% monitored stands in a balanced proportion (1–12 pieces). The highest abundance was noted in October. After wintering, their number substantially decreased (Fig 2A), similarly as on birch in the Ore Mountains (KULA, 2007). The

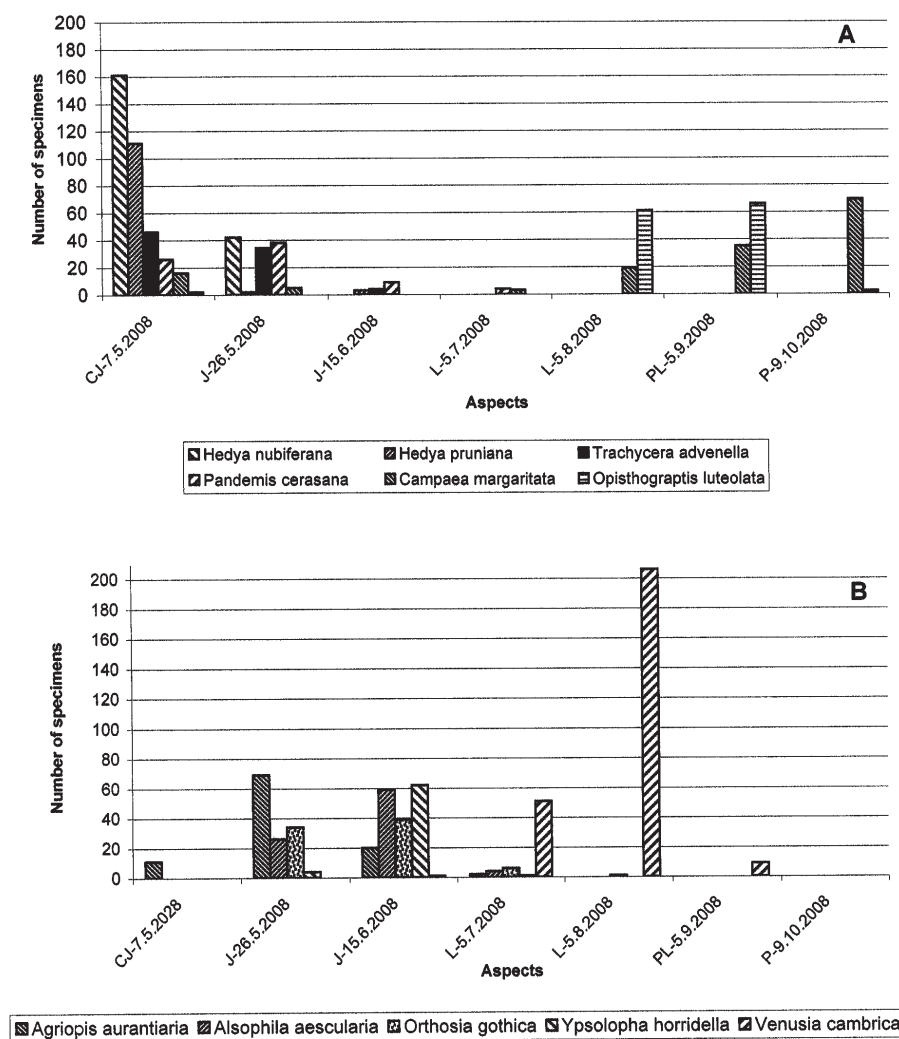


Fig 2. Seasonal changes in the total number of caterpillars obtained from mountain ash crowns in the 31 localities in the Ore Mountains in 2008 (CJ, J, PL, P: aspects, see Table 4)

imagoes belonged to the commonly occurring species the abundance of which culminated in 2002 and 2006 (KULA, 2007).

Opisthograptis luteolata (L.). It is an abundant species distributed from lowlands up to mountain locations. Various authors (REUTTI, 1898; KOCH, 1984; REIPRICH, 2001; EBERT et al., 2003) mention one or two or even more generations. Imagoes can occur from April to September. Caterpillars created an important component of the late-summer fauna of mountain ash (August–mid–September). They occurred throughout the region (90% monitored stands) without any site preference (1–15 pieces). In the area of Sněžník, we did not prove two generations because imagoes occurred from 23 April to 12 July. The species abundance culminated rather shortly in the first half of June; after a faster increase a slower decline occurred (Fig 2A). Population density values did not show bigger variations, they commonly did not exceed 10 individuals per night.

Agriopsis aurantiaria (Hbn.). The species is polyphagous (broadleaved species and larch) with considerable vertical distribution. It shows a trend towards local gradations (ŠUŠLÍK and KULFAN, 1993; PATOČKA et al., 1999; EBERT et al., 2003). Caterpillars are relatively numerous on birch trees, and they do not manifest evident population dynamics (KULA, 2007); on mountain ash, it occurred in 70% monitored stands, from May to mid-June at numbers of 1–11 individuals per a sample (Fig 2B).

Alsophila aescularia (Den. & Schiff.). The species is distributed from lower to medium locations. It is a polyphage on broadleaved species and shows a potential for occasional gradations (SCHNEIDER, 1938; BERGMANN, 1955; CARTER, 1984; PATOČKA et al., 1999). REIPRICH (2001) does not mention it on mountain ash. The species was observed at altitudes of 500–900 m asl, with a higher proportion in stands at above 700 m asl (11.5%) than below 700 m asl (2.5%). We sampled caterpillars from the end of May to the beginning of July; the most intensive sampling ran in the mid-June (Fig 2B). In 70% monitored stands, a balanced proportion was noted (1–11 ex.) (Table 3). In the light trap on Sněžník, imagoes occurred from 25 March to 8 May, without marked fluctuations in abundance. In total, only 59 individuals arrived in 1989–2007.

Orthosia gothica (L.). The species is commonly distributed from lowlands to mountains. It is broadly polyphagous, its caterpillars live on broadleaved and coniferous trees as well as on some herbs (BERGMANN, 1954; FORSTER and WOHLFAHRT, 1960; KOCH, 1984; KULFAN, 1994; PATOČKA et al., 1999; PATOČKA and KULFAN in press). Caterpillars occurred in mountain ash stands (out of 77% monitored) in low abundance. In crowns of birch in a nearby locality Sněžník, caterpillars occurred sporadically (KULA, 2007). On Sněžník, imagoes were noted in a light trap from March to mid-June with a culmination in the 2nd and 3rd thirds of April (Fig 2B). The highest numbers of individuals caught per a night were:

187 (17/4/2004) and 173 (17/4/2004). The particular years markedly differed in abundance, and population dynamics became characterised (typical) by repeated and frequent culminations (1992–1993, 1996–1997, 1999–2000, 2002, 2004 and 2007).

Pandemis cerasana (Hbn.). This broadly polyphagous species is mainly distributed on trees. Sometimes it displays gradations. Larvae of the 3rd instar winter in splits of bark or between connected leaves (PATOČKA, 1955). In spring, they attack young shoots; later browse leaves (SCHWENKE, 1974; RAZOWSKI, 2001; REIPRICH, 2001; PATOČKA and KULFAN, in press). On mountain ash in our study, the species showed a broad distribution (73% stands) but low abundance. In the crown fauna of birch trees, we trapped only 64 caterpillars from the beginning of May to the beginning of August with a maximum at the end of May (KULA, 2006). The occurrence of caterpillars indicated the partial second generation, which was not mentioned by RAZOWSKI (2001). Imagoes were recorded as early as May but the common occurrence was noted from June to August, high arrivals and proportion had peaks between 15/6 and 10/7. The last individuals were found towards the end of September. At the Sněžník locality, it was the third most abundant species caught into the light trap (1989–2007). Its population dynamics became evident based on irregular culminations (1992, 1999–2000, 2002–2003) (Fig 2A).

Lycia hirtaria (Cl.). It is a spring species with imagoes occurring sometimes as early as in February (EBERT et al., 2003). Caterpillars were found in 67% monitored mountain ash stands (1–12 individuals) from the end of May, with a culmination at the turn of June and July. It occurred uniformly at altitudes 500–900 m asl in the Ore Mountains, and showed higher proportion at higher locations (up to 700 m asl 2.2%, above 700 m asl 6.6%). We trapped imagoes in the Sněžník locality from April to mid-June with the same intensity of increase and decline of culmination. As a rule, the maximum of abundance occurred in the last third of April. The species maximum arrival to the light trap was 60 individuals per night (1/5/2003).

Ypsolopha horridella (Tr.). Females lay eggs on woody species of Pomoideae and Prunoideae (PATOČKA and KULFAN, in press). Caterpillars were found on mountain ash in mid-June. Their abundance changed with the development of foliage (9.8–8.3–6.1%). Although imagoes are attracted by light (they occur in July and August) (EMMET, 1996), no individual was found in the light trap in the Sněžník locality in 1989–2007.

Argyresthia conjugella (Zell.). Imagoes occur from the end of July to August and mating comes about at nights with a light intensity of 500–2000 lx. Females lay individual eggs at a light intensity of 50–500 lx on developing rowanberries (JAASSTAD et al., 2005). Caterpillars hatch 14 days later, gnaw out fruits and damage also seeds. Fully developed caterpillars leave fruits and pupate in litter (August–October) (KŘÍSTEK et al., 1992). At the high rowanberry crop in 2006, the proportion of

the invaded rowanberries was low (<10%). In 2008, the fruit production in the studied area decreased due to unpollinated flowers. Full fecundity was noticed only in site 18 (altitude 496 m asl). At locations between 526 and 870 m asl, rowanberries occurred sporadically or were missing at all). In 2008, the degree of damage to rowanberries caused by moth larvae was very high (49.4–94.1%) in stands with the low and sporadic occurrence of rowanberries. Only sites with a high and medium crop of mountain ash in the lowest-situated localities recorded lower attacks (21.6–29%) (Table 2). In the same period, we observed a very low attack (0–3.2%) on mountain ash trees with high fruit production in the urban areas of Brno - Líšeň and Černá pole (Czech Republic) and Krakow (Poland), and along a road outside forest (Libouchec – Chlumec) (Czech Republic). In 1970, a 36.3% attack on rowanberries was confirmed in the Ore Mountains, and in the České středohoří (the Bohemian Highlands) Mountains (KŘÍSTEK et al., 1992). According to the imagoes trapped in the light trap, the species population dynamics was irregular (culmination in 2002 and 2007). A direct effect of climatic factors on changes in population dynamics of imagoes in the study years 1997–2007 was not detected. In the Sněžník locality, imagoes occurred from mid-May to July with a culmination between 13/6–22/6 and a maximum abundance of 177–318 individuals (June 13–23, 2008). Due

to the early beginning of spring (higher temperatures and lower precipitation in April), the hatching in the year of culmination (2007) began nearly 20 days earlier than in 2008. In the period 18/5–12/6 2007, 28.6% imagoes from the total of the whole growing season were recorded, in contrast to the only 6.1% adult moths in 2002 (Fig 3). The sum of positive temperatures on 30/4 in 2002 and 2007 reached a value of 322.3 and 554.4 °C, respectively. The hatching of imagoes began between 24/5–28/5/2007 at a temperature sum of 912.2 °C and in the period 8/6–12/6/2002 at a temperature sum of 896 °C. In the period of culmination 13/6–17/6/2007, the sum of temperatures reached 1261.1 °C, while the culmination 23/6–27/6/2002 was characterized by a temperature sum of 1,078.9 °C. In the other years 1997–2005, the beginning of hatching was related to a temperature sum ranging from 603.6–1070.1 °C (Table 5). In Scandinavia, it represents an important pest of orchards, as in case of lacking food, the females invade fruit orchards where they destroy crop (AHLBERG, 1927; KOBRO, 1995; SPERENS, 1997). In areas with the natural occurrence of mountain ash, it is a common species and the intensity of attacks to rowanberries is dependent on the fecundity of the mountain ash trees. To monitor the occurrence of butterflies, it is possible to use sexual pheromones (JAASTAD et al., 2002).

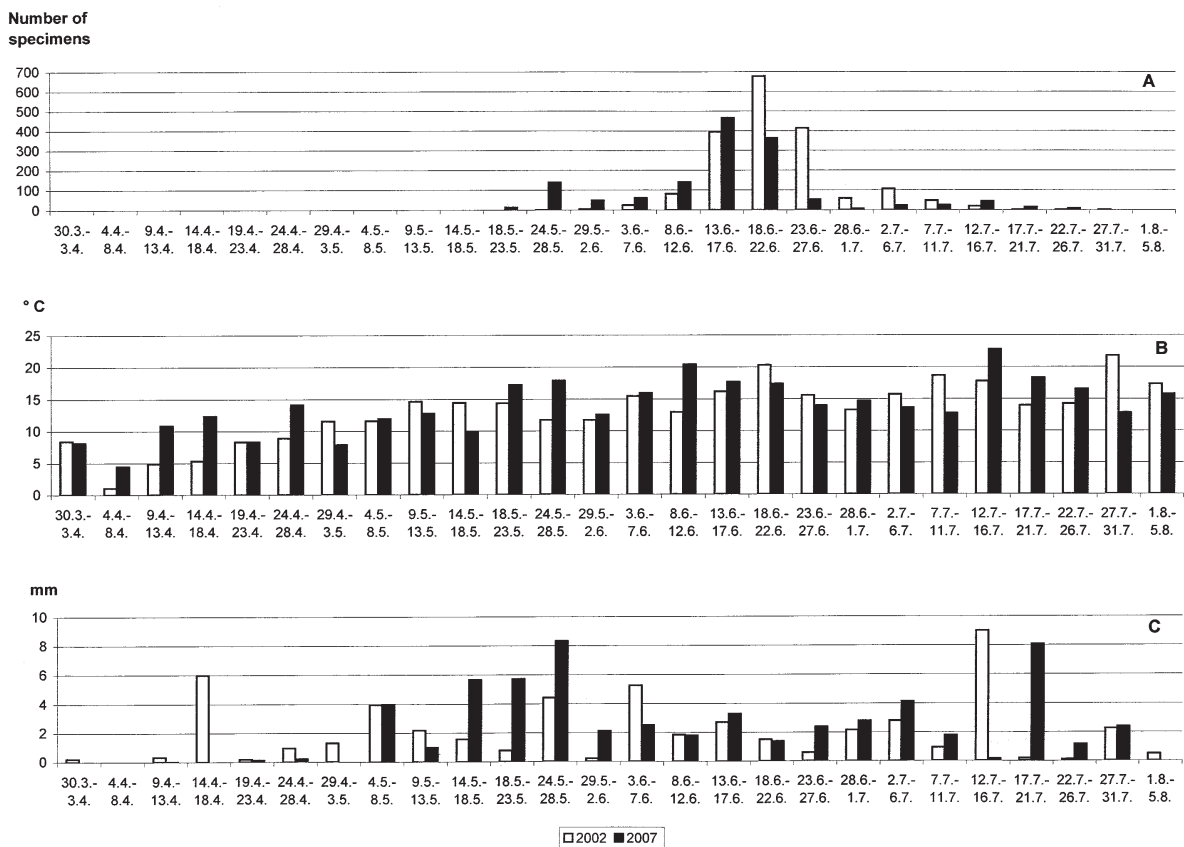


Fig 3. Seasonal changes in flight activity (A) of *Argyresthia conjugella* imagoes (Zell.) (Sněžník, light trap) depending on temperature (B) and precipitation total (C)

Table 5. Seasonal changes in the flight activity of *Argyresthia conjugella* imagoes (number of specimens collected) and sum of effective temperatures at the beginning of hatching (Snežnik, 1997–2007)

Year/Datum	18.5.-23.5.	24.5.-28.5.	29.5.-2.6.	3.6.-7.6.	8.6.-12.6.	13.6.-17.6.	18.6.-22.6.	23.6.-27.6.	28.6.-1.7.	2.7.-6.7.	7.7.-11.7.	12.7.-16.7.	17.7.-21.7.	22.7.-26.7.	27.7.-31.7.	1.8.-5.8.	6.8.-10.8.	11.8.-15.8.	16.8.-20.8.	21.8.-25.8.	26.8.-30.8.	Sum of imagoes	Sum of temperatures
1997				6	59	141	4	71	61	16	36			4	1				1	1		400	603.6
1998						29	87	24		6												146	1070.1
1999						41	47		439	30	8	3	3	1	2						1	572	880.8
2000		3	8	47	23	18	33	4	1		1								1			139	843.5
2001	3					18		1	10	16	5	12	6	6	5	1		1				78	855.7
2002		1	5	24	81	395	677	413	59	106	47	19	1	1	1							1,830	896.0
2003		2	5	23	19	11	9	13	4	3		4	2		1							96	685.7
2004			1	4	7	4	15	60	105	162	15	34	77	22	4	1	1					512	758.0
2005				5		23	24	60	14	13	1	6			1							147	662.0
2006						3		9	2	1	4	4	1	4								28	×
2007	13	139	48	60	140	466	363	52	6	23	24	43	15	7								1,399	912.2
Total	16	145	67	163	285	997	1,332	750	296	829	154	168	99	46	21	3	1	2	1	1	1	5,377	

× Data lacking

Conclusion

We studied moth caterpillars on mountain ash across a wide area of the Ore Mountains by the method of shaking off from trees. Our research results, have allowed us to include the caterpillars of *Venusia cambrica*, *Campaea margaritata*, *Opisthograptis luteolata* and *Hedya nubiferana* among generally distributed ones of the mountain ash fauna (84 species). The numerical proportion was balanced, and the altitudinal gradient of the area became partly evident in the species diversity. Communities of caterpillars on mountain ash changed according to the season: in the early spring aspect (31 species), *H. nubiferana*, *H. pruniana* and *Trachycera advenella* predominated; in the spring aspect (57 species), it was *Agriopsis aurantiaria* and *Alsophila aescularia*; in the summer aspect (55 species) *V. cambrica*; in the late summer aspect (23 species) *O. luteolata* and *C. margaritata* and in the autumnal aspect (11 species) *C. margaritata*. Under conditions of the lack of rowanberries after frost damage, the attack by caterpillars of *Argyresthia conjugella* increased (21.3–94.1%). In the gradation years 2002 and 2007, the moths hatched at the sum of effective temperatures of about 900 °C.

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Housenky motýľů v korunové fauně jeřábu ptačího (*Sorbus aucuparia* L.) v Krušných horách

Souhrn

Jeřáb ptačí (*Sorbus aucuparia* L.) je významně zastoupenou dřevinou v porostech náhradních dřevin imisního území Krušných hor. Z 84 zjištěných druhů housenek řádu Lepidoptera v korunách jeřábu v r. 2008 metodou skle-pávání měly nejvyšší abundanci *Campaea margaritata* (L.), *Venusia cambrica* Curtis, *Opisthograptis luteolata* (L.), *Hedya nubiferana* (Haw.). S nadmořskou výškou se zvýšila druhová diverzita, bez zásadní preference se mění dominance u jednotlivých druhů. V časně jarním aspektu (31 druhů) byly nejpočetnější *Hedya nubiferana*, *H. pruniana* (Hbn.), *Trachycera advenella* (Zincken); v jarním (57 druhů) *Agriopsis aurantiaria* (Hbn.), *Alsophila aescularia* (Den. et Schiff.); v letním (55 druhů) *V. cambrica*; v pozdně letním (23 druhů) *O. luteolata*, *C. margaritata*; v podzimním (11 druhů) *C. margaritata*. Poškození malvic jeřabin v rozsahu 21,3–94,1 % způsobila *Argyresthia conjugella* (Zell.), jejíž motýli se líhli v gradačních letech při sumě efektivních teplot okolo 900 °C.

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