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Review of Lepidoptera with trophic relationships to *Picea abies* (L.) in the conditions of Czechia

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Abstract
Trophic relationships of Lepidoptera (Insecta) occurring in the territory of Czechia to the Norway spruce (*Picea abies* L.) was evaluated on the basis of the excerption and critical evaluation of literature. Each species was classified into the following categories – spruce as the host plant, regular development on spruce, narrow trophic relationship, indirect relationship and episodical occurrence. The particular taxa were also characterized according to their distribution and the form of larval life was specified. The development on spruce was documented in 96 species of Lepidoptera, which represented less than 3% of taxa belonging to this group and being reported from Czechia. Of that, spruce was a common host plant for 67 species, 23 species were polyphagous and might develop on spruce, and 6 species belonged to soil species damaging spruce roots, mainly in forest nurseries. Among the species of Lepidoptera, which regularly develop on spruce in the Czech conditions, 55 species were classified. As narrow specialists with special trophic relationship to spruce, 33 taxa could be considered. There were 15 spruce species with forestry importance, which were able to outbreak their populations regularly or irregularly. Among spruce species it was possible to classify 16 taxa as rare. The provided information on Lepidoptera with trophic relationship to spruce is applicable also for other Central European areas. Besides the species with importance for forest pest management, also rare taxa, which can become endangered by climate change or by forest management, were indicated.

Key words: species richness; host plant; mono- and oligophagy; species diversity; forest pest

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1. Introduction

Butterflies and moths (Lepidoptera) represent insect order with special and narrow trophic relationship to plants. Most of described species (99%) are phytophagous (Grimaldi & Engel 2005). Trophic relationships of butterflies and moths are understood as the form of larval nutrition. With regard to the degree of a reletionship to the host plant, monophagous, oligophagous and polyphagous species are usually distinguished. For each category, it is possible to distinguish the degree of relationship as partial or complete. For classifying into these categories, the number of host plant species is not important, contrary to taxonomic relationship of these species (Jolivet 1998). The monophagous species develop on single plant species or closely related species of single genus. The most specialised herbivores are able to consume only a certain part of a concrete plant, moreover in a certain time section. The oligophagous species use several species of host plants, usually belonging to one genus or several related genera of a single family. Usually a similarity in the plant chemism is the key factor (Jaenike 1990; Menken et al. 2010). Polyphagous species develop on many plant species from various families. Extremely polyphagous species are able to profit on most plant tissues occurring in their vicinity (Nyman 2010). For the colonization of another plant species, the balance between sensitivity to plant attractants and insensitivity to plant deterrents is crucial (Menken et al. 2010). For a succesful development and subsequent adaptation of a butterfly or moth to a certain host plant species, also different rate of parasitism of individual woody species is important (Lill et al. 2002).

In general, the woody species are hosts to more species of Lepidoptera than the herbs (Tallamy & Shropshire 2009), whereas angiosperm woody species have richer fauna of Lepidoptera (Brändle & Brandl 2001). The number of insect (butterfly/moth) species associated with a woody species depends on the history of its spreading in the course of recent, on its actual distribution, morphological and physiological characteristics and its taxonomic relation to another woody species (Strong 1974; Kennedy & Southwood 1984; Brändle & Brandl 2001). Among European conifers, the most species of Lepidoptera are hosted by the Scots pine *Pinus sylvestris* L. (Klimetzek 1992; Brändle & Brandl 2001), the second in line is the Norway spruce *Picea abies* (L.) H. Karst. (Brändle & Brandl 2001; Reiprich 2001).

However, the evaluation of the complete number of butterfly/moth taxa which are possible to develop on a certain woody species interfers with a number of problems and data from various authors greatly differ. Trophic relationship to the Norway spruce is presented for 71 species of Lepidoptera by Wolff & Krause (1922), whereas e.g. Patočka (1951) reported 51 species. However, the overlap between these two accounts represents only 37 species. Schütze (1931) published 22 species from the group "Microlepidoptera", Brändle & Brandl (2001) presented 64 species from Germany – 30 from the group of "Macrolepidoptera" and 34 from the group

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of "Microlepidoptera", whereas in the paper from the British Isles, Kenedy & Southwood (1984) published only 22 taxa (6 from the Macrolepidoptera and 16 from the Microlepidoptera). The most complete list comprising 112 species of Lepidoptera was published by Reiprich (2001). Remarkable differences among authors are caused by variously defined extent of trophic relationships, the inclusion of episodic occurrence on a woody species in unnatural situation (e.g. in breeds, extremely polyphagous species or yet unclear biology or the form of life/the host plant). Therefore the main goal of this work was to determine those species of Lepidoptera, which develop on the Norway spruce in the conditions of Czechia, the ones with a regular occurrence on spruce and those which use spruce exclusively. Such information can be used to classify Lepidoptera into potentially harmful or endangered groups of taxa. Eventually, this information can support decisions concerning the introduction of *P. abies* into new areas outside its natural range.

2. Material and methods

In the first step, a list of all species of Lepidoptera, for which *P. abies* is refered to as the host plant in the professional entomological literature, and for which the occurrence in Czechia is evident[1] was compiled. Mainly surveillance publications by Wolff and Krause (1922), Schütze (1931), Patočka (1951), Reiprich (2001), Hacker & Müller (2006), Patočka & Kulfan (2009) were used. The final species list was confronted with the authors´ experience, supplemented or critically compared to the literature specialized on particular groups of Lepidoptera (e.g. Buszko 2000; Fajčík 1998, 2003; Laštůvka & Laštůvka 2001; Lepidopteren-Arbeitsgruppe 1997; Macek et al. 2007, 2008; Patočka 1960; Patočka & Turčáni 2005; Razowski 2001, 2002a, 2002b; Slamka 1995) and divided into the following categories – spruce is the host plant, regular development on spruce, narrow trophic relationship, indirect relationship and episodical occurrence (Table 1).

For each species, larval biology is introduced after Patočka & Kulfan (2009) and authors´ experiences. Particular taxa are also characterized, according to their distribution, in the four categories – A) widespread species; B) widespread but uncommon; C) rare, local species; and D) introduced species. Nomenclature and the higher classification of Lepidoptera were adopted from the general work of Laštůvka & Liška (2011). The final list of species is presented in Table 2.

3. Results

The development on spruce was documented for 96 species of Lepidopteda, from which for 67 species the spruce is an usual host plant, 23 species are polyphagous with a possibility to develop on spruce, 6 species belong among the soil species damaging roots of spruce, usually in forest nurseries. For one species (*Cydia coniferana*) it is desirable to document the development on spruce recently (see discussion). Among Lepidoptera with the regular development on spruce in the conditions of Czechia, 55 species were classified. As narrow specialists with crystallized trophic relationship to spruce, 33 taxa are possible to classify.

The dominant part across all categories was represented by the species from the families Tortricidae and Geometridae, except the species damaging spruce roots, which belong exclusively in the family Noctuidae.

Numerous species living on spruce are, with regard to longstanding and more or less full-area cultivation of this woody species in Czechia, widely distributed and occur in high population densities, whereas 15 species have potential to outbreak their populations regularly or irregularly. In the category of the so-called rare species, altogether 16 taxa are possible to classify, generally of primary mountain or foothill character, which usually do not descend into secondary spruce area at lower altitudes. Only one spruce species (*Coleotechnites piceaella*) was introduced.

Table 1. Categories used to group Lepidoptera according to their trophic relationship, and characteristics of these categories.

Category	Description of the category
Spruce is host plant	The occurrence on spruce was reliably documented (concrete dating, accordant data from more literary sources, corresponding to the authors´ experience) are listed. Among the species with confirmed development on spruce, a widely polyphagous taxa (P), and the species with larvae living in soil and feeding on roots (S), were separated in Table 2. By these species, the trophic relationship to spruce is documented, however it is no way tight.
Regular development on spruce	The taxa of which at least some populations in an area use the spruce as the host plant continuously (during multiple subsequent vegetation seasons) were designated. For each species with regular development on spruce, four categories of the population outbreak risk were defined in Table 2. (+ low risk, ++ medium risk, +++ high risk, single symbol X – no risk).
Narrow trophic relationship	The taxa with the host plant radius restricted to *P. abies*, eventually another taxonomically relative particular woody species, were defined.
Indirect relationship	Rrelationship to another organisms having any relationship to spruce (or woody species), where the spruce is not a primarily consumed food. In this case the development of a butterfly/moth species is linked to organisms, which ecological niche are various parts of spruce. These are represented mainly by algae, lichenes and fungi (in Table 2 as Org). As an indirect relationship we understand also the development in decaying wood (in Table 2 as D).
Epizodical occurence	The feeding on spruce was documented only during a population outbreak, after a clear-eating on the main host woody species. For this type of occurrence it is typical that if the larvae are able to finish the development on "emergency" woody species, emerged adults will again oviposit on the main host woody species.

[1] In the paper we use geographically correct name Czechia, which is a codified designation of Bohemia, Moravia and Silesia (i. e. all parts of the Czech Republic). Contrary to political name the Czech Republic, which describes temporary state authority system of this country, the geographical name Czechia is independent on the form of the political organisation and therefore is more stable and permanent (Lutterer & Šrámek 1997).

In terms of the larval life strategy or their biology and food niche utilisation, prevailing are the species feeding on assimilatory organs (needles). These species live either entirely free (Geometridae, Erebidae, Noctuidae) or inside shelters between needles (Gelechiidae, Tortricidae). Several species directly sponge the needles (so-called mining) (Batrachedridae, Tortricidae). A smaller group sponge buds and the terminal parts of shoots (Argyresthiidae) or generative organs, especially cones (Tortricidae, Geometridae, Pyralidae). Several remaining species live under bark (Tortricidae) or in swellings (so-called galls) produced by another insect species (Tortricidae, Geometridae, Pyralidae). All characteristics for particular species are designated in Table 2.

4. Discussion

Altogether 137 species of Lepidoptera (Table 2), for which larval occurrence or development on *P. abies* was documented in the special literature, are presented in the review. By separating the species with indirect relationship, episodical occurrence, improbable data or mistakes, 96 species of Lepidoptera were documented to develop on spruce. These species represent less than 3% of taxa belonging to this group and being reported from Czechia, i.e. 3 429 (Laštůvka & Liška 2011). However, among the species with documentary development on spruce, there are numerous taxa whose relationship to this woody species is very loose. These are especially widely polyphagous species and the "soil species". The enumeration of polyphagous species of Lepidoptera with a potential to develop on spruce is not complete and new findings are expected by ongoing research of the lepidopterocoenoses in the spruce-tops (cf. Kulfan et al. 2010;Röder et al. 2010; Kulfan et al. 2016). Also the list of soil species of Lepidoptera is probably incomplete. These species oviposit their eggs in the soil or on its surface and the larvae then feed on the roots of a vegetation covering given area, i.e. the spruce seedlings in this case. By excluding the soil and polyphagous species, 66 species will remain, for which the spruce can be considered as a common host plant, in the sense of monophagy and oligophagy. Narrowing the selection to the criterion of a regular occurrence we get 55 species, which use the spruce for the development annually, or prefer it in a given habitat, respectively. As narrow specialists with a pronounced trophic relationship to spruce, 30 taxa are possible to consider. These species use spruce as a host plant preferably or exclusively, which the most corresponds to the characteristics of total and partial monophagy.

Comments on trophic relationship and other discussed aspects are ranged correspondingly to the systematic order of particular families and lower taxa in the following text (after Table 2). For particular species, usually in relation to their economic importance, also an information on affected damage is given.

Adelidae

Species from the family Adelidae are dependent on decaying material of plant origin. In the case of ***Nemophora congruella*** that material is represented by decaying coniferous detritus (Hacker & Müller 2006), mainly from *P. abies* and *Abies alba* Mill. (Patočka & Kulfan 2009). However ***Nemophora associatella*** develops on hitherto vital, freshly fallen needles of *A. alba*. Reiprich´s (2001) remark on the development on *P. abies* resulted from the "Prodromus" by Hrubý (1964), who adopted that information from Nickerl (1908), Hering (1932) and Werner (1958). However, indicated host plants differ within those three sources. According to Nickerl (1908) the larva develops in fallen green needles of *P. abies* and *A. alba*. Hering (1932) mentioned the development to proceed only among fallen needles of *P. abies*. Werner (1958) drew from the work of Schütze (1931), who considered the development to proceed only in the needles of *A. alba* (the larva is being found in soil under the tree-top space). Bionomical data of Schütze (1931) coincided with later conclusions of other authors (cf. Patočka 1960; Patočka & Turčáni 2005; Hacker & Müller 2006). Therefore *P. abies* as a host plant is not accepted. Larvae of ***Nematopogon robertellus*** develop on *Vaccinium myrtillus* (L.) as the main host plant and alongside it also in plant detritus and various animal substrates (Hacker & Müller 2006). Besides *V. myrtillus* it was mentioned also from *P. abies* (Reiprich 2001), but that was an incorrect interpretation of Hering (1932), who described that adults like to occur in spruce thickets.

Tineidae

Representatives from the family Tineidae include two cases of species (*Montescardia tessulatella* and *Morophaga choragella*) which primarily develop on lichens or sporocarps of wood-decaying fungi and later they can pass also into dead wood. ***M. tessulatella*** develops in tree polypores from the genus *Polyporus* (s.l.) (Petersen 1965), which colonize old individuals of *Fagus sylvatica* L. and *P. abies*. For ***M. choragella***, two fungi species from the family Polyporaceae were mentioned by Petersen (1965): *Phellinus ignarius* (L.:Fr.) Quel. and *Laetiphorus sulphureus* (Bull.:Fr) Murril. These two species of wood-decaying fungi are not too frequent parasites of *P. abies* or, in the case of *P. ignarius*, the occurrence on spruce is not known at all (cf. Kotlaba 1984). Reiprich (2001) adopted the note concerning the occurrence on *P. abies* from Schütze (1931), who proposed list of decaying wood: *Salix* spp., *Populus* spp., *Tilia* spp., *F. sylvatica*, *P. abies* and *Alnus* spp. According to Petersen (1965), the larvae of ***Niditinea truncicolella*** live in rotten wood and probably develop in ant colonies. Reiprich (2001) considered *P. abies* to be the main host plant and based this claim upon the review of Reiprich (1993), who summarized newly found species of Lepidoptera in Slovakia in 1992. In a brief bionomical characteristics he mentioned a larva under the bark of *P. abies* and added the data concerning the development in ant-hill, however without further specification. The source of the above mentioned characteristics in the publication by Reiprich (1993) was the list of newly recorded Lepidoptera for CSFR from Laštůvka et al. (1992). It noted the adults of *N. truncicolella* found on tree trunk of *P. abies* invaded by ants of the species *Camponotus ligniperda* (Latreille, 1802). For the wool moth ***Infurcitinea ignicomella***, Reiprich (2001) cited fungi (Fungi) as the main host plant, however he supposed also the development on *P. abies* and *A. alba*, whereas these data were adopted from Gozmány (1955). Petersen (1965) presented probable larval

Table 2. Summary of Lepidoptera, for which the spruce is referred to as the host plant in selected special literature – Wolff & Krause 1922, Schütze 1932, Patočka 1951, Reiprich 2001, Hacker & Müller 2006, Patočka & Kulfan 2009; × = spruce is listed; C = conifers.

	Wolff, Krause 1922	Schütze 1931	Patočka 1951	Reiprich 2001	Hacker, Müller 2006	Patočka, Kulfan 2009	Other autors	Larval behaviour	Spruce is host plant	Regular development on spruce	Narrow trophic relationship	Indirect relationship	Epizodical occurence	Distribution
MONOTRISIA														
Incurvarioidea														
Adelidae														
Nemophora associatella Zeller, 1839	×			×		?		Nm (Cb)	—					C
Nemophora congruella (Zeller, 1839)				×	×	×		?Nm (Cb)	×	×		D		B
Nematopogon robertellus (Clerck, 1759)				×				Nm (Cb)	—					A
DITRYSIA														
Tineoidea														
Tineidae														
Infurcitinea ignicomella (Heydenreich, 1851)				×				Ls	—			Org		B
Montescardia tessulatella (Lng & Zeller, 1846)				×				Ss	—			Org		B
Morophaga choragella (Den. & Schiff., 1775)		?		×				Ss	—					B
Niditinea truncicolella (Tengström, 1848)				×				Ni, Ss	—			Org		C
Psychidae														
Narycia astrella (Her.-Sch., 1851)				×		C		Cb	—			Org		B
Siederia listerella (Linnaeus, 1758)						C		Cb	—			Org		B
Yponomeutoidea														
Argyresthiidae														
Argyresthia glabratella (Zeller, 1847)	×	×	×	×	×	×		Bu, Spr	×	× (+)	×			A
Argyresthia svenssoni (Bengtsson & Johansson, 2012)		×	×	×	×	×		Bu, Spr	×	×	×			B
Argyresthia bergiella (Ratzeburg, 1840)	×	×	×	×	×	×		Bu	×	×	×			B
Gelechioidea														
Oecophoridae														
Schiffermuelleria schaefferella (Linnaeus, 1758)				×		C		Ss	—			D		A
Schiffermuelleria grandis (Desvignes, 1842)				×		C		Ss	—			D		C
Denisia stroemella (Fabricius, 1781)				×		C		Ss	—			D		C
Denisia similella (Hübner, 1796)				×	×	C		Ss	×	×		D		A
Denisia albimaculea (Haworth, 1828)				×		C		Ss	—			D		C
Denisia nubilosella (Her.-Sch., 1854)				×	×	C		Ss	×	×	×	D		B
Denisia stipella (Linnaeus, 1758)				×	×	C		Ss	×	×		D		A
Denisia oliviella (Fabricius, 1794)				×		C		Ss	—			D		C
Borkhausenia luridicomella (Her.-Sch., 1856)				×		C		Ba, Ni, Ss	—			D		C
Crassa tinctella (Hübner, 1796)							7	Ss	—			D,Org		C
Batrachedridae														
Batrachedra pinicolella (Zeller, 1839)	×	×	×	×	×	×		Nm, Sn	×	×				B
Blastobasidae														
Hypatopa binotella (Thunberg, 1794)				×	×			Ss	×			D		B
Gelechidae														
Coleotechnites piceaella (Kearfott, 1903)				×	×	×		Nm, Sn	×	× (+)	×			D
Exoteleia dodecella (Linnaeus, 1758)				×	×			Nm, (Bu), (Spr)	×	× (+)				A
Chionodes luctuellus (Hübner, 1793)				×	×	×		Sn	×	×	×			C
Chionodes electellus (Zeller, 1839)	×	×	×	×	×	×		Nm, Sn	×	×	×			A
Dichomeris latipennella (Rebel, 1937)				×	×	×		Co	×	×	×			C
Tortricoidea														
Tortricidae														
Eupoecilia angustana (Hübner, 1799)				×				Sfl, Fr	—					A
Tortrix viridana (Linnaeus, 1758)				×				Sl	—					A
Acleris abietana (Hübner, 1822)	×	×	×	×	×	×		Sn	×	×				C
Eana argentana (Clerck, 1759)				×				Sl	—				×	B
Cnephasia incertana (Treitschke, 1835)							2	Sl	—				×	A
Philedone gerningana (Den. & Schiff., 1775)				×				Sl	—					B
Philedonides lunanus (Thunberg, 1784)				×				Sl, Sfl	—					B
Archips oporanus (Linnaeus, 1758)	×		×	×	×	C		Nm, (Sn), (Spr)	×	× (+)				B
Archips podanus (Scopoli, 1763)				×		C		Sn	P					A
Choristoneura murinana (Hübner, 1799)				×				Sl, Spr	—				×	B
Argyrotaenia ljungiana (Thunberg, 1797)				×				Sl	P					A
Ptycholoma lecheanum (Linnaeus, 1758)				×				Sl	P					A
Pandemis corylana (Fabricius, 1794)				×				Sn	P					A
Pandemis cerasana (Hübner, 1786)				×		C		Sl	P					A
Pandemis cinnamomeana (Treitschke, 1830)				×	C	C		Sn	P	×				B

	Wolff, Krause 1922	Schütze 1931	Patočka 1951	Reiprich 2001	Hacker, Müller 2006	Patočka, Kulfan 2009	Other autors	Larval behaviour	Spruce is host plant	Regular development on spruce	Narrow trophic relationship	Indirect relationship	Epizodical occurence	Distribution
Syndemis musculana (Hübner, 1799)				×	×			Sl, Sn	P					A
Lozotaenia forsterana (Fabricius, 1781)				×	×			Sl, Sn	P					B
Aphelia viburnana (Den. & Schiff., 1775)							1	Sl, Sn	P				×	C
Aphelia paleana (Hübner, 1793)				×				Sl, Sn	P					B
Dichelia histrionana (Frölich, 1828)	×	×	×	×	×	×		Nm, (Sn)	×	× (+)	×			B
Clepsis senecionana (Hübner, 1819)				×	×			Sl, Sn	P					A
Capricornia boisduvaliana (Duponchel, 1836)				×		×		Sn	×					C
Celypha lacunana (Den. & Schiff., 1775)				×				Sl, Sn, Sfl	—					A
Cymolomia hartigiana (Saxesen, 1840)	×	×	×	×	×	×		Nm, (Sn)	×	×	×			B
Piniphila bifasciana (Haworth, 1811)							8	Fl, Bu	×	?				B
Pseudohermenias abietana (Fabricius, 1787)	×	×	×	×	×	×		Nm, (Sn)	×	×	×			B
Epinotia tedella (Clerck, 1759)	×	×	×	×	×	×		Nm, Sn	×	× (+++)	×			A
Epinotia fraternana (Haworth, 1811)	×				×			Nm, Sn	×	×				C
Epinotia granitana (Her.-Sch., 1851)	×	×	×	×	×	×		?Nm, ?(Sn)	×	×	×			B
Epinotia rubiginosana (Her.-Sch., 1851)	×		×	×	×			Nm, (Sn)	×					C
Epinotia nanana (Treitschke, 1835)	×	×	×	×	×	×		Nm, Sn	×	× (+)	×			A
Epinotia pygmaeana (Hübner, 1799)	×	×	×	×	×	×		Spr, Sn	×	× (+)	×			A
Epinotia subsequana (Haworth, 1811)	×			×	×			Spr, Sn	×					C
Zeiraphera ratzeburgiana (Saxesen, 1840)	×	×	×	×	×	×		Spr, Sn	×	× (+)				A
Zeiraphera rufimitrana (Her.-Sch., 1885)				×	×			Spr, Sn	×					C
Zeiraphera griseana (Hübner, 1799)	×	×	×	×	×	×		Spr, Sn	×	× (+++)	×			A
Barbara herrichiana Obraztsov, 1960	×		×	×				Fr	×					C
Gravitarmata margarotana (Heinemann, 1863)	×							Bu (Spr, Fr)	—					C
Rhyacionia pinivorana (Lng & Zeller, 1846)				×				Bu (Spr)	—					B
Cydia pactolana (Zeller, 1840)	×	×	×	×	×	×		Ba	×	× (++)	×			A
Cydia grunertiana (Ratzeburg, 1868)				×				Ba	—					C
Cydia duplicana (Zetterstedt, 1839)	×	×	×	×	×	×		Ba	×	×				B
Cydia cosmophorana (Treitschke, 1835)				×	×	C		Tw, Bu, Ba	×			Org		B
Cydia indivisa (Danilevski, 1963)				×	×			Ba	×	×	×			C
Cydia coniferana (Saxesen, 1840)				×		×		Ba	?					B
Cydia illutana (Her.-Sch., 1851)	×	×	×	×	×	×		Fr, Ga	×			Org		C
Cydia strobilella (Linnaeus, 1758)	×	×	×	×	×	×		Fr	×	× (+++)	×			A
Pammene ochsenheimeriana (Lng & Z., 1846)	×	×	×	×	×	×		Tw, Bu	×	×		?		B
Cossoidea														
Sesiidae														
Synanthedon cephiformis (Ochsenheimer, 1808)	×			×				Tr	—					C
Pyraloidea														
Pyralidae														
Dioryctria abietella (Den. & Schiff., 1775)	×	×	×	×	×	×		Fr, Ga, Spr	×	× (++)	×			A
Dioryctria simplicella Heinemann, 1863				×				Spr, Ba	—					B
Dioryctria schuetzeella Fuchs, 1899	×	×	×	×	×	×		Bu, Spr, Sl	×	×	×			B
Dioryctria sylvestrella (Ratzeburg, 1840)	×							Ba	—					B
Assara terebella (Zincken, 1818)	×	×	×	×	×	×		Fr	×	×	×			B
Eudonia sudetica (Zeller, 1839)				×				Ss	—			Org		C
Crambidae														
Loxostege sticticalis (Linnaeus, 1761)				×				Nsl, Sfl, Fr	—				×	A
Lasiocampoidea														
Lasiocampidae														
Lasiocampa quercus (Linnaeus, 1758)			×	×				L	—				×	B
Dendrolimus pini (Linnaeus, 1758)	×		×	×	×	C		N	×	×				A
Cosmotriche lobulina (Den. & Schiff., 1775)	×		×	×	×	×		N	×	×				B – C
Bombycoidea														
Sphingidae														
Sphinx pinastri Linnaeus, 1758	×		×	×	×	×		N	×	×				A
Geometroidea														
Geometridae														
Macaria signaria (Hübner, 1809)	×		×	×	×	×		N	×	×	×			B
Macaria liturata (Clerck, 1759)	×			×	×	×		N	×	×				A
Odontoptera bidentata (Clerck, 1759)	×		×	×		×		L, N	P					A
Peribatodes secundarius (Den. & Schiff., 1775)	×			×	×	×		N	×	×	×			B
Deileptenia ribeata (Clerck, 1759)	×			×	×	×		N, L	×	×				B
Alcis repandata (Linnaeus, 1758)				×	×	×		N, L	P					A

	Wolff, Krause 1922	Schütze 1931	Patočka 1951	Reiprich 2001	Hacker, Müller 2006	Patočka, Kulfan 2009	Other autors	Larval behaviour	Spruce is host plant	Regular development on spruce	Narrow trophic relationship	Indirect relationship	Epizodical occurence	Distribution
Alcis bastelbergeri (Hirschke, 1908)				×				N, L	P					B
Alcis jubata (Thunberg, 1788)				×	×			S	—			Org		C
Hypomecis punctinalis (Scopoli, 1763)				×	×	C		L, N	P					A
Ectropis crepuscularia (Den. & Schiff., 1775)					×	×		L, N, Fl	P					A
Paradrisa consonaria (Hübner, 1799)						×		N, L	P					B
Bupalus piniarius (Linnaeus, 1758)				×	×			N	×					A
Hylaea fasciaria (Linnaeus, 1758)	×		×	×	×	×		N	×	×	×			A
Pungeleria capreolaria (Den. & Schiff., 1775)	×			×	×	×		N	×	×	×			B
Thera firmata (Hübner, 1822)				×				N	—					B
Thera obeliscata (Hübner, 1787)	×			×	×			N	×	×				B
Thera variata (Den. & Schiff., 1775)	×		×	×	×	×		N	×	×	×			A
Thera britannica (Turner, 1925)				×	×	×		N	×					B
Thera vetustata (Den. & Schiff., 1775)				×	×	?		N	×	×				C
Thera juniperata (Linnaeus, 1758)							3	N	—					B
Epirrita autumnata (Borkhausen, 1794)				×		C		L, N	P					A
Mesotype verberata (Scopoli, 1763)	×			×				L, N, Fr, Fl	P					B
Eupithecia abietaria (Goeze, 1781)			×	×	×	×		Fr	×	× (++)	×			A
Eupithecia analoga Diakonoff, 1926	×			×	×	×		Fr, Ga	×			Org		B
Eupithecia lariciata (Freyer, 1842)							5	N	×					C
Eupithecia tantillaria Boisduval, 1840	×		×	×	×	×		N	×	×	×			A
Eupithecia lanceata (Hübner, 1825)	×		×	×	×	×		N	×	×	×			A
Eupithecia indigata (Hübner, 1813)				×	×			N	×					B
Eupithecia conterminata (Lng. & Zeller, 1846)				×	×	×		N	×	×	×			C
Noctuoidea														
Erebidae														
Orgyia antiqua (Linnaeus, 1785)				×		C		L, N	P	×				A
Gynaephora selenitica (Esper, 1789)							9	L, N	—				×	C
Calliteara abietis (Den. & Schiff., 1775)	×		×	×	×	×		N	×	×	×			C
Lymantria monacha (Linnaeus, 1758)	×		×	×	×	×		N, L	P	× (+++)				A
Lymantria dispar (Linnaeus, 1758)				×		C		L, N	—				×	A
Atolmis rubricollis (Linnaeus, 1758)				×		C		S, L	—			Org		B
Eilema complanum (Linnaeus, 1758)							10	S, L	—			Org		A
Eilema depressum (Esper, 1787)				×		C		S, L	—			Org		B
Lithosia quadra (Linnaeus, 1758)				×		C		S, L	—			Org	×	B
Noctuidae														
Autographa gamma (Linnaeus, 1758)							6	L, N	P					A
Panthea coenobita (Esper, 1785)			×	×	×	×		N	×	×				B
Conistra vaccinii (Linnaeus, 1761)				×				L, N	S					A
Lacanobia suasa (Den.& Schiff., 1775)							4	L, N	S					A
Ceramica pisi (Linnaeus, 1758)				×			4	L, N	S					A
Orthosia gothica (Linnaeus, 1758)				×		C		L, N	P					A
Panolis flammea (Den. & Schiff., 1775)	×			×				N	×					A
Euxoa nigricans (Linnaeus, 1761)							4	R	S					A
Agrotis vestigialis (Hufnagel, 1766)							4	R, L, N	S					B
Agrotis segetum (Den. & Schiff., 1775)				×				R, L, N	S					A
Xestia sincera (Herrich-Schäffer, 1851)					×			L, N	×	×	×			C

Other autors: 1) Patočka (1960), 2) Bogenschütz (1978), 3) Kudler (1978), 4) Kurir (1978), 5) Hatcher & Winter (1990), 6) Kulfan & Šušlík (1998), 7) Kulfan & Zach (2004), 8) Liška & Modlinger (2007), 9) Macek et al. (2007), 10) Kulfan et al. (2010).

× = species listed by the author, ? = data concerning development on spruce are not reliable or are otherwise problematic.

Larval behaviour: modified after Patočka & Kulfan (2009) Ba = under the bark; Bu = in/on buds; Cb = case bearer; Co = in cones; Fl = on/in flowers; Fr = on/in fruits; Ga = in galls; L = free on leaves; Ls = leaf sklerotiser or perforater; N = free on needles; Ni = nidicolous, i.e. living in the nests or lairs of animals; Nm = needle miner; Nsl = in nestlike spun leaves or in spun silk nest, single larvae often in tubular silk webs; R = on/in roots, rootheads, tubers or bulbs; S = free on substrate; Sfl = in spun flowers, flower heads; Sl = in spun leaves; Sn = in spun needles; Spr = in vegetative sprouts, shoots; Ss = in spun substrate; Tr = borer inside of trunks; Tw = in twigs.

Spruce is the host plant = ×; polyphagous species = P; soil species = S; spruce is not the host plant = – ;

Regular development on spruce: × no risk of population outbreak, ×(+) low risk of population outbreak, ×(++) medium risk of population outbreak, ×(+++) high risk of population outbreak;

Narrow trophic relationship = ×; Episodical occurrence = ×;

Indirect relationship: development in detritus = D; development on organisms dependent on spruce = Org

Distribution: A = widely distributed and common species, with possible tendency to population outbreaks; B = widely common species, without outbreak potential; C = local and rare species; D = introduced species.

development in lichens (Lichenes) covering rocks surface. Hannemann (1977), Hacker & Müller (2006) and Patočka & Kulfan (2009) mentioned tree lichens.

Psychidae

The main host plants for both listed species of the bagworm moths (Psychidae) are algae and lichens growing on trunks of various woody species (Lepidopteren-Arbeitsgruppe 1997). The findings of bags on *P. abies* therefore must be related to the occurrence of these epiphytes. Larvae of ***Narycia astrella*** are rarely able to feed also on decaying plant parts (Lepidopteren-Arbeitsgruppe 1997). Besides algae, Reiprich (2001) mentioned also the possibility of the development on *P. abies*; that detail was adopted from Schütze (1931), who however described development on lichens covering spruce branches. According to Hacker & Müller (2006) the species develops on the lichen *Lepraria incana* (L.) Ach. The bag of the second listed species of bagworm moths ***Siederia listerella*** is to be found on trunks of *Pinus* spp. Lepidopteren-Arbeitsgruppe (1997) mentioned also algae and lichens growing on rocks, Wolff & Krause (1922) extended the possibility of finding the bags also on trunks of *P. abies*.

Argyresthiidae

Among the moths from the family Argyresthiidae, the species ***Argyresthia glabratella*** and ***A. bergiella*** have potential to cause considerable damage during population outbreaks, namely by destroying the buds (Kudela 1970). ***Argyresthia svenssoni*** is a species described fairly recently by the Scandinavian authors (Bengtsson & Johansson 2012); its Central European distribution is still insufficiently known. Its occurrence in Czechia is reliably known only from the area of the Giant Mountains (Liška et al. 2014) – in the past, this taxon was listed as *A. amiantella* (cf. Laštůvka & Liška 2011) and even earlier it was considered to be a spruce species (Patočka 1951).

Oecophoridae

All species of the concealer moths (family Oecophoridae) which were presented by Reiprich (2001) as occurring on *P. abies*, develop in dead wood of various tree species. For ***Denisia similella***, ***Denisia nubilosella*** and ***Denisia stipella*** it is possible to consider *P. abies* as a common host woody species (cf. Tokár et al. 2005). The larvae of ***Schiffermuelleria schaefferella*** live under dead bark or in decaying wood of various deciduous trees (Schütze 1931; Patočka 1951), both living and dead (Novák & Severa 2002). Reiprich (2001) adopted a statement concerning the development on spruce from Gozmány (1958), which is however only of a general nature. Schütze (1931) mentioned *Salix* spp., *Quercus* spp., *F. sylvatica*, *Pyrus communis* L., *Populus* spp. Besides the above mentioned woody species, Tokár et al. (2005) added *Larix decidua* Mill. and *Pinus sylvestris*, but the authors did not mention *Picea abies*. ***Schiffermueleria grandis*** is very rare, polyphagous species. According to Reiprich (2001) the species is able to develop on *P. abies* and *A. alba*, however the main host plants are *Quercus* spp. Schütze (1931) mentioned *Quercus* spp. as well, but also *F. sylvatica*. Besides numerous gymnospermous and angiospermous trees, Tokár et al. (2005) introduced this species directly from *Picea*. Hacker & Müller (2006) mentioned the spruce, but with a question mark. The species is thermophilous in Central Europe and possible occurrence on spruce is absolutely unique. Reiprich (2001) adopted the indication concerning the development of ***Denisia stroemella*** on *P. abies* from Hrubý (1964), who indicated *P. abies* with a question mark, referring to Gozmány (1958). Wolff & Krause (1922) indicated *A. alba* (and *Quercus* spp. with a question mark). According to repeated findings of this species in the mountain spruce forests, its development on spruce is very probable (e.g. Šumpich et al. 2012). Classifying the concealer moths ***Denisia albimaculea*** and ***D. oliviella*** amongst spruce species (cf. Reiprich 2001) is very surprising, as these taxa are strongly thermophilous. According to Schütze (1931) or Tokár et al. (2005) the larva of *D. albimaculea* was found under bark of *Tilia* spp., *P. communis*, *Acer* spp. and *P. sylvestris*. *P. abies* was not mentioned as a host plant by Tokár et al. (2005). *D. oliviella* develops in decomposing wood of *Quercus* spp. and *Robinia pseudoacacia* L. (Schütze 1931), also *Prunus* spp. and *Corylus* spp. (Bělín 2003). Besides many species of deciduous trees, Tokár et al. (2005) presented also *P. abies* and *Pinus*. However the species is strongly thermophilous in Central Europe and eventual occurrence on spruce is entirely unique. Reiprich (2001) considered *P. abies* to be the main host plant for the species ***Borkhausenia luridicomella***. After Tokár et al. (2005), information on its bionomics is very scarce, the larvae were found in decomposing wood under the bark of dead both deciduous and coniferous trees but also inside the nests of birds. Kulfan & Zach (2004) recorded a larva on a Norway spruce branch. One larva of ***Crassa tinctella*** was recorded on a Norway spruce branch (Kulfan & Zach 2004).

Batrachedridae and Blastobasidae

Batrachedra pinicolella, a member of the family Batrachedridae, develops on needles of *A. alba*, *P. sylvestris* and *P. abies*, which is preferred by the species (cf. Patočka & Kulfan 2009). The larva of ***Hypatopa binotella***, which is included among Blastobasidae, lives in fallen needles (Patočka & Kulfan 2009), the information concerning its development on *P. abies* by Reiprich (2001) was adopted from Hrubý (1964) who referred to Gozmány (1958).

Gelechiidae

Only five representatives from a species-rich family of the gelechiid moths (Gelechiidae) are presented from *P. abies*. ***Coleotechnites piceaella*** is a non-indigenous North American species, introduced to Europe, preferring *Picea pungens* Engelm., (Elsner et al. 1999). Concerning our territory, this species with possible economic importance in the future is so far known from South Moravia (Laštůvka & Liška 2011) and newly also from Central Bohemia (Liška et al. 2014). Another potentially harmful species is ***Exoteleia dodecella***, for which the harmful occurrence on *P. abies* is known from Poland (Dierl 1978). The species was introduced to North America where it occurs mainly on introduced *P. sylvestris* (Adamski et al. 2010), which also represents the main host plant in Europe (Elsner et al. 1999). ***Chionodes luctuellus*** is

a boreo-montanne species and its larva develops on needles of coniferous trees, including *P. abies* (Elsner et al. 1999). In one case the larva was reared by J. Liška from a cocoon on spruce branch found in the Šumava Mts. ***Chionodes electellus*** mines older (mainly spruce) needles (Schütze 1931), according to some authors it is also being found in galls (Wolff & Krause 1922; Elsner et al. 1999). Until recently, ***Dichomeris latipennella*** was considered to be rare in Central Europe. During the last period, its tendency to spread is observed in our conditions. An example can be repeated observations by J. Liška in the area of the Bohemian Karst in Central Bohemia.

Tortricidae

An extensive family of the leafroller moths (Tortricidae) contains numerous species dependent (with a various degree of ecological valence) on conifers, and which are also known through a potential to outbreaks. The species ***Eupoecilia angustana*** develops on the flowers and ovaries of meadow herbs, e.g. *Thymus* spp., *Achillea* spp., *Plantago* spp., *Solidago* spp. and other plants (Razowski 2002a). Reiprich (2001) adopted the information concerning the development on spruce from Bradley et al. (1973a), who mentioned fairly exceptional finding of larvae on *Picea sitchensis* (Bong.) Carrière in Scotland. The species ***Tortrix viridana*** is a well known defoliator of oaks (*Quercus* spp.) and in case of total defoliation the larvae are able to feed on leaves of many various plant species (Razowski 2002a), e.g. *Urtica* spp. or *Vaccinium* spp. (Razowski 2001). However, eggs and the youngest larval stage occur only on *Quercus* spp. (Escherich 1931). Reiprich (2001) adopted the detail concerning its development on spruce from Escherich (1931), who mentioned a totally extraordinary observation made by Reh during a total defoliation, on primary host plants. ***Acleris abietana*** is a species living in bunched needles of *A. alba* and *P. abies* (Wolff & Krause 1922; Schütze 1931; Patočka 1951), with a preference for fir (Razowski 2001). ***Eana argentana*** is a polyphagous species of low vegetation, mainly on grasses and shrubs, preferring *Poaceae* spp. (Razowski 2001; Hacker & Müller 2006). The occurrence was documented also on *Salix* spp. and bryophytes (Bryophyta) (Razowski 2001). Razowski (2001) presented the development on *P. abies*, however the following publication (Razowski 2002a) already did not mention *P. abies*. Reiprich (2001) adopted the information of Hannemann (1961), who considered the species to be polyphagous on low vegetation and also highlighted the damages observed in young spruce outplantings. For the species ***Cnephasia incertana***, Bogenchütz (1978) mentioned a case of episodical population outbreak in Central France in 1956, where two years old seedlings of *Larix* sp., *Pseudotsuga* sp. and also *P. abies* were eaten off. The larva is widely polyphagous and develops on various herbs, e.g. from the family *Plantaginaceae* or *Fabaceae*, but also on woody plants – *Malus* spp., *Larix* sp. and *Pseudotsuga* sp. (Razowski 2001). In the following publication Razowski (2002a) already did not list conifers directly. Leafroller ***Philedone gerningana*** utilizes beside herbs, e.g. *Lotus* spp., *Plantago* spp., *Scabiosa* spp., *Peucedanum* spp., *Potentilla* spp., *Vaccinium* spp., (Razowski 2001), also woody plants as *Populus tremula* L. or *A. alba* (Razowski 2002a). Reiprich (2001) adopted the information concerning the development on *P. abies* from Bradley et al. (1973a), however it originated from *P. sitchensis*. Reiprich (2001) mentioned possible development on spruce in the leafroller ***Philedonides lunanus***, however he considered *Mentha* spp. to be the main host plant. According to Razowski (2001) the species is polyphagous on a variety of herbaceous species, but also on some woody plants, including *Picea* spp., *Pinus* spp. (Razowski 2001). However, the feeding on *P. abies* and *P. sylvestris* is known only from the British Isles (Razowski 2002a). ***Archips oporanus*** most frequently attacks 10 – 30 years old *P. sylvestris*, but similarly it feeds also on the needles of *P. abies* and *A. alba* (Kudela 1970). It damages not only young needles but also shoots, which then wither and bend to the ground (the same as in leafrollers from the genus *Rhyacionia*). ***Archips podanus*** is a polyphagous species on deciduous trees (Novák & Severa 2002) and various herbs (Razowski 2001). It is indicated also from *P. abies* (Razowski 2001; Szabóky & Csóka 2010). The host plant of the leafroller ***Choristoneura murinana*** is *A. alba* (Patočka 1960; Bogenchütz 1978; Reiprich 2001; Razowski 2002a). The oviposition on young *P. abies* or migration of larvae to spruce occur only during massive population outbreaks (Patočka 1960, Bogenchütz 1978). Reiprich (2001), Razowski (2001) and Szabóky & Csóka (2010) presented possible occurrence of the leafroller ***Argyrotaenia ljungiana*** on *P. abies*. The species is polyphagous on *Myrica gale* L., *Calluna* spp., *Erica* spp., *Vaccinium* spp., *Betula* spp., *Malus* spp., *Prunus* spp., *A. alba*, *Larix* spp. and more (Razowski 2001). *A. ljungiana* occasionally causes damages in forest nurseries (Patočka & Turčáni 2005). ***Ptycholoma lecheanum*** is a polyphagous species on *Quercus* spp., *Acer* spp., *Populus* spp. and fruit trees, rarely on *Abies*, *Larix* and more (Razowski 2001). Rare data from the above mentioned conifers originated from Siberia (Razowski 2002a). According to Reiprich (2001) the development on *P. abies* is possible; this information is adopted from Bradley et al. (1973a), who however did not mention more details. ***Pandemis corylana*** is a polyphagous species on a variety of deciduous trees and shrubs (Patočka & Kulfan 2009). Razowski (2002a) listed numerous host plant species, with *Corylus avellana* (L.) considered to be the main. Concerning the conifers, the author directly mentioned only exceptional data from *Pinus* and *Larix*. The detail concerning the development on *P. abies* was adopted by Reiprich (2001) from Kulfan (1994), who collected larvae using the method of shaking from spruce branches and used to find the larvae of *P. corylana* on two localities which were quite far from each other hypsometrically (500 and 1100 m a.s.l.). The leafroller ***Pandemis cerasana*** is a polyphagous species on deciduous trees and shrubs and fruit trees (Razowski 2002a). Less often (Patočka 1960) or rarely (Patočka & Kulfan 2009) it occurs on conifers. Among conifers, Razowski (2001) listed *Larix* and *Pinus*, with a postscript "and more". According to Reiprich (2001), the main host plant is *Ribes*, but the development on *P. abies* and *A. alba* is possible. Escherich's (1931) information concerning trophic relationship to spruce is supported by the publication by Kulfan (1994), who found the species on the Norway spruce. ***Pandemis cinnamomeana*** represents a widely polyphagous species, which

probably preferred deciduous woody species historically (e.g. Wolff & Krause (1922) presented *Frangula alnus* Mill., *Prunus padus* L., *P. domestica* L., *Quercus* sp., *Sorbus* sp., *Betula* sp.) and together with the expansion of cultivated conifers, it probably gradually started to use these food sources for the development more frequently. Razowski (2001) firstly mentioned *Larix* spp., *A. alba* and other conifers (*Pinaceae*), and then the author listed also deciduous trees. Larvae were collected from branches of the Norway spruce at several localities in Western Carpathians (Kulfan 1994; Kulfan & Zach 2004; Kulfan et al. 2010). According to Reiprich (2001), the main host plants of ***Syndemis musculana*** are *Salix* spp., with possible development on *P. abies*. Razowski (2001) considered the species to be polyphagous on the leaves of *Rubus*, *Betula*, *Quercus*, *Picea* and *Pinus*. In the subsequent publication, Razowski (2002a) extended the list of host plants and characterized the larva as polyphagous on shrubs and trees, with observations of development on *Picea* and *Larix*. Larvae of this species were sporadically found on *P. abies* (Kulfan 1994; Kulfan & Zach 2011). ***Lozotaenia forsterana*** is a polyphagous species with *Vaccinium* as the main host plant, however its development on *P. abies* is possible (Razowski 2001, Reiprich 2001). The leafroller ***Aphelia viburnana*** is a polyphagous species on herbs and shrubs (Patočka & Kulfan 2009). Only during population outbreaks, groundfeed on fresh shoots of spruce branches can occur. Patočka (1960) presented the data of Escherich (1931) concerning harmful occurrence on pine and spruce and observation by Schütze (1931) from fir. Bogenchütz (1978) added the data on harmful occurrence on *P. abies* and other conifers from South Norway and Southeast Germany. Alongside numerous herbs and shrubs, Razowski (2002a) presented also *A. alba* and *P. sylvestris*, but not *P. abies*. Also the leafroller ***Aphelia paleana*** is a polyphagous species on herbs and shrubs (Patočka & Kulfan 2009). According to Reiprich (2001), the main host plant is *Vaccinium* spp. Razowski (2002a) presented a variety of other plants, e.g. *Anemone*, *Carduus*, *Cirsium*, *Plantago*, *Ranunculus*, and *Quercus*. According to Razowski (2002a), the species is sometimes harmful on the grass *Phleum pratense* (L.). Reiprich (2001) adopted the data concerning the development on *P. abies* from Bradley et al. (1973a), who presented occasional occurrence on *P. sitchensis* in Scotland. The main host plant of ***Dichelia histrionana*** is *P. abies* (Patočka & Kulfan 2009) and during feeding, also 12 – 30 years old annual shoots can be damaged and as a consequence of repeated damages, atrophies occur (Schütze 1931, Kudela 1970). ***Clepsis senecionana*** is a polyphagous species on *Myrica*, *V. myrtillus*, *Lotus*, *Onobrychis*, *Polygonatum*, *Potentilla*, *Convallaria*, but also *Picea*, *Pinus*, *Larix* and more (Razowski 2001). Reiprich (2001) adopted data concerning the development on spruce from Bradley et al. (1973a), who presented findings on *Picea* sp. in Scotland.

The leafroller ***Capricornia boisduvaliana*** represents a rare species in the whole Europe. Its occurrence in Czechia has not been documented so far, but it can not be excluded, with respect to its presence in Slovakia and Poland. *P. abies* is presented as the only one known host plant for this species (cf. Razowski 2002b). ***Celypha lacunana*** is a widely polyphagous species on herbs – *Mentha*, *Artemisia*, *Inula*, *Chrysanthemum*, *Ranunculus*, *Fragaria*, *Urtica*, shrubs – *Rubus*, *Ligustrum* and trees – *Salix*, *Betula*, *Larix* etc. (Razowski 2001), Razowski (2002b) presented also *Abies*, but not spruce. Reiprich (2001) adopted the reference concerning the development on spruce from Bradley et al. (1973b), who presented occurrence on *P. sitchensis*. The leafrollers ***Cymolomia hartigiana*** and ***Pseudohermenias abietana*** are dependent on *A. alba* and *P. abies* (Patočka & Kulfan 2009), however these species usually do not cause damage to stands (Schröder 1978). According to Razowski (2002b), larval development of the species ***Piniphila bifasciana*** proceeds on generative organs and shoots of young *P. sylvestris*. Liška & Modlinger (2007) found this species in Malaise trap localized in a mountain spruce forest in the Šumava Mts. With respect to the absence of pine in surrounding areas they suppose that also *P. abies* can serve as a host plant. ***Epinotia tedella*** is an important pest of spruce stands, the ground feeding is known to occur in all age classes (Führer 1978), however the species prefers younger age degrees, in the stage of stake forest (Wolff & Krause 1922). Mass damages occur mainly outside the area of natural occurrence of *P. abies* among 200 – 800 m a.s.l. (Führer 1978). The main host plant of the leafroller ***Epinotia fraternana*** is *A. alba* (Patočka & Kulfan 2009). After Razowski (2002b), the species is able to develop ocassionally also on *P. abies*. Wolff & Krause (1922) also presented the species to be mining inside spruce needles. The linkage to *P. abies* was also confirmed by catching two adults of this species by Liška and Modlinger (2007) in Malaise trap localized in a mountain spruce forest in the Šumava Mts. ***Epinotia granitana*** is considered to be a narrow specialist in *P. abies*, Razowski (2002b) presented its development probably inside needles (however the form of the ground feed was not documented, the larva probably mines). The main host plants of the leafroller ***Epinotia rubiginosana*** are *Pinus* spp. (Patočka & Kulfan 2009), the development on spruce is possible (Razowski 2001, 2002b). ***Epinotia nanana*** is linked to *P. abies*, it attacks mainly younger to 15 years old spruces on warm and sunny habitats (Kudela 1970). The species is more important in horticulture, where huge damages are often observed (Führer 1978). ***Epinotia pygmaeana*** is a pest of forest stands at the age of 30 – 70 years, where ground feeds repeated for several years visibly damage firstly the upper part of the tree-top, later also single branches in lower parts (Wolff & Krause 1922). It preferrably attacks the sturdiest trees in the stand, the overall appearance resembles the ground feed of sawflies (Kolubajiv 1947). The main host plant of the leafroller ***Epinotia subsequana*** is *A. alba* (Patočka & Kulfan 2009), however the development is also possible on the needles of *P. abies* (Wolff & Krause 1922; Razowski 2001, 2002b). Ground feed of ***Zeiraphera ratzeburgiana*** proceeds on fresh shoots of *P. abies* (Wolff & Krause 1922; Schütze 1931; Patočka 1951) at the age of 20–50 years (Kudela 1970). Until the year 1950 the species was considered to be only minutely harmful, later it started to collectively reproduce in monocultures of *P. sitchensis* in Schleswitz-Holstein, also on young spruce cones in Norway and in the district of Leningrad (Bovey 1978). The host plant of ***Zeiraphera rufimitrana*** is *A. alba*, occasionally also *P. abies* (Razowski 2002b). The leafroller ***Zeiraphera griseana*** is an important pest. In high mountains it

occurs on *L. decidua* and *Pinus cembra* (L.), in Central European mountains, a nutritive form dependent on *P. abies* (in North Europe also on *P. sylvestris* (Wolff & Krause 1922)) occurs. The species attacks only the needles on annual shoots. The importance of the *Z. griseana* intensely increased together with anthropogenic influence on forests as the pollution load (Kalina & Skuhravý 1985). Host plants of the leafroller ***Barbara herrichiana*** are various species of *Abies* (Patočka 1951, Kudela 1970, Razowski 2001, Reiprich 2001, Razowski 2002b). From *P. abies*, the species was mentioned by Wolff & Krause (1922), Patočka (1951), and Reiprich (2001). Until recently, the occurrence of the leafroller ***Gravitarmata margarotana*** in Czechia was known only from Moravia (Laštůvka 1998). Recently it was confirmed for Bohemia (Laštůvka & Liška 2011). The species develops on *P. sylvestris* (Patočka & Kulfan 2009). In fact, the data from *P. abies* (Wolff & Krause 1922) concern the fir species *Barbara herrichiana* Obraztsov, 1960. Recent indication concerning trophic relationship to *P. abies* was given by Razowski (2001). In the following publication, the author (Razowski 2002b) indicated spruce, however with a question mark. The leafroller ***Rhyacionia pinivorana*** develops in shoots of *P. sylvestris* (Razowski 2002b). Reiprich's (2001) statement concerning the development on *P. abies* insisted on the prodromus of Hrubý (1964), who adopted the detail from Hering (1932), concerning the ground feed in buds and lateral branches of *P. sylvestris* and *P. abies*. Patočka (1951) mentioned *P. abies* with a question mark and in the last paper, Patočka & Kulfan (2009) mentioned only *P. sylvestris*. Razowski (2002b) did not stated *P. abies*, howewer he declared the data from *A. alba* to be erroneous. Larva of the leafroller ***Cydia pactolana*** develops in the phloem of 8–25 years old *P. abies*, which consequently have not height growth (Wolff & Krause 1922). A variety of population outbreaks are known from South Germany, mainly with consequential under-bark pests (especially the bark beetle *P. chalcographus* and weevils from the genus *Magdalis*) (Postner 1978). Larval development of the leafroller ***Cydia grunertiana*** is described by Razowski (2002b) to occur under the bark of *L. decidua*. Also Postner (1978) reported it from that species, however as an so called aberration of the taxon *C. pactolana*. Reiprich (2001) reported this species from *A. alba* and *P. abies*. These data were adopted from the prodromus of Hrubý (1964), who however considered *C. grunertiana* to be a synonym of *C. pactolana*, so the data concerning development on *A. alba* (Nickerl & Nickerl 1906) and *P. abies* (Hering 1932) probably concern this species. Larval ground feed of ***Cydia duplicana*** occurs in the phloem of *P. abies* or other conifers (Patočka 1951; Razowski 2002b). The larvae of ***Cydia cosmophorana*** are found at points neglected after ground feed of the leafroller *Retinia resinella* (Wolff & Krause 1922, Razowski 2002b) or the pyralid *Dioryctria abietella* (Razowski 2001, 2002b). Host woody species are those, on which damages caused by the above mentioned species occur, i.e. *P. sylvestris* and *P. abies* (Razowski 2001). ***Cydia indivisa*** is an uncommon species of unclear bionomics, Liška & Modlinger (2007) recorded it in Malaise trap localized in a mountain spruce forest in the Šumava Mts. The authors incline to the statement of Krampl (cf. Šumpich 2006), stating that also *P. abies* is a possible host plant. Even Reiprich (2001) report the species as monophagous on spruce. After Razowski (2001), the species is dependent on *A. alba* only. Subsequently Razowski (2002b) reported its occurrence from pine forests of South Tyrol. Hacker & Müller (2006) took these data into account and reported *Pinus*, *A. alba* and *P. abies*. The leafroller ***Cydia coniferana*** develops in so-called cancerous tumors (Patočka 1951) or in shoots (Razowski 2002b) of *A. alba* and *Pinus* spp. Reiprich (2001) mentioned the development on *P. abies* after Hrubý (1964), who referred to the publications by Hering (1932) and Nickerl & Nickerl (1906). Following the older work of Nickerl & Nickerl (1906), the larva is being found under resinous bark of *P. abies* and *A. alba*. Hering (1932) reported *P. sylvestris* and *P. abies* with the occurrence of cancerous tumors. Both these woody species were mentioned also by Hacker & Müller (2006). The development of *C. coniferana* on spruce was cited mainly in older publications; to rank it among species with trophic relationship to this conifer, it would be desirable to document larval occurrence in the recent period. In the first phase, the larva of ***Cydia illutana*** develops in galls neglected by *Sacchiphantes viridis* and lastly in green cones of *P. abies* (Wolff & Krause 1922). Wolff & Krause (1922), Schütze (1931), Patočka (1951) and Reiprich (2001) reported *P. abies*. Razowski (2002b) distinguished two subspecies, European ssp. *illutana*, whose main host plant is *L. decidua* subsp. *polonica* (Racib.) Dom., the occurrence on *A. alba*, *P. abies* and *Pseudotsuga* spp. is dependent on the galls of aphids from the genus *Sacchiphantes*. *C. illutana* ssp. *dahuricolana* is a pest of *Abies* spp. and *Picea* spp. and occurs in Siberia. ***Cydia strobilella*** is the most important pest of spruce cones, recent damages of the harvest of spruce cones was reported e.g. by Modlinger et al. (2015) from Czechia. The main ground feed of the larvae of ***Pammene ochsenheimeriana*** was reported by Razowski (2002b) in the buds of *Abies* and *Picea*. The author also pointed out the data of Kuznetzov, who reported the larval occurrence under fir bark and in the buds of aphids from the genus *Sacchiphantes*.

Sesiidae

Concerning the family of the clearwing moths (Sesiidae), Wolff & Krause (1922) reported development of the clearwing moth ***Synanthedon cephiformis*** in *P. abies*, *A. alba* and *L. decidua* (by specimens attacked by the fungus *Aecidium elatinum* = *Melampsorella caryophyllacearum*). Also Reiprich (2001) adopted the data concerning the development on spruce and fir. Wolff & Krause (1922) reported further occurrence of this species on *P. sylvestris* attacked by the fungi *Gymnospermium* sp. or *Peridermium pini*. Schwarz (1953) reported mainly or only *A. alba*, whereas other woody species presented in literature were questioned by this author. Laštůvka & Laštůvka (2001) published data concerning the development in the tumors caused by the rust *Melampsorella caryophyllacearum* (DC.) and besides *A. alba* the authors reported also *Abies cephalonica* Loud. and *Abies borisii-regis* Mattf.

Pyralidae

In the family of the pyralid moths (Pyralidae), certainly the most important species is ***Dioryctria abietella***, which develops in the top shoots of mainly young (5 – 20 years old) *P. abies* (Matschek 1978), significant damages occur also on the crop of spruce seeds (Kudela 1970; Modlinger et al. 2015). In the past, the species ***Dioryctria simplicella*** was considered to be only a biological race by some authors (Wolff & Krause 1922). According to current knowledge this is a separate species, however information on its bionomics are considerably limited (Slamka 1995). After Reiprich (2001), the main host plant is *P. sylvestris* and the author supposed also the development to occur on *P. abies* and *A. alba* – those data were based on the characteristics of the species *D. mutatella* by Patočka in the work of Reiprich & Okáli (1989). In later publications, Patočka & Turčáni (2005) and Patočka & Kulfan (2009) reported the larva to live endophagously in the buds, shoots and cambium of the terminal tree-top parts of *Pinus* spp. Larval feeding of ***Dioryctria schuetzeella*** occurs on budding spruce shoots (Wolff & Krause 1922; Matschek 1978), which are being nibbled from outside by the larva (Wolff & Krause 1922); the development occurs mainly on *P. abies*, less frequently on fir. The main host plants of ***Dioryctria sylvestrella*** are *Pinus* spp. (Patočka 1951, Matschek 1978, Slamka 1995, Patočka & Turčáni 2005, Patočka & Kulfan 2009). A harmful occurrence on *P. abies* was reported by Wolff & Krause (1922) and Matschek (1978), howewer a confusion for another species of *Dioryctria* cannot be excluded. The pyralid moth ***Assara terebrella*** develops in the basal parts of spruce cones (Čermák 1952, Křístek et al. 1992). The crambid moth ***Eudonia sudetica*** is a rare species, presented by Hacker & Müller (2006) as a typical member of mountain spruce forest. Larva develops on mosses (Bryophyta) growing on tree trunks (Slamka 1995, Novák & Severa 2002, Hacker & Müller 2006). Reiprich (2001) also considered the development on mosses as the main strategy, however he reported also *P. abies* as another host plant (however, as a base of that statement he added only his „mark“, which could mean that it was his own observation, but there is also a possibility of a mistake in printing). Nevertheless it is apparent that the classification of *E. sudetica* among spruce-bound species is incorrect.

Crambidae

The species ***Loxostege sticticalis*** from the family Crambidae is a known agricultural pest, which attacks mainly *Beta vulgaris* (Slamka 1995, Novák & Severa 2002), *Trifolium* spp. and *Nicotiana* spp.; it can develop also on various shrubs and trees (Slamka 1995). During population outbreaks it migrates, even high in mountains (Novák & Severa 2002). Based on Miller (1956), who reported the species to be considerably polyphagous (it can develop on plants belonging to 35 families), Reiprich (2001) published also *P. abies* and *A. alba* as possible host plants. Miller (1956) exactly stated that, besides all fruit tree species, the species is also able to develop on numerous conifers, except *Pinus nigra* Arnold.

Lasiocampidae

Within the family of the lappet moths (Lasiocampidae), the species ***Lasiocampa quercus*** is a polyphagous defoliator of *Prunus*, *Quercus* and *Salix*, but also many more tree and shrub species (Exler 1898). Patočka & Kulfan (2009) classified it among polyphagous species on low growing trees, shrubs and subshrubs. An extensive account of host plants was published by Macek et al. (2007). Data concerning the feeding on conifers appeared in a publication by German entomologists. Those data were summarized by Schwenke (1978a) and the author supposed the feeding to occur on *P. sylvestris*, *P. abies*, *A. alba* and *L. decidua*. However, this is a typical episodical occurrence during population outbreaks. The main host plant of the lappet moth ***Dendrolimus pini*** is *P. sylvestris* (Reiprich 2001); according to Wellenstein (1978), the only species of conifers that are not fed by the larva are *Taxus baccata* (L.) and *Juniperus* spp. Outbreaks are common mainly in the northern part of Central Europe, namely in pine overgrowths on sandy soils. Only several older outbreaks are known from our territory (Švestka et al. 1998). The development of ***Cosmotriche lobulina*** occurs on *P. sylvestris* at lower altitudes, and on *P. abies* at higher altitudes (Macek et al. 2007).

Sphingidae

The species ***Sphinx pinastri*** from the family of the hawk moths (Sphingidae) is commonly distributed throughout coniferous forests, the most commonly in lowland pine woods, but also at higher altitudes (Fajčík 2003). More massive occurrence is known from Poland where the species outbreaks on *P. sylvestris* (Skatulla 1978).

Geometridae

Within the family of the geometrid moths (Geometridae) there are numerous species dependent on *P. abies*. The larva of ***Macaria signaria*** feeds on older needles (Kudler 1978), mainly of *P. abies* (Joukl 1910; Patočka & Kulfan 2009). The feeding of ***Macaria liturata*** occurs on older needles, mainly of *P. sylvestris* (Kudler 1978), less frequently also *P. abies* (Joukl 1910, Kudler (1978). ***Odontoptera bidentata*** develops on various woody species, mainly deciduous, less frequently coniferous (Buszko 2000). The main host plants are *Populus*, *Prunus spinosa* (L.), *Quercus* and *Alnus* (Exler 1898; Joukl 1910; Buszko 2000) or *Salix caprea* (L.) (Buszko 2000). The most often reported coniferous host plant is *Abies* (Patočka 1960; Kudler 1978; Buszko 2000; Reiprich 2001), *P. abies* was mentioned by Buszko (2000) and Reiprich (2001). The larvae of *O. bidentata* were often found on the Norway spruce in various forest stands (Kulfan 1994; Kulfan & Šušlík 1998). Hatcher & Winter (1990) and Hatcher (1991) presented records from *P. abies* from Great Britain. ***Peribatodes secundarius*** is a species polyphagous on conifers, the development on *P. abies* occurs very frequently (Joukl 1910; Kudler 1978; Reiprich 2001; Fajčík 2003). ***Deileptenia ribeata*** is a polyphagous moth on woody species, mainly coniferous (*P. abies*, *A. alba*) (Joukl 1910; Kudler 1978; Patočka 1960; Reiprich 2001; Hacker & Müller 2006), but also deciduous (*Fagus*, *Quercus*) (Patočka 1960; Buszko

2000, Patočka & Kulfan 2009). ***Alcis repandata*** is a widely polyphagous species developing on both coniferous and deciduous trees (Patočka 1960; Novák & Severa 2002, Patočka & Turčáni 2005), sometimes also on herbs (Kudler 1978; Fajčík 2003). Reiprich (2001) adopted the data concerning its development on *P. abies* from Koch (1988). Larvae of *A. repandata* were collected from branches of the Norway spruce several times (Kulfan 1995; Kulfan et al. 2010). Kulfan (1995) found more larvae of this species in autumn in comparison with spring. The author supposed that the larvae can leave spruce branches and complete their development on other host plants after overwintering. The Norway spruce as the host plant of *A. repandata* is known also from Great Britain (Hatcher & Winter 1990; Hatcher 1991). Larva of ***Alcis bastelbergeri*** is polyphagous and prefers lower forest plants, such as *Rubus* spp. (Patočka & Turčáni 2005). Buszko (2000) reported *V. myrtillus*, *Calluna vulgaris* (L.) and *Betula* spp., but also conifers (Buszko 2000, Fajčík 2003). Reiprich (2001) adopted the data concerning the development on *P. abies* from Hrubý (1964), who considered *A. bastelbergeri* to be a biological race and referred the taxon to be polyphagous, with a reference to Hering (1932). ***Alcis jubata*** develops on tree lichens (Lichenes), e.g. *Usnea barbata* (L.) Weber (Buszko 2000; Fajčík 2003). Reiprich (2001) also considered lichens to be main host plants, but the author accented the specification of Koch (1988), saying that the development occurs on beard lichens growing on *P. abies* and *A. alba*. ***Hypomecis punctinalis*** feeds on leaves and needles of woody species, but mainly on *Quercus* spp. (Kudler 1978; Fajčík 2003; Patočka & Kulfan 2009). Only sporadically it develops on conifers (Buszko 2000). Patočka & Turčáni (2005) reported only deciduous trees as the host species. Reiprich (2001) published *Populus* spp. as the main host plant, and the information on possible development on *P. abies* was adopted from Koch (1988). In any case it is essential to consider the development on spruce as largely uncommon. ***Ectropis crepuscularia*** is a polyphagous species on woody species and herbs (Fajčík 2003, Hacker & Müller 2006), preferring ground forest herbaceous vegetation (Patočka & Turčáni 2005). Rarely it feeds on conifers (Buszko 2000). Hacker & Müller (2006) directly mentioned *P. sylvestris* and *P. abies*. Reiprich (2001) mentioned the development on *A. alba* and *P. abies*, the data concerning the development on spruce were adopted from Koch (1988). The larvae of this species were collected from the Norway spruce several times (Kulfan 1995; Kulfan & Zach 1995). ***Paradarisa consonaria*** is a polyphagous species on deciduous woody species (Buszko 2000; Hacker & Müller 2006), but also on coniferous species (Fajčík 2003). Patočka & Turčáni (2005) directly mentioned *Abies* and *Picea*. The main host woody plant of ***Bupalus piniarius*** is *P. sylvestris*, rarely it occurs on other conifers (Novák & Severa 2002; Fajčík 2003). Nevertheless, Kudler (1978) contradicted the occurrence on conifers others than *P. sylvestris.* However, this species was also caught in a large spruce complex on Trojmezná, which supports also the trophic relationship to spruce (Šumpich et al 2012), moreover *B. piniarius* was observed by Liška in various spruce overgrowths repeatedly. By the species ***Hylaea fasciaria,*** so-called form *prasinaria* (Joukl 1910), which occurs at higher altitudes and has only one generation a year, is dependent on spruce (Patočka 1960). A harmful influence of this form was not published. ***Pungeleria capreolaria*** is linked mainly to *A. alba* (Patočka 1960), but also *Picea* (Joukl 1910; Reiprich 2001; Fajčík 2003; Patočka & Turčáni 2005). ***Thera firmata*** is a monophagous species on *P. sylvestris* (Patočka 1951; Kudler 1978; Buszko 2000; Fajčík 2003; Patočka & Kulfan 2009). Reiprich (2001) adopted the data concerning the development on *P. abies* from Bergmann (1955), who however published only a possibility of laboratory breeding on *P. abies*. ***Thera obeliscata*** feeds mainly on the needles of *Pinus* spp. (Patočka 1951; Kudler 1978; Reiprich 2001; Fajčík 2003), but also *P. abies* (Kudler 1978; Reiprich 2001; Buszko 2000). *T. obeliscata* was recorded on *P. abies* in Great Britain (Hatcher & Winter 1990; Hatcher 1991). The main host plant of ***Thera variata*** is *P. abies* (Joukl 1910; Kudler 1978; Reiprich 2001) and often it occurs also on *A. alba* (Kudler 1978; Reiprich 2001). Most authors consider the geometrid moth ***Thera britannica*** to be monophagous on *A. alba* (Buszko 2000, Novák & Severa 2002; Fajčík 2003; Patočka & Turčáni 2005). Reiprich (2001) reported the development on *P. abies*, according to the publication by Krampl & Novák (1979), where occasional oviposition on spruce was mentioned. *T. britannica* was generally recorded on the Norway spruce from Great Britain (Hatcher & Winter 1990; Hatcher 1991). For the species ***Thera vetustata***, Patočka (1951) published a relationship only to *Abies* spp., concersely Buszko (2000) and Hacker & Müller (2006) reported only *P. abies*, both species were mentioned by Reiprich (2001), Fajčík (2003) and Patočka & Turčáni (2005), however Patočka & Kulfan (2009) reported *P. abies* with a question mark. Kudler (1978) published young individuals of *Picea* as the host plant of ***Thera juniperata***. However the species is a narrow specialist on *Juniperus communis* (L.) (Buszko 2000; Fajčík 2003; Patočka & Turčáni 2005; Hacker & Müller 2006), eventually Cupressaceae (Patočka & Kulfan 2009). ***Epirrita autumnata*** is a polyphagous species on trees and shrubs. Buszko (2000) reported only deciduous woody species as host plants. *P. abies* was mentioned by Reiprich (2001) and Fajčík (2003), Patočka (1960) published *A. alba* and *P. abies*. Kulfan & Zach (2005) collected its larva on the Norway spruce. The larva of ***Mesotype verberata*** is polyphagous (Buszko 2000; Novák & Severa 2002, Mironov 2003) on herbs (Fajčík 2003; Hacker & Müller 2006). Mironov (2003) published observations from *Abies*, *Vaccinium* and *Picea*. ***Eupithecia abietaria*** is a specialist in spruce cones (Čermák 1952; Křístek et al. 1992). Damages done by this geometrid are fairly extensive, however mostly overlooked (Kudela 1970). Patočka (1960) reported very rarely also the cones of *A. alba*. According to Wolff & Krause (1922), the geometrid ***Eupithecia analoga*** lives in galls after the gall aphids from the genus *Chermes*, rarely also in fir cones. Fajčík (2003) reported also the galls of gall aphids *Sacchipantes viridis* and *Adelges laricis* on *P. abies*. According to Kudela (1970), the larvae cause damages in cones, which in strong occupancy are conspicuous by bundles of faeces, which fringe nearly each scale. Mironov (2003) considered the larva to be monophagous, being found inside galls of gall aphids (Adelgidae) on spruce, and contradicted the data of forest protection entomologists, concerning exclusive larval feeding in

spruce cones. An occasional occurrence of the species ***Eupithecia lariciata*** on spruce was reported by Hatcher & Winter (1990) from the British Isles, Mironov (2003) also mentioned the occurrence on spruce from the area of Great Britain. ***Eupithecia tantillaria*** feeds on needles of *P. abies* (Joukl 1910, Kudler 1978, Reiprich 2001), but also other conifers (Mironov 2003). The larva of ***Eupithecia lanceata*** lives on young shoots of *P. abies* (Joukl 1910), sometimes also on female inflorescence (Mironov 2003) and rarely it attacks these parts also on other conifers (Mironov 2003, Patočka & Turčáni 2005). After Mironov (2003), the larva of ***Eupithecia indigata*** is oligophagous and prefers *P. sylvestris* (Fajčík 2003). Mironov (2003) and Fajčík (2003) considered the occurrence on *L. decidua* and *P. abies* as infrequent. ***Eupithecia conterminata*** is a species dependent on the range of natural occurrence of spruce, very rare in Central Europe except Alps. From Czechia, only a single occurrence in North Bohemia is known, which is of older date indeed. One of a few species, for which a strict monophagy on spruce is referred to in the literature (Mironov 2003).

Erebidae

In the family Erebidae, the Rusty Tussock Moth ***Orgyia antiqua*** is a remarkable polyphagous species on trees, shrubs and subshrubs. It attacks forest overgrowths or solitary trees of all host plant species, especially older individuals. Among conifers, the most frequently attacked species is *P. abies*, followed by European and Japanese Larch, overgrowths of *P. sylvestris* are being attacked only rarely (Wellenstein 1978). The larvae often completely feed undergrowth firstly (e.g. *V. myrtillus*) and only then the forest overgrowth. However, in older spruce overgrowths, a reverse action was also observed (Wellenstein 1978). The lymantriid moth ***Gynaephora selenitica*** sometimes occurs in higher numbers outside its host plants from the legume family (Fabaceae) on various broad-leaved trees and conifers. Total defoliation can occur on young *Larix* and annual shoots of three- and four-year *Pinus* (Wolff & Krause 1922). Macek et al. (2007) directly published also *P. abies*. However, the occurrence of this species in Czechia was known only till 1920 (Laštůvka & Liška 2011), nowadays it is considered to be missing or extinct. The lymantriid moth ***Calliteara abietis*** lives freely on the needles of *P. abies* and *A. alba* (Wolff & Krause 1922) and occurs not very often, mainly at higher altitudes. The lymantriid moth ***Lymantria monacha*** belongs among the most serious pests of our spruce and pine woods (Kudler 1954). In the 20th century, harmful population outbreaks occurred on an area of more than 0,5 mil. ha (Liška et al. 1991). It is broadly polyphagous species, its larvae can consume all species of our conifers and the majority of broad-leaved trees (Švestka 1999). The lymantriid moth ***Lymantria dispar*** is also broadly polyphagous species, known mainly as a defoliator of *Quercus* spp. It was observed on 270 plant species in Romania, on 300 plant species in Russia, even in the USA (where it is a non-indigenous species) on 450 plant species (Wellenstein 1978). It prefers broad-leaved woody species, however, during population outbreaks, it feeds also on coniferous trees (Novák & Severa 2002; Fajčík 2003). Its feeding on *P. sylvestris* is more often; from *Picea* sp. it was published by Wellenstein (1978) only from the Serbian spruce (*Picea omorica* (Pančić) Purkyně). Among conifers, Reiprich (2001) listed *A. alba* and *P. abies*. The author adopted the data concerning the development on spruce from Bergmann (1953), who recorded an unusual observation by Kuntz. Also the record concerning possible development on *P. abies* in the recent publication by Macek et al. (2007) came from Bergmann. However this is a typically episodic occurrence. Kulfan (1994) confirmed an episodic occurrence of a young larva on young shoot of the Norway spruce at an altitude of about 1300 m. The larva was successfully reared on young needles until last instar.

The footman ***Atolmis rubricollis*** develops on lichens, fungi (Fungi) or algae (Algae) and prefers the lichens growing on conifers and broad-leaved trees (Hacker & Müller 2006). Fajčík (2003) reported it to consume also leaves and needles. Reiprich (2001) considered lichens to be host plants, for a possible development on *P. abies* he referred to the data of Koch (1988), who reported lichens on *P. abies* and deciduous trees though. ***Eilema depressum*** also develops on algae (Algae) and lichens (Lichenes) growing on conifers and broad-leaved trees (Fajčík 2003; Hacker & Müller 2006). According to Fajčík (2003) it consumes also needles and leaves. In the case of the development on *P. abies*, Reiprich (2001) refers to Hrubý (1964), however that author reported lichenes from the genus *Parmelia* and *Hagenia* growing on trunks of *P. abies*. The larvae of related species ***Eilema complanum*** were found on spruce by Kulfan et al. (2010), the development of this taxon is also dependent on tree lichens (Hacker & Müller 2006), growing mainly on deciduous trees (Patočka & Kulfan 2009). ***Lithosia quadra*** develops on lichens (Lichenes) growing on woody species, during population outbreaks it feeds on leaves and needles of woody species or even on other larvae (Fajčík 2003). Reiprich (2001) referred to oak (*Quercus*) as the main host plant, data concerning the development on *P. abies* were adopted by this author from Hrubý (1964), however that author published the development on tree lichens.

Noctuidae

Only a small part of species-rich family of the owlet moths (Noctuidae) develops (or rather is able to develop) on spruce. One of few "coniferous" specialists is the species ***Panthea coenobita*****,** living loosely on the needles of *A. alba* and *P. abies* (Wolff & Krause 1922). It occurs nearly in all spruce overgrowths, but mainly at higher altitudes, however it is common nowhere (Kudela 1970). One larva of ***Autographa gamma*** was found on a Norway spruce branch (Kulfan & Šušlík 1998) and reared on spruce sprouts into adult. The owlet moth ***Conistra vaccinii*** feeds first on various deciduous woody species, later on herbs in the undergrowth (Fajčík 1998). In an extensive list of woody species and shrubs, Kurir (1978) did not mention any coniferous species. Reiprich (2001) referred to *Quercus* spp. as the main host plants. He adopted the data concerning the development on spruce from Kulfan (1994), who used to find larvae in spruce tops. The owlet moth ***Lacanobia suasa*** is a polyphagous species on various herbs (Fajčík 1998, Hacker & Müller 2006, Patočka & Kulfan 2009). Kurir (1978) mentioned *P. abies* and some

other woody species, however those data concerned the feeding on seedlings in forest nurseries. ***Ceramica pisi*** is a polyphagous species occurring on fields on *Trifolium* spp., *Pisum* spp. and *Linum* spp. (Novák & Severa 2002) or on herbs and low-growing woody species (Fajčík 1998). Kurir (1978) reported the feeding on annual or biennal seedlings of *Pinus* spp., *Picea* spp., *Larix* spp., *Quercus* spp., *Populus* spp. and *Robinia* sp. Also Reiprich (2001), who considered pea to be the main host plant, published that species from *P. abies*. Hacker & Müller (2006) classified *C. pisi* among oligophagous species on herbs and grasses, preferring herbs. ***Orthosia gothica*** develops on deciduous woody species and on herbs, occasionally also on conifers (Fajčík 1998); however, *P. abies* is not directly reported. Kurir (1978) counted numerous deciduous species, but no conifers. After Hacker & Müller (2006) it prefers *Quercus* spp., *Tilia* spp., *Populus* spp., *Ulmus* spp., *Prunus* spp. Reiprich (2001) reported *Quercus* spp. as the main host plant, the data concerning the development on *P. abies* were adopted from Kulfan (1994). Larvae of *O. gothica* were frequently found on spruce in various forest stands (Kulfan 1994; Kulfan & Zach 1995, 2004, 2005; Kulfan et al. 2010). The main host plant of the moth ***Panolis flammea*** is *Pinus* (Exler 1898; Wolff & Krause 1922, Kudela 1970, Fajčík 1998, Reiprich 2001), but also other conifers (Wolff & Krause 1922), however rarely (Fajčík 1998). *P. abies* was mentioned by Schwenke (1978b) and Reiprich (2001), who adopted indigenous data of Hrubý (1964). ***Euxoa nigricans*** consumes roots and ground leaves of herbs and grasses (Fajčík 1998). Damages on *Picea* spp. and *Pinus* spp. in the forest nurseries and cultures were reported by Kurir (1978). ***Agrotis vestigialis*** is a pest in forest nurseries (Kudela 1970). Besides *Pinus sylvestris* and *Picea abies*, Kurir (1978) mentioned all deciduous species and low herbs, which was also confirmed by Fajčík (1998), however this author considered grasses (Poaceae) as the main host plants. ***Agrotis segetum*** is a widely polyphagous species and one of the most serious mass agricultural pests (Novák & Severa 2002). The development on roots and leaves of various herbs and grasses and also on seedlings of woody species was mentioned by Fajčík (1998). Kurir (1978) and Reiprich (2001) published the data concerning the development on *P. abies*. ***Xestia sincera*** is very rare species across Central Europe; findings of this species strongly decrease recently and it is considered to be missing or extinct in many regions (e.g. Hacker & Müller 2006). In Czechia it is known to occur only on the peat habitats of the Šumava Mts (Laštůvka & Liška 2011). Its host plant had not being known for a long time, nowadays *P. abies* is considered to be the only host plant (e.g. Hacker & Müller 2006; Macek et al. 2008).

5. Distribution and importance

The paper presented a comprehensive information which is applicable not only for the area of Czechia. Absolute majority of the taxa from the species level, listed in Table 2 and discussed in the text, occurs throughout the Central European region or in countries with a significant distribution of spruce in forest species composition (cf. Gaedike & Heinicke 1999; Buszko & Novacki 2000; SwissLepTeam 2010; Huemer 2013; Pastorális et al. 2013). For individual countries (Germany, Poland, Switzerland, Austria, Slovakia) it always makes up at least 90 – 95% from the total of 137 listed taxa, and by the species with a trophic relationship to spruce (67 taxa) the presence is almost complete (excluding the taxon *Capricornia boisduvaliana*).

For all species in Table 2, the data on their distribution in Czechia are given, based on long term authors´ experience. It is necessary to state that the abundances of particular species have remarkably changed in several last vegetation seasons. These changes are in broad contrast with previous experiences. Yet it is not possible to evaluate to what extent these changes are permanent or whether it is only a temporary trend. However, it is necessary to understand the data concerning the species distribution with respect to the above-mentioned facts.

6. Conclusion

In the conditions of Czechia, development on spruce was documented for 96 species from the order Lepidoptera, of which 67 species utilize spruce as an usual host plant, 23 species are polyphagous with possible development on spruce, 6 species belong to the soil species harmful to spruce roots, usually in forest nurseries. The fauna of Lepidoptera on spruce hereby represents less than 3% species known from Czechia. Among 55 species regularly developing on spruce, the trophic relationship is considered to be "close" in 33 taxa.

Regarding the fact that for many taxa (which also occur in Czechia), host plant is still not reliably known, and related species simultaneously live on conifers, their possible relationship to spruce can not be excluded. Also several Central European species with close relationship to spruce, which were not found in Czechia yet, are necessary to take into account. Hereby the presented list might further enrich in the future, together with increasing knowledge of the distribution and biology (bionomics) of this attractive insect group. However, it will undoubtedly be rather individual cases than tens of species.

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