

INTRODUCED AND INVASIVE INSECT SPECIES IN THE CZECH REPUBLIC AND THEIR ECONOMIC AND ECOLOGICAL IMPACT (INSECTA)

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Abstract

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A total of 383 alien insect species were registered in the Czech Republic, which represents 1.4% of local fauna. The most numerous taxonomic groups are Homoptera (116 species, 30.3%), Coleoptera (110; 28.7%) and Lepidoptera (37; 9.7%). The occurrence of 200 species (52.2%) are limited to closed heated spaces, casual aliens (28; 7.3%) infiltrate the outdoor environment for a short term only, 36 (9.4%) naturalized non-invasive species do not spread from the location of introduction, 50 (13.1%) species are post-invasive and 69 (18.0%) invasive. From the species registered, 61 (15.9%) are stored product pests (especially Coleoptera 36 species, Psocoptera 11, and Lepidoptera 9), 50 (13.1%) are plant pests indoors (especially Coccinea 33 species, Aphidinea 7, and Thysanoptera 6), 25 (i.e. 6.5% of aliens) are pests in agriculture, forestry, and in ornamental cultures, 15 species (3.9%) are important animal parasites, and 5 species (1.3%) can affect biodiversity. Of the remaining 227 species (59.3%), no economic or ecological effects were found. The origin of most of the species living eusynanthropically is in the tropics and subtropics; of the 155 naturalized (non-invasive, post-invasive, and invasive) species, 42 (27.1%) originate from the Mediterranean, 36 (23.2%) from North America, 28 (18.1%) from Central to Southwest Asia, 14 (9.0%) from East Asia, 13 (8.4%) from South and Southeast Asia, with the remaining 22 species (14.2%) coming from other areas.

alien insect species, Czech Republic, composition, origin, impact

The introduced and especially invasive insect species have substantial economic or ecological impact in many cases (cf. e.g. PIMENTEL, 2002; KOWARIK, 2003). Those species originating in warmer areas are harmful to greenhouse and house plants, and as storage and domestic pests. The species which can reproduce outdoors, especially those which can spread in their new location, are often harmful to ornamental plants, agricultural crops, and forest woods. Some of them infiltrate semi-natural and natural communities and can interfere in the existing interspecific relationships and in biodiversity. The start of the

introductions of non-native organisms can be dated back to the times of the origin and spread of the oldest human civilisations. For the Czech Republic, this means about 6500 years ago. Due to the sharp increase in travel and the transport of the most varied materials in the 20th century, the danger of undesirable species is growing dramatically. For this reason, the problem is of global and correspondingly local interest.

Most of the insect alien species are not documented until they reach a certain population density or until they cause the initial damage. If specific attention is not given to the actual control of imported materials

(cf. e.g. VERNER et al., 1965, 1975; STEJSKAL & KUČEROVÁ, 1993), especially particular individuals of alien species are not usually noticed or noted. For this reason, in the case of insects (as opposed to plants or vertebrates), individual and casual occurrences represent a very small portion of the total number of alien species (cf. PYŠEK et al., 2002; ŠEFROVÁ & LAŠTŮVKA, 2005). On the contrary, in insects a significant portion is comprised of species which occur only indoors eusynanthropically (a category of alien species that is not represented in plants and is of a very low number in vertebrates).

Most of the systematic groups of insects have been intensively studied for only 100–150 years; some taxa only since the 1950s. Historical occurrence data are therefore much shorter-term than that for plants or several species of vertebrates. In some instances it is not certain whether the newly discovered species was specifically alienated, spread spontaneously, or had simply not been noticed before (some Aphidinea, Auchenorrhyncha, some hymenopteran parasitoids, etc.). Only those whose alienation was specifically documented or have some degree of sufficient indices are here, therefore, considered species of alien origin. Similarly, in the case of eusynanthropic species, only species of proven alienation are included, or species not occurring outside of heated buildings. The high population density of some eusynanthropically-living insect species is not of itself proof of alien origin, but simply a reflection of optimal living conditions for a species that can survive in the outdoor environment.

For the above-mentioned reasons, most insect species that were spread before about 1850 and most cases of single non-recurring instances of introductions are missing from the statistics. This is also why the proportion of insect species of alien origin comprise only 1–2%, whereas vertebrates make up 10% or more, and plants 20–40% or even more of the total number of species (cf. GEITER et al., 2002; ESSL & RABITSCH, 2002; PYŠEK et al., 2002; WILLIAMSON, 2002; WHITE & HARRIS, 2002; ŠEFROVÁ & LAŠTŮVKA, 2005, etc.). The catalogue of animal species of alien origin in the Czech Republic was compiled by ŠEFROVÁ & LAŠTŮVKA (2005). This paper shows the results of analyses of alien and invasive insect species as they pertain to the economic impact of their activity (storage and plant pests).

METHODS AND TERMS

Wherever possible, terminology and categories for alien plant species were used (RICHARDSON et al., 2000; PYŠEK et al., 2002), in some cases with minor modifications in accordance with specific characters of animals. The term alien species refers to species that are non-native in a given territory and came here through either direct or indirect human intervention,

deliberately or unintentionally (for details see ŠEFROVÁ & LAŠTŮVKA, 2005). Species of alien origin do not include those which spread spontaneously (expansive species), such as *Colias erate* (Esper, 1805), *Phyllonorycter medicaginella* (Gerasimov, 1930), and *Diuraphis noxia* (Kurdjumov, 1913) from the East, or *Mythimna sicula* (Treitschke, 1835), and *Noctua interjecta* Hübner, 1803 from the West (BERÁNKOVÁ & NOVÁK, 1986; STIOVA, 1991; ŠEFROVÁ, 2002; STARÝ et al., 2003). Individual categories of alien species are conceived as follows (see Fig. 1):

- eusynanthropic species – species creating short-term or long-term populations only in heated spaces, with the ability to survive outside only during warm periods of the year, but not under winter conditions;
- casual alien species – species which create short-term outdoor populations after introduction, or escape; later they disappear or are liquidated;
- naturalized, non-invasive species – species creating a long-term population that spreads only in the location of introduction;
- naturalized, post-invasive species (cf. PYŠEK et al., 2002) – their spreading occurred in the past, but are now fully naturalized and the boundaries of their secondary area remain largely unchanging;
- naturalized invasive species – a sub-section of naturalized species that spread in various ways from their introductory location and create a more or less extensive secondary area.

RESULTS AND DISCUSSION

Overall evaluation of the analysis

In the Czech Republic, there are about 27 200 insect species known (own data), and so far 383 alien species have been documented, i.e. 1.4%. Of this, 200 (52.2%) are limited by their occurrence in only closed heated spaces and 53 of these evidently do not occur permanently; they are introduced only occasionally and disappear on their own or are immediately liquidated. Another 28 species (7.3%) occasionally create short-term populations in outdoor environments. The populations of these species are usually decimated by adverse weather conditions, surviving winter with difficulty or gradually disappearing for other reasons. There are 155 species (40.5%) that can be considered naturalized; they easily tolerate the local climatic conditions and their populations survive for decades. Of these species, 36 (9.4% of aliens) remain non-invasive, 50 (13.1%) species are post-invasive at present, and the final remaining 69 species (18.0%) can be considered invasive. The categories of aliens with the numbers of species are shown in Fig. 1 and their proportionality in Fig. 2A. The actual numbers of alien

species in individual insect orders are given in Tab. I, from which it is clear that there are noticeable differences resulting from food and other ecological demands, vagility, tendencies to passive spreading, etc. The largest proportion of species of alien origin is in Blattodea, Zygentoma, and Psocoptera, but the most numerous are Homoptera (especially Aphidinea and Coccinea), Coleoptera, and Lepidoptera (Fig. 2B). By contrast, no alien species were documented from the following orders: Microcoryphia, Ephemeroptera, Odonata, Plecoptera, Mantodea, Megaloptera, Raphidioptera, Neuroptera, Strepsiptera, Trichoptera, and Mecoptera.

The vast majority of alien species (317, 82.7%) were introduced unintentionally; only 19 species (5%), mostly of the order Hymenoptera (13) and partly of Coleoptera (3), Heteroptera (2) and Diptera (1), were introduced deliberately (for reasons of biological control). The remaining 47 species (12.3%) spread from their autochthonous area probably spontaneously when they followed the previously introduced host plant.

Origin of alien species

The vast majority of alien species occurring only eusynanthropically are naturally found in tropical and sub-tropical regions, and their origin is usually insufficiently known, if at all. Many of them were not discovered or documented until after they were introduced (cf. e.g. ZÁHRADNÍK, 1990). Of the 155 naturalized alien species (i.e. non-invasive, post-invasive, and invasive), most come from various parts of the Mediterranean (42, 27.1%). These species spread with the expansion of human civilisation, or followed later for various reasons. A comparable number of species originate in North America (36, 23.2%), which can be explained by its analogous climatic conditions and the frequent transport of materials between the two continents; this is also partly due to the impossibility of spontaneous spreading of most species of corresponding ecological demands (the geographical barrier is usually insurmountable without human intervention). Thirdly, there are the species from Central and Southwest Asia (28, 18.1%), whose spread is also connected with the expansion of human civilisation. Their lower number can be explained by the somewhat differing climatic conditions of this territory. Only 14 species (9.0%) come from Eastern Asia. This is a climatically similar region, but in contrast to North America, is not separated by an insurmountable geographical barrier. Many species could therefore spread spontaneously from Eastern Asia through a trans-Siberian route as far back as the Pleistocene or post-glacial periods so the number of potential invaders therefore decreased. Another 13 species (8.4%) come from South and Southeast Asia,

but as this is a significantly different climatic region, the species generally could not survive under central European conditions. The species that were introduced from this region are usually endo- or ectoparasites of vertebrates, and their existence is closely linked to their hosts, with which they can survive even in different climatic conditions. The remaining 22 species (14.2%) were introduced from other regions (the Alps, Western Europe, Northern Asia, Australia, Central America, and Africa), or their origin is unknown. The proportions of the above-mentioned categories is shown in Fig. 2C.

Economic impact

The consequences of alien species is primarily a result of their habitat and trophic bonds. The impact of alien insects is generally expressed in Fig. 2D, the taxonomic composition of important species (plant and storage pests) is given in Fig. 2E, F. Of the above-mentioned 200 species occurring in closed spaces, 50 (13.1% of aliens) act as indoor and greenhouse plant pests, and 61 (15.9%) are storage pests. The remaining 89 species (23.2%) in this category do not have great practical significance (permanently low abundance, only occasional occurrence, or trophic bonds to unimportant materials), but there are not a sharp border between simple occurrence and harmfulness. Of the greenhouse plant pests, Coccinea (33 species) are dominant, followed by Aphidinea (7 species), and Thysanoptera (6 species). In the case of storage-product pests, Coleoptera (36 species) are even more noticeably dominant, followed by Psocoptera (11 species), and Lepidoptera (9 species).

Of the alien species living under outdoor conditions, the species of casual occurrence and naturalized non-invasive species do not have great significance, because they are active only in the short-term or inhabit a very small territory. Depending on their food bonds and population dynamics, post-invasive and invasive species have various degrees of importance. These species can be pests to ornamental or cultivated plants or woods, possibly even acting as parasites to domestic and wild animals. The animal parasites belong to Phthiraptera, Diptera, and Siphonaptera (15 more important species). An overview of plant pests, including their origin and trophic bonds, is shown in Tab. II. From this table, it is evident that the largest proportion is made up of Aphidinea, Coccinea, and Coleoptera; one or two species belong to Aleyrodinea, Thysanoptera, Lepidoptera, Diptera, and Hymenoptera.

Effects on local biodiversity

The often discussed possible impact of alien species on local biodiversity is minimal in the case of insect species. Alien species existing eusynanthropi-

cally (i.e. more than half) have no effect on biodiversity; this is also true for species of casual occurrence and for naturalized non-invasive species. The last mentioned species either cannot find optimal conditions in the region, or for some other reasons do not spread from their location of introduction; therefore, they cannot be considered to be of impact to local biodiversity. At present, post-invasive species are fully naturalized, with a certain position in the communities; their impact on biodiversity today cannot be evaluated, although it would have been possible in the past, during the time of their invasion. Some possible impact on biodiversity can therefore be expected only from invasive species. Of these, 29 show a clear food bond to the plant host of alien origin; they do not transfer to autochthonous species or even influence them. Similarly, 14 of them are bound to urban environments or human-controlled communities of the cultural landscape. Although several invasive species, such as *Japananus hyalinus* (Osborn, 1900) (Auchenorrhyncha), *Lithocharis nigriceps* (Kraatz, 1859), *Oxytelus migrator* (Fauvel, 1904), *Philonthus rectangulus* (Sharp, 1874), several other Coleoptera, *Phyllonorycter issikii* (Kumata, 1963) (Lepidoptera), and some hymenopteran parasitoids can attack autochthonous species, they cannot be considered to have significant impact or act as competitors given their relatively low abundance. Over long-term or periodically high abundance periods, a mere 5 invasive species (i.e. 1.3% of species of alien origin and 7.2% of invasive species) can interfere with parasitoid trophic

chains, thereby affecting an abundance and diversity of autochthonous relatives. This involves *Eriosoma lanigerum* (Hausmann, 1802) (Aphidinea), *Quadraspidiotus perniciosus* (Comstock, 1881) (Coccinea), *Cameraria ohridella* Deschka & Dimić, 1986, *Phyllonorycter platani* (Staudinger, 1870), and *P. robiniella* (Clemens, 1859) (Lepidoptera).

Key conclusions

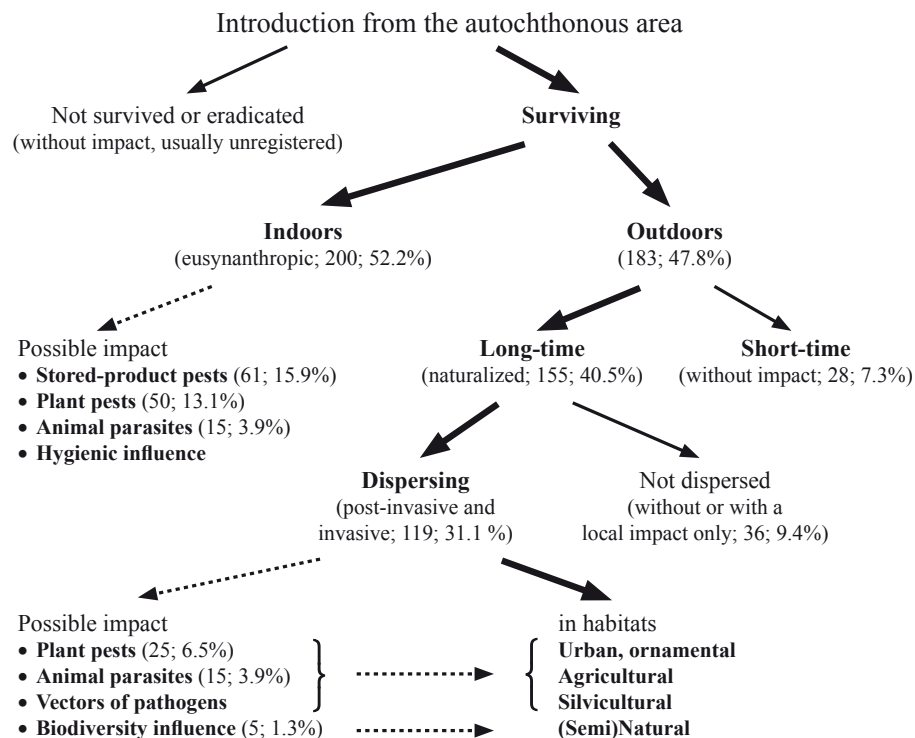
1. About 15% of insect species of alien origin act as pests to storage products, especially Coleoptera, Psocoptera, and Lepidoptera.
2. More than one-tenth of species of alien origin are pests to greenhouse and house plants, especially Coccinea, Aphidinea, and Thysanoptera.
3. About 6% of species (some invasive and post-invasive species) are pests to agricultural, forestry, and ornamental plants.
4. In contrast to alien vertebrates, the impact of alien insect species on local biodiversity is minimal and only possible in the case of about 5 species (i.e. less than 1.4%).
5. Nineteen species (5%) of alien origin have been repeatedly and intentionally introduced for the purpose of biological control (especially Hymenoptera).
6. More than a half of the species of alien origin have no negative impact (economic or ecological) on their new environment, or their impact cannot be evaluated given the present scientific knowledge.

I: Composition of alien insect species in individual orders (Hemiptera divided); S – eusynanthropic, C – casual, N – naturalized (non-invasive), *N – post-invasive, I – invasive

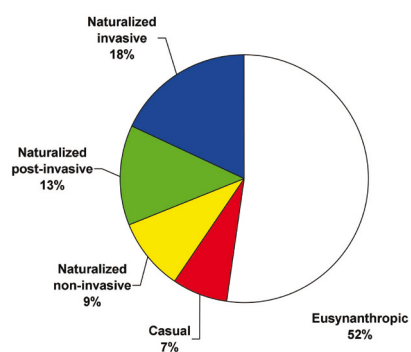
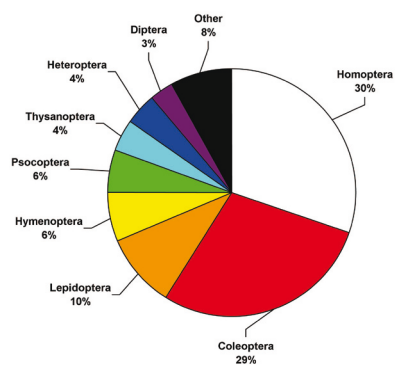
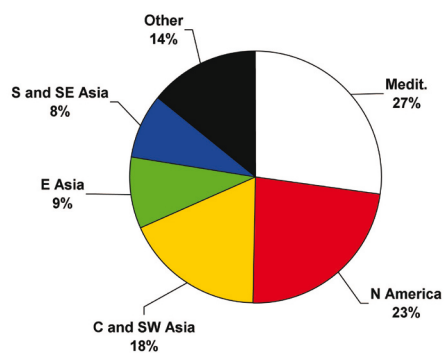
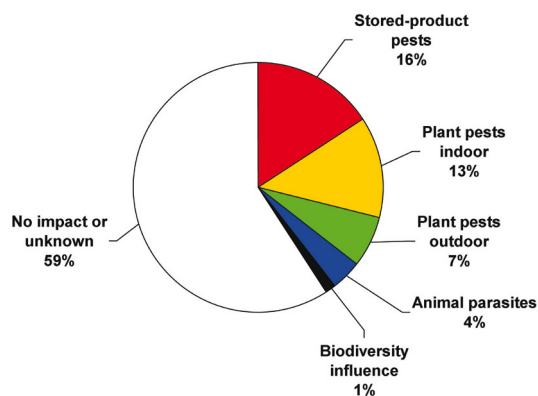
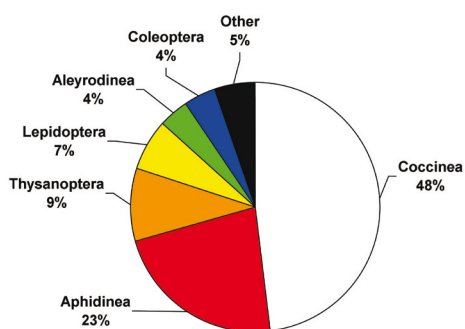
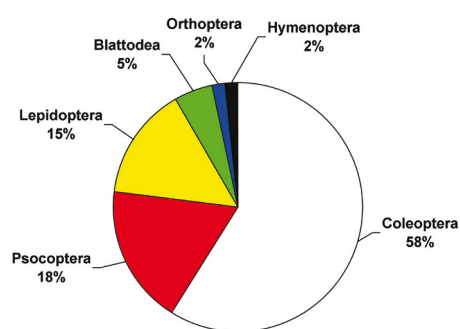
Taxon	Spp. CR	Aliens	% of all	S	C	N	*N	I
Zygentoma	4	2	50.0	2	-	-	-	-
Blattodea	14	9	64.3	9	-	-	-	-
Orthoptera	94	3	3.2	2	-	1	-	-
Dermaptera	8	1	1.3	-	1	-	-	-
Psocoptera	70	22	31.4	21	1	-	-	-
Phthiraptera	370	12	3.2	-	-	12	-	-
Heteroptera	850	15	1.8	3	-	-	7	5
Auchenorrhyncha	550	9	1.6	-	2	-	2	5
Psyllinea	116	7	6.0	1	-	-	6	-
Aleyrodinea	20	4	20.0	3	-	-	1	-
Aphidinea	680	48	7.1	7	2	3	19	17
Coccinea	140	48	34.3	45	-	-	2	1
Thysanoptera	240	16	6.7	9	-	-	6	1
Coleoptera	6100	110	1.8	60	19	11	1	19
Lepidoptera	3380	37	1.1	25	-	-	1	11
Diptera	7400	12	0.2	2	2	4	1	3
Siphonaptera	80	4	5.0	-	-	4	-	-
Hymenoptera	6400	24	0.4	11	1	1	4	7
Insecta total	27 200	383	1.4	200	28	36	50	69

II: Invasive and post-invasive alien insect species causing regular or occasional damages to agricultural, silvicultural, and ornamental plants

Species	Family	Origin	Host plant
<i>Aphis forbesi</i> Weed, 1889	Aphididae	N America	<i>Fragaria</i>
<i>Aphis spiraephaga</i> Müller, 1961	Aphididae	C Asia	<i>Spiraea</i>
<i>Argyresthia thuiella</i> (Packard, 1871)	Yponomeutidae	N America	<i>Thuja</i>
<i>Argyresthia trifasciata</i> Staudinger, 1871	Yponomeutidae	Alps	<i>Juniperus</i>
<i>Bruchus pisorum</i> (Linnaeus, 1758)	Bruchidae	Medit.	<i>Pisum</i>
<i>Cameraria ohridella</i> Deschka & Dimić, 1986	Gracillariidae	? E Asia	<i>Aesculus</i>
<i>Chromasphus juglandicola</i> (Kaltenbach, 1834)	Aphididae	SW Asia	<i>Juglans</i>
<i>Contarinia pisi</i> (Winnertz, 1854)	Cecidomyiidae	Medit.	<i>Pisum</i>
<i>Corythucha ciliata</i> (Say, 1832)	Tingidae	N America	<i>Platanus</i>
<i>Diabrotica virgifera</i> Le Conte, 1868	Chrysomelidae	N America	<i>Zea</i>
<i>Dialeurodes chittendeni</i> Laing, 1928	Aleyrodidae	Alps ?	<i>Rhododendron</i>
<i>Dreyfusia nordmanniana</i> (Eckstein, 1890)	Adelgidae	SW Asia	<i>Abies</i>
<i>Eopineus strobis</i> (Hartig, 1837)	Adelgidae	N America	<i>Pinus strobus</i>
<i>Eriococcus buxi</i> (Fonscolombe, 1834)	Eriococcidae	SW Europe	<i>Buxus</i>
<i>Eriosoma lanigerum</i> (Hausmann, 1802)	Pemphigidae	N America	Maloidea
<i>Gilletteella cooleyi</i> (Gillette, 1907)	Adelgidae	N America	<i>Pseudotsuga</i>
<i>Hyphantria cunea</i> (Drury, 1773)	Arctiidae	N America	Polyphagous
<i>Leptinotarsa decemlineata</i> (Say, 1824)	Chrysomelidae	N America	<i>Solanum</i>
<i>Macrosiphum euphorbiae</i> (Thomas, 1878)	Aphididae	N America	Polyphagous
<i>Megastigmus spermotrophus</i> (Wachtl, 1893)	Eurytomidae	N America	<i>Pinus strobus</i>
<i>Panaphis juglandis</i> (Goeze, 1778)	Aphididae	SW Asia	<i>Juglans</i>
<i>Parthenolecanium fletcheri</i> (Cockerel, 1893)	Coccidae	?	Pinopsida
<i>Quadraspidiotus perniciosi</i> (Comstock, 1893)	Diaspididae	E Asia	Polyphagous
<i>Thrips simplex</i> Morrison, 1930	Thripidae	Australia	<i>Gladiolus</i>
<i>Viteus vitifoliae</i> (Fitch, 1855)	Phylloxeridae	N America	<i>Vitis</i>



1: Categories of alien insects with numbers of species

**A****B****C****D****E****F**

2: A – ecological composition of alien insect species; B – taxonomic composition; C – origin of naturalized species; D – impact; E – taxonomic composition of plant pests (both indoors and outdoors); F – taxonomic composition of stored product pests

SOUHRN

Zavlečené a invazní druhy hmyzu v České republice a jejich ekonomický a ekologický význam (Insecta)

V České republice bylo dosud zaregistrováno 383 druhů hmyzu cizího původu, což představuje 1,4 % místní fauny. Druhově nejpočetnější jsou Homoptera (116 druhů, 30,3 %), Coleoptera (110; 28,7 %) a Lepidoptera (37; 9,7 %) (Obr. 2B). Z celkového počtu je 200 druhů (52,2 %) svým výskytem omezeno na uzavřené vytápěné prostory, 28 druhů (7,3 %) proniká jen krátkodobě do vnějšího prostředí, 36 (9,4 %) naturalizovaných neinvazních druhů se nešíří z místa introdukce, u 50 (13,1 %) postinvazních druhů proběhla invaze v minulosti a 69 (18,0 %) druhů je invazních (Obr. 2A). Ze zaregistrovaných druhů se 61 (15,9 %) uplatňuje jako škůdci uskladněných materiálů (nejvíce Coleoptera 36 druhů, Psocoptera 11 a Lepidoptera 9, obr. 2F), 50 (13,1 %) druhů škodí na skleníkových a pokojových rostlinách (nejvíce Coccinea 33, Aphidinea 7, Thysanoptera 6 druhů) a dalších 25 (tj. 6,5 % druhů cizího původu) v zemědělství, lesnictví nebo na okrasných kulturách (Obr. 2E), 15 druhů (3,9 %) jsou důležití parazité živočichů a 5 druhů (1,3 %) může ovlivnit biodiversitu. U zbývajících 227 druhů (59,3 %) nebyly zjištěny ekonomické ani environmentální vlivy (Obr. 2D). Původ většiny druhů žijících eusynantropně je v tropech a subtropích, ze 155 naturalizovaných (neinvazních, postinvazních a invazních) druhů pochází 42 (27,1 %) z Mediterránu, 36 (23,2 %) ze Severní Ameriky, 28 (18,1 %) ze Střední až jihozápadní Asie, 14 (9,0 %) z Východní Asie, 13 (8,4 %) z Jižní a jihovýchodní Asie, zbývajících 22 druhů (14,2 %) bylo zavlečeno z jiných oblastí (Obr. 2 C).

nepůvodní druhy hmyzu, Česká republika, složení, původ, vlivy

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