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Damage by Pests in Herbarium LJU

Škoda zaradi herbarijskih škodljivcev v Herbariju LJU

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Abstract: The article discusses the damage caused by herbarium pests in Herbarium LJU. The aim of the study was to determine the damage in the herbarium, to find out, which herbarium-pests are present, and to investigate their food-preference by means of checking the extent of damage on a selection of plant families *Alliaceae, Apiaceae, Araceae, Asteraceae*, *Brassicaceae*, *Chenopodiaceae*, *Cichoriaceae, Fabaceae*, *Lamiaceae*, *Poaceae*, *Polypodiaceae*, *Ranunculaceae*, *Rosaceae* and *Scrophulariaceae.* Since the *Asteraceae* and *Cichoriaceae* are known to be among the most attractive families for herbarium-pests, we examined them in detail. In the study about 7500 herbarium sheets were examined, which represents 5% of all the sheets in Herbarium LJU. In addition to the most frequent pest tobacco beetle (*Lasioderma sericorne),* we also found beetles *Stegobium paniceum* and *Attagenus piceus*, booklice (*Psocoptera*), moulds and Pharaoh's ants (cf. *Monomorium pharaonis*). Pest-damage was observed in 18 % of the examined herbarium sheets. The study confirmed that the pests are prone to attack certain families over others: the greatest damage (about 25 % - 40 % of the damaged sheets) was observed in *Apiaceae*, *Asteraceae s. lat.*, *Brassicaceae*, *Fabaceae*, *Alliaceae*, *Araceae*, *Rosaceae* and *Chenopodiaceae,* while the other investigated families ranked among less damaged (about less then 10 % of the damaged sheets). Among *Asteraceae*, tribus *Cardueae* proved to be the most attractive tribe for the pests.

Keywords: Herbarium LJU, herbarium-pests, dry plants, *Lasioderma serricorne, Stegobium paniceum, Attagenus piceus, Psocoptera.*

Izvleček: Članek obravnava škodo, ki jo povzročajo herbarijski škodljivci v herbarijski zbirki LJU. Namen raziskave je bil ugotoviti obseg poškodovanosti rastlinskega materiala, določiti, kateri herbarijski škodljivci so prisotni v LJU in raziskati njihovo prehrambeno preferenco z ugotavljanjem obsega škode na izboru rastlinskih družin *Alliaceae, Apiaceae, Araceae, Asteraceae*, *Brassicaceae*, *Chenopodiaceae*, *Cichoriaceae, Fabaceae*, *Lamiaceae*, *Poaceae*, *Polypodiaceae*, *Ranunculaceae*, *Rosaceae* in *Scrophulariaceae.* Ker družini *Asteraceae in Cichoriaceae* veljata za najbolj privlačne za herbarijske škodljivce, smo ju še posebej podrobno obravnavali. V raziskavi smo pregledali okoli 7500 herbarijskih pol, kar predstavlja 5 % vseh pol v herbariju LJU. Ugotovili smo, da je v LJU najpogostejši škodljivec tobačni hrošč (*Lasioderma serricorne),* poleg njega pa smo naleteli tudi na hrošča *Stegobium paniceum* in *Attagenus piceus*, prašne uši (*Psocoptera*), molje and faraonske mravlje (cf. *Monomorium pharaonis*). Škodo zaradi herbarijskih škodljivcev smo opazili v 18 % pregledanih herbarijskih pol. Raziskava je potrdila, da herbarijski škodljivci jedo herbarijski material določenih rastlinskih družin raje kot drugih. Največjo poškodovanost herbariziranih rastlin (25 do 40 % pregledanih pol s poškodovanih materialom) smo tako opazili pri družinah *Apiaceae*, *Asteraceae s. lat.*, *Brassicaceae*, *Fabaceae*, *Alliaceae*, *Araceae*, *Rosaceae* in *Chenopodiaceae.* Ostale pregledane družine so bile znatno manj poškodovane (pod cca. 10 % poškodovanih pol). Znotraj družine *Asteraceae* se je kot najbolj privlačen za herbarijske škodljivce izkazal tribus *Cardueae*.

Ključne besede: herbarjska zbirka LJU, herbarijski škodljivci, posušene rastline, *Lasioderma serricorne*, *Stegobium paniceum, Attagenus piceus, Psocoptera.*

Introduction

Herbaria are permanent collections only if preserved in dry, airy, dark place and protected against pests (Podobnik 1993). The problem of damage by pests is common problem of many herbaria. Most significant herbarium pests are some insects, moulds and sometimes even some rodents. In temperate regions herbivore insects grazing plants in nature can not survive in heated buildings and so they are not considered a threat to herbarium material. The infestation, caused by herbarium pests, occurs within storehouses, buildings, cabinets and herbaria (Skvorcov 1977). Therefore fresh plant material is not infected by herbarium pests yet, and the other pests, brought with the fresh material from the field, can not survive the drying procedure.

There are two common features of herbarium pests (Stein 1986): they feed on dry herbal material and they can survive under severe conditions of temperature and humidity in herbarium. Unlike the fresh-plant eating insects, being usually stenophagous, the herbarium pests are commonly euryphagous. They feed on the preserved plant material as well as on any other plant products like paper, textile, dry food etc. Provisionally deposed herbarium specimens in uncontrolled conditions are very likely to become infected (Skvorcov 1977). Most serious threat to herbarium material is by insects, particularly some beetle species (*Coleoptera*). They can also be found in storehouses, causing damage on cereals, flour, tea, tobacco, as well as in museum collections. The most frequent pest, causing great damage in herbaria as well as in tobacco storehouses, is tobacco beetle *Lasioderma serricorne* (*Anobiidae*), which is distributed worldwide (Ryan 1995, Zuska 1994). Some other significant beetle pests are: *Stegobium paniceum* (*Anobiidae*), *Ptinus fur* (*Ptinidae*), *Anobium punctatum* (*Anobiidae*), *Hylopteres bajulus* (*Cerambycidae*), *Xestobium rufovilllosum* (*Anobiidae*), *Lyctus brunneus* (*Lyctidae*), *Mycrobium castaneum* (*Anobiidae)*, *Attagenus piceu*s (*Dermestidae*) (Valentin 1993, Stein 1986). Some herbarium pests can also be found among other invertebrate groups: various booklices (*Psocoptera*) and silverfish (*Lepisma saccharina*, *Thysanura*).

Long-lasting high humidity in herbarium room often results in fungal damage of plant material. Fungal attack causes decomposition of the plant tissues and may cause plant features to be obscured and unsuitable for study (Bridson 1992). Even if the hyphae are destroyed, their spores may still persist for a longer period of time and germinate, when the conditions change (Rode 1989). Naphthalene and lauryl pentachlorophenate (LPCP) are believed to have fungicidal properties, however, Thymol is quite effective as fungicide (Maden 2004). There are many different chemical methods for desinsection and mould control in herbaria, but at present time there does not seem to be an ideal chemical to protect specimens from mould or insect attack (Clark 1986). Of the physical methods deep freezing for the incoming material is advisable (Clark 1986) and even microwave treatment is used in some herbaria (Hall 1981, Hill 1983).

Interesting feature of herbarium pests is their food-preference: insect pests are known to be naturally attracted to herbarium material of certain plant families like *Asteraceae* s. lat., *Brassicaceae, Capparaceae* and petaloid monocotyledons (*Liliaceae* s. lat.). If *Stegobium paniceum* is present, the damage occurs on *Asteraceae* s. lat*., Apiaceae*, *Ericaceae* and plant families that contain latex, e.g. *Apocynaceae*, and *Asclepiadaceae*. (Bridson 1992). Families *Betulaceae*, *Fagaceae*, *Caryophyllaceae*, *Convolvulaceae*, *Poaceae* and *Polypodiaceae* are considered to be less attractive to pests and therefore less threatened (Skvorcov 1977).

Since the important prevention measure against pests is a constant look-out for insects, Skvorcov (1977) recommends to bait the herbarium-pest traps with their favorite plant material to monitor the eventual infestation of the herbarium. He also suggests regular checks of *Tragopogon*, *Angelica* and *Vicia faba* herbarium sheets.

In the last decade, a considerable pest damage was observed in Herbarium LJU, at the Department of Biology, Biotechnical Faculty of University of Ljubljana. The aim of the study was to determine the damage in the herbarium, to find out, which herbarium-pests are present, and to investigate their food-preference by

means of checking the extent of damage on a set of certain plant families. The results of the research in Herbarium LJU should be comparable to other smaller herbaria in the temperate regions. They should also represent a basis for pest-control strategy in Herbarium LJU and comparable herbaria.

Materials and Methods

Herbarium LJU

Herbarium LJU is a typical local herbarium, covering mostly Slovenian flora. It comprises about 160.000 herbarium sheets. Though it is relatively small, it represents the largest herbarium collection in Slovenia and has a history of over 100 years. It includes several important exsiccate collections, like Flora exsiccata Carniolica and Flora exsiccata Styriaca, and relatively many type specimens.

Before 1995 the herbarium was regularly fumigated with various gases, like carbon disulfide and – later – hydrogen cyanide. In 1995 the herbarium was moved to a new location. The first fumigation of the herbarium in the new locality was performed in 2000; phosphine gas was used. Until 2009 three additional fumigations with phosphine gas were performed and re-infestation with insects has not been observed so far. A common practice for prevention of infestation in LJU is decontamination of the incoming dried material before it enters the herbarium room. The sheets are subjected to deep freezing (at least -18°C) for a few days.

Until recently, the temperature and humidity in the herbarium were not controlled and the conditions somewhat vary during the year. During our investigation, the temperature and humidity was measured. The air temperature was found to be 19°C and the humidity 42 %. Since the investigation was performed during heating season, the measured temperature was probably a bit higher then otherwise.

The Examined Plant Material

The following set of plant families was chosen for the examination: *Alliaceae, Apiaceae, Araceae, Asteraceae, Cichoriaceae*, *Brassicaceae*, *Chenopodiaceae*, *Fabaceae*, *Lamiaceae*, *Poaceae*, *Polypodiaceae*, *Ranunculaceae*, *Rosaceae* and *Scrophulariaceae*.

For each of the studied families (with an exception of *Asterales*) in a random sample of genera a satisfactory amount of herbarium sheets has been chosen. In small plant families (*Araceae, Alliaceae*) a sample of over 30 herbarium sheets of various genera was chosen and in larger families (*Apiaceae, Brassicaceae, Chenopodiaceae, Asteraceae, Cichoriaceae, Fabaceae, Lamiaceae*, *Poaceae, Rosaceae, Scrophulariaceae, Ranunculaceae* and *Polypodiaceae*) the size of the sample was over 100 sheets. The criterion for the random sampling of genera was set according to alphabetical order. For the inclusion of a certain genus in a sample, the genus had to be represented by a minimum of 10 sheets (smaller genera) or 30 sheets (larger genera) of at least one species: the examined genera and the sample sizes are listed in

Table 1: Percentages of the damaged sheets in the examined genera.
Tabela 1: Odstotek poškodovanih herbarijskih pol pri pregledanih rodovih.

	% damaged sheets	inspected sheets		% damaged sheets	inspected sheets
Alliaceae			*Anthriscus*	34,0	50
Allium	24,1	170	*Aethusa*	33,3	21
Araceae			***Compositae***		
Arum	25	24	*Achilea*	90,1	223
Acorus	5	2	*Adenostyles*	13,9	36
Apiaceae			*Ambrosia*	33,3	15
Aegopodium	28,6	21	*Antennaria*	8,6	58
Angelica	51,5	33	*Anthemis*	25,0	44

	% damaged sheets	inspected sheets
Aposeris	11,8	34
Arctium	72,7	44
Arnica	42,9	35
Artemisia	46,8	79
Aster	17,4	167
Brassicaceae		
Aethionema	11,5	26
Alliaria	6,7	15
Alyssum	36,7	79
Arabidopsis	12,5	16
Arabis	22,7	255
Chenopodiaceae		
Atriplex	17,2	29
Fabaceae		
Anthyllis	41,5	130
Astragalus	1,0	103
Lamiaceae		
Acinos	2,3	130
Ajuga	0,0	96
Ballota	0,0	16
Betonica	3,8	79
Poaceae		
Achnatherum	0,0	20
Agropyron	0,0	62
Agrostis	0,0	39
Alopecurus	2,5	40
Anthoxanthum	1,8	56
Apera	16,7	12
Arrhenatherum	0,0	30
Polypodiaceae		
Adianthum	14,3	21
Asplenium	3,7	242
Athyrium	4,8	104
Telypteris	0,0	73
Pteridium	3,0	33
Ranunculaceae		
Actaea	5,0	40
Anemone	0,6	181
Batrachium	3,1	127
Pulsatilla	13,0	100
Rosaceae		
Agrimonia	0,0	39
Alchemilla	34,6	347
Aphanes	0,0	10
Aremonia	4,5	44
Aruncus	32,0	25
Amelanchir	25,0	44
Scrophulariaceae		
Bartsia	0,0	28
Digitalis	11,4	44
Scrophularia	40,9	44

Since ordo *Asterales* is known to be one of the most attractive families for herbarium pests, we examined it in detail, checking all the available genera. In this separate analysis the following genera were included: *Achilea, Adenostyles, Ambrosia, Anthemis, Antennaria, Aposeris, Arctium, Arnica, Artemisia, Aster, Bellis, Carduus, Carlina, Centaurea, Cirsium, Conyza, Crepis, Doronicum, Echinops, Erigeron, Eupatorium, Filago, Gnaphalium, Hieracium, Homogyne, Hypochoeris, Inula, Lactuca, Leontodon, Leucanthemum, Petasites, Picris, Pulicaria, Saussurea, Scorzonera, Senecio, Serratula, Solidago, Sonchus, Tanacetum, Taraxacum, Tragopogon* and *Tussilago.* For each of the investigated genera all the available material was examined, with an exception of *Hieracium, Crepis, Leontodon* and *Centaurea*, where only a satisfactory large random sample was chosen.

Very old sheets (over 100 years) were not taken into account, since most of the them were at that time protected with mercuric chloride, which provides a long-lasting immunity and may therefore blur the results. Non-slovenian material was also excluded from the examination.

Examining the Extent of Damage

The examination of the extent of damage included visual inspection and counting the damaged and intact herbarium sheets. The counts obtained were used to calculate percentage of

the damaged sheets for the examined families and genera.

The sheets were characterized as 'damaged', if the following evidences of herbarium pests were present:

– deposits of fine granular droppings on the plant specimens and paper,
– missing parts of plants, holes in sheets, leaves, stems, roots and rhizomes, inflorescence and/or flowers as a result of larval forage,
– ruined inflorescence and/or flowers,
– a presence of crawling or dead adult pests.

Results and Discussion

The herbarium pests

In the last few years and during our examination the following *Coleoptera* species were found: *Lasioderma serricorne*, *Stegobium paniceum* in *Attagenus piceus.* Most of the found individuals were determined as *Lasioderma serricorne*, while the last two species were represented each by only a single adult. All the adult beetles were found dead. The results partly correspond to the list of coleopteran pests, found in herbarium material in nature-history department of National museum in Ljubljana (Kos 1944). Among the listed species in Kos (1944) there are *Attagenus piceus* and *Sitodrepa panicea* (syn.: *Stegobium paniceum*), but *Lasioderma serricorne*, the main pest in LJU 50 years latter, was missing. The other species from the museum herbarium are *Anthrenus verbasci*, *Ptinus fur*, *Cartodere filiformis*, *C. filum* (most common) (Kos 1944).

Other observed pests belong to *Psocoptera*: the booklices were alive and very numerous. They are known to attack tenderer plant organs, like petals and anthers (Skvorcov 1977). The damage we observed was rather heavier: leaves, stems and peduncles were also attacked.

Fungal damage was observed, too. Considering the fact that in LJU there had been no humidity control, the fungal infection is not surprising.

In the working room of herbarium, where a considerable amount of unsorted material is tem-

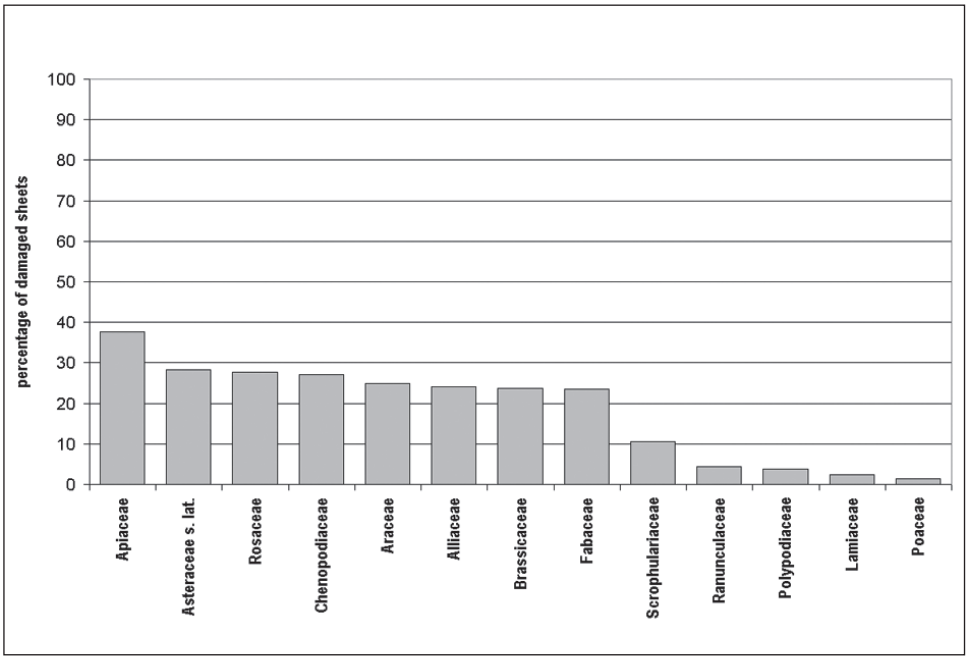

Figure 1: Percentages of the damaged sheets in the examined families.
Slika 1: Odstotek poškodovanih herbarijskih pol po družinah.

porarily deposed and the temperature is a few degrees higher, Pharaoh's ants (cf. *Monomorium pharaonis*) were found in some sheets. Bridson and Forman (1992) report that these pests are rather common in heated herbaria of temperate regions. They are also common pests in storehouses in Ljubljana (Hržič and Urek 1989).

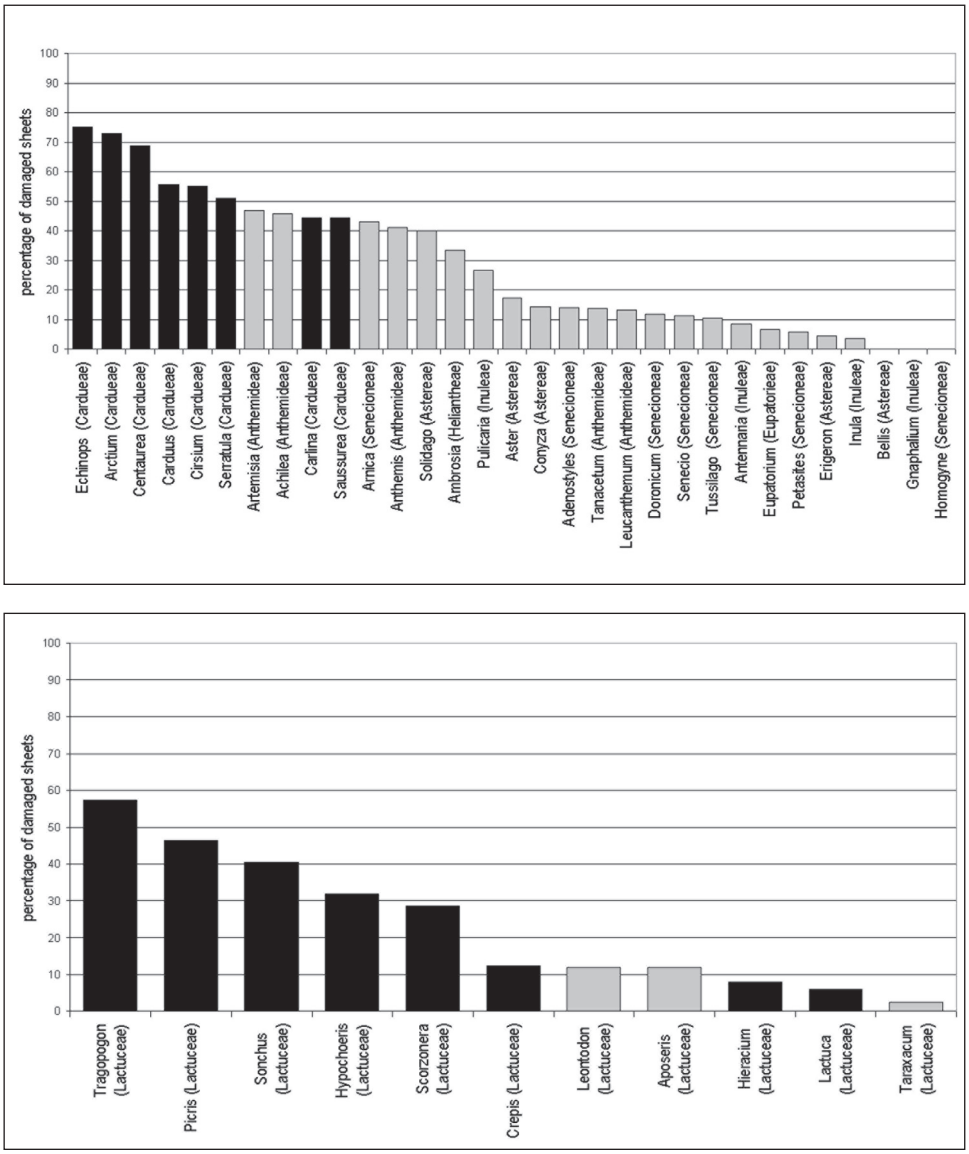

Figure 2: Percentages of the damaged sheets in the examined Asteraceae genera grouped by 2 subfamilies (upper graph: *Asteroideae*, lower graph: *Cichorioideae*). Tribus *Cardueae* shown by black coloumns.

Slika 2: Odstotek poškodovanih herbarijskih pol pri košarnicah združenih po poddružinah (zgornji graf: *Asteroideae*, spodnji graf: *Cichorioideae*), tribus *Cardueae* obarvan črno.

The damage

In the study there were about 7500 herbarium sheets examined, which roughly represent 5 % of all the sheets in Herbarium LJU. Pest-damage was observed in 18 % of the examined herbarium sheets. This percentage can not be applied to all the material in LJU, since the family sample was not chosen randomly.

The results fully confirm the fact, that the pests are prone to attack certain families over others: in accordance with the literature (Skvorcov 1977, Hall 1988, Bridson 1992, Nikolić 1996,) the greatest damage was observed in *Apiaceae*, *Asteraceae, Cichoriaceae*, *Brassicaceae*, *Fabaceae* and *Alliaceae* (Fig. 1). The study showed approximately the same high level of damage in *Araceae*, *Rosaceae* and *Chenopodiaceae* (Fig.1).

The high percentage of the damaged sheets in *Chenopodiaceae* was rather unexpected since Skvorcov (1977) reports the family to be among less threatened. However, the damage on *Chenopodiaceae* specimens was far less extreme than for instance on *Apiaceae* and *Asteraceae*. In the column chart in Fig. 1 a gap between the 10 % and 20 % of the damaged sheets can be observed: it represents the gap between the 'threatened' and the 'less threatened' families. *Poaceae* and *Polypodiaceae* proved to be among the latter. Family *Lamiaceae*, commonly reported to be attractive to pests (Skvorcov 1977), also appeared among the less damaged. Considering the great content of essential oils, which are known to act as repellent substances, this result can be explained. Families *Ranunculaceae* and *Scrophulariaceae* also ranked among the less damaged. The two are known for their poisonous and repellent secondary substances. Tab. 1 shows the sample sizes and percentages of the damaged sheets in all of the examined genera.

With over 20 000 species, family *Asteraceae s.lat.* is one of the largest plant families. According to some authors (Cronquist 1981) one of the reasons for it's evolutionary successfulness is also the presence of poisonous and repellent substances, for instance polyacetylene, sesquiterpene lactones, alkaloids (*Senecioneae*), latex (*Lactuceae*) and further some malodoriferous essential substances (*Heliantheae* in *Anthemideae*). According to the study, the poisons and repellents are not very effective in the case of herbarium-pest attack.

Among *Asteraceae, Cardueae* proved to be the most attractive tribe. The damage increases from about 50 % of the damaged sheets in genera *Saussurea*, *Carlina*, *Cirsium* and *Carduus*, reaches 70 % in genus *Centaurea* and the maximum damage of 75 % in *Echinops* (Fig. 2).

The damage is generally limited to the inflorescence, but sometimes leaves are also eaten. The tribe *Cardueae* is known for it's ambiguous taxonomical status: it's (sub)family alliance is yet uncertain (Heywood 1993). The position of the *Senecioneae* tribe, one of the less damaged, is also doubtful: some authors consider it as a third subfamily (Heywood 1993). As expected (Skvorcov 1977), among *Cichoriaceae, Tragopogon* is the most attractive (almost 60 % of the damaged sheets). All the investigated genera belong to *Lactuceae*, which is also mentioned by Hall (1988) as one of the most attractive for the herbarium pests. The column chart of the two families in Fig. 2 reveals a gap approximately between the 15 % and 30 % of the damaged sheets, the 'less threatened' genera being under the lower value and the 'threatened' above the upper. Probably the pests eat the 'less threatened' material only by chance or when their population is sufficiently large.

Conclusions

As a result of our study, a list of most threatened families and genera by herbarium pests is produced. For the herbaria with predominantly northern hemisphere temperate region plant material, keepers should regularly monitor sheets of *Apiaceae*, *Asteraceae s. lat.*, *Brassicaceae*, *Fabaceae*, *Alliaceae*, *Araceae*, *Rosaceae* and *Chenopodiaceae* for the presence of common herbarium-pests. In addition to that, for *Stegobium paniceum* a pheromone trap is commercially available and can be used specially in herbaria after infestation of *Lasioderma serricorne* to monitor efficiency of pest control and early detect surviving population.

Povzetek

Težave s škodljivci imajo v mnogih herbarijskih zbirkah. Najbolj značilni herbarijski škodljivci so nekatere žuželke (posebej hrošči - *Coleoptera*, pa tudi prašne uši - *Psocoptera* in srebrne ribice - *Thysanura*), plesni in celo nekateri glodalci. Herbarijski škodljivci se hranijo s posušenim rastlinskim materialom, kot tudi z izdelki iz rastlin, kot so papir, tkanine, suha hrana, tobak ...

Žuželke v vlogi herbarijskih škodljivcev naravno privlačijo herborizirane rastline določenih družin pred drugimi. Tako so na primer posebej ogrožene družine *Asteraceae* s. lat., *Brassicaceae, Capparaceae* in petaloidne enokaličnice (*Liliaceae* s. lat.), po drugi strani pa so družine kot *Betulaceae*, *Fagaceae*, *Caryophyllaceae*, *Convolvulaceae*, *Poaceae* in *Polypodiaceae* škodljivcem manj privlačne (Skvorcov 1977).

Herbarij LJU na Oddelku za biologijo Biotehniške fakultete Univerze v Ljubljani obsega približno 160 000 herbarijskih pol in kljub relativni majhnosti predstavlja največjo urejeno herbarijsko zbirko v Sloveniji. V zadnjem desetletju je bila v herbariju LJU opažena znatna škoda zaradi harbarijskih škodljivcev. Namen raziskave je bil ugotoviti obseg škode, dognati, kateri herbarijski škodljivci se tu pojavljajo in ugotoviti njihovo prehrambeno preferenco s primerjanjem obsega poškodovanosti herbarijskih pol različnih rastlinskih družin. Rezultati raziskave lahko služijo kot osnova za pripravo strategije nadzora nad herbarijskimi škodljivci tako v zbirki LJU, kot tudi v primerljivih manjših herbarijih v zmernem pasu.

V raziskavo smo vključili naslednje rastlinske družine: *Alliaceae, Apiaceae, Araceae, Asteraceae, Cichoriaceae*, *Brassicaceae*, *Chenopodiaceae*, *Fabaceae*, *Lamiaceae*, *Poaceae*, *Polypodiaceae*, *Ranunculaceae*, *Rosaceae* in *Scrophulariaceae*. Za vsako od raziskovanih družin (razen *Asteralceae* s. lat.) smo znotraj naključno izbranega niza rodov pregledovali herbarijske pole. Pri manjših družinah (*Araceae, Alliaceae*) je bil vzorec velik preko 30 pol iz različnih rodov, pri velikih družinah (*Apiaceae, Brassicaceae, Chenopodiaceae, Asteraceae, Cichoriaceae, Fabaceae, Lamiaceae*, *Poaceae, Rosaceae, Scrophulariaceae, Ranunculaceae* in *Polypodiaceae*) pa je bilo število pregledanih pol čez 100. Košarnice (*Asterales*) smo pregledali podrobneje, in sicer v glavnem vse pole vseh razpoložljivih rodov: *Achilea, Adenostyles, Ambrosia, Anthemis, Antennaria, Aposeris, Arctium, Arnica, Artemisia, Aster, Bellis, Carduus, Carlina, Centaurea, Cirsium, Conyza, Crepis, Doronicum, Echinops, Erigeron, Eupatorium, Filago, Gnaphalium, Hieracium, Homogyne, Hypochoeris, Inula, Lactuca, Leontodon, Leucanthemum, Petasites, Picris, Pulicaria, Saussurea, Scorzonera, Senecio, Serratula, Solidago, Sonchus, Tanacetum, Taraxacum, Tragopogon* in *Tussilago.*

Za vsako polo smo ugotovili, ali herborizirane rastline kažejo znake poškodovanosti zaradi herbarijskih škodljivcev, kot so odloženi drobni zrnati iztrebki na rastlini ali papirju, požrti deli rastlin, luknje v papirju, listih, steblih, podzemnih delih, socvetju ali cvetovih kot posledica pašnje larv, uničenost socvetij ali cvetov in prisotnost živih ali mrtvih odraslih škodljivcev. Poškodovane pole smo prešteli in iz števil poškodovanih in vseh pregledanih pol izračunali odstotek poškodovanih pol za posamezne družine oz. rodove. Opazili smo naslednje škodljivce: hrošče *Lasioderma sericorne*, *Stegobium paniceum* in *Attagenus piceus,* prašne uši - *Psocoptera* in plesni, v herbarijskem predprostoru pa tudi faraonske mravlje *(Monomorium pharaonis).* Med hrošči nismo našli živih primerkov, prašne uši pa so bile žive in zelo številne. Napadajo predvsem nežnejše rastlinske dele, kot so cvetni listi in prašniki (Skvorcov 1977).

Med raziskavo smo pregledali okoli 7500 pol, kar predstavlja približno 5 % vseh pol v LJU. Škodo zaradi herbarijskih škodljivcev smo opazili pri 18 % pregledanih pol.

Rezultati povsem podpirajo navedbe, da imajo herbarijski škodljivci preferenco do določenih družin pred drugimi. Največja škoda je tako bila opažena pri družinah *Apiaceae*, *Asteraceae, Cichoriaceae*, *Brassicaceae*, *Fabaceae* in *Alliaceae* (Fig. 1)*,* ki jih tudi literatura navaja za posebej privlačne (Bridson 1992, Skvorcov 1977, Nikolić 1996, Hall 1988). Približno enak (visok) delež poškodovanosti pa je bil ugotovljen tudi za družine *Araceae*, *Rosaceae* in *Chenopodiaceae* (Fig.1). Visoka stopnja poškodovanost družine *Chenopodiaceae* je v

nasprotju z literaturnimi navedbami, po katerih naj bi bila ta družina manj privlačna (Skvorcov, 1977). Družini *Poaceae* in *Polypodiaceae* sta se izkazali za manj privlačne. Tudi *Lamiaceae*, ki jih sicer navajajo za bolj privlačne (Skvorcov 1977), so se v naši raziskavi uvrščale med manj poškodovane. To si lahko razlagamo z veliko vsebnostjo eteričnih olj, ki imajo repelentno delovanje. Tudi družini *Ranunculaceae* in *Scrophulariaceae* se uvrščata med manj privlačne, obe sta tudi znani po strupenih in repelentnih snoveh. Znotraj družine *Asteraceae* so se za najprivlačnejše izkazali predstavniki tribusa *Cardueae.* Odstotek poškodovanosti pol je naraščal od približno 50 % poškodovanih pol pri rodu *Saussurea*, *Carlina*, *Cirsium* in *Carduus*, dosegel 70 % pri rodu *Centaurea*, največja poškodovanost pol (75 %) pa se je izkazala pri rodu *Echinops* (Fig. 2). Najpogosteje so bila poškodovana socvetja, sem in tja pa tudi listi. Po pričakovanjih (glej Skvorcov 1977) je znotraj družine *Cichoriaceae* najprivlačnejši rod *Tragopogon* (skoraj 60 % poškodovanih pol).

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References

Bridson, D., Forman, L., 1992. The Herbarium Handbook. Royal Botanical Gardens, Kew, 303 pp.

Clark, S.H., 1986. Preservation of herbarium specimens: an archive conservator's approach. Taxon, 35, 675-683.

Cronquist, A., 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, 1262 pp.

Hall, D.W., 1981. Microwave: a method to control herbarium insects. Taxon, 30(4), 818-819.

Hall, A.V., 1988. Pest Control in Herbaria. Taxon, 37(4), 885-907.

Heywood, V.H., 1993. Flowering Plants of the World. Andromeda, Oxford, 335 pp.

Hill, S.R., 1983. Microwave and the herbarium specimen: potential dangers. Taxon 32(4), 614-615.

Hržič, A., Urek, G., 1989. Skladiščni škodljivci na območju Ljubljane. Sodobno kmetijstvo 22(3), 119-130.

Kos, F., 1944. Postanek in razvoj Prirodoslovnega muzeja v Ljubljani. Prirodoslovna izvestja, knjiga 1, Prirodoslovni muzej Slovenije, Ljubljana, 199-219.

Maden, K., 2004. Plant Collection and Herbarium Techniques, Our Nature, 2, 53-57.

Nikolić, T., 1996. Herbarijski priručnik. Školska knjiga, Zagreb, 167 pp.

Podobnik, A., 1993. Navodilo za izdelavo herbarija. VTOZD za biologijo, Biotehniška fakulteta, UEK v Ljubljani, 31 pp.

Rode, J., 1989. Manj znana nevarnost za herbarijske zbirke. Proteus, 51(7), 277-278.

Ryan, L., 1995. Post-harvest Tobacco Infestation Control. Chapman & Hall, London, 155 pp.

Skvorcov, A.K., 1977. Gerbarij, posobie po metodike i tehnike. Nauka, Moskva.

Stein, W., 1986. Vorratsschädlinge und Hausungziefer: Biologie, Ökologie, Gegenmaßnahmen. Ulmer, Stuttgart.

Valentin, N., 1993. Comparative Analysis of Insect Control by Nitrogen, Argon and Carbon Dioxide in Museum, Archive and Herbarium Collections. International Biodeterioration & Biodegradation, 32, 263-278.

Zuska, J., 1994. Haus- und Vorratschädlinge. Werner Dausien, Hanau, 192 pp.