

BOOK OF ABSTRACTS

CONFERENCE



THE HISTORY AND THE PRESENT
OF THE BOTANICAL RESEARCH
AND NATURE CONSERVATION
3.-4.9.2020, Košice, Slovakia

70 YEARS

OF BOTANICAL GARDEN OF P. J. ŠAFÁRIK UNIVERSITY IN KOŠICE

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Lichens in „extreme“ environment

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Lichens are symbiotic “organisms” composed from vegetative body (thallus), consisting from cells of the fungal partner (mycobiont) and algal and/or cyanobacterial partner (photobiont). Due to mutualistic symbiosis may lichens survive in extreme environments, e.g. cold, hot, dry, UV exposed, or metal polluted habitats, where existence of single symbionts without mutualistic partner of symbiosis is not possible (Bačkor and Loppi, 2009). However, lichens may be considered more like an ecosystem or community than a typical organism.

Lichens are producing more than 1000 unique substances (Goga et al., 2018), usually unique for this group, called also as secondary metabolites. Secondary metabolites of lichens are not typically present in other organisms and play mostly diverse biological and ecological roles helping lichens to survive in “extreme” environments. They are usually extracellular phenols, which are secreted by the fungal partner, and mostly deposited on the surface of hyphae, but also photobionts cells in lesser extent. These substances in lichens occur in very considerable amounts, typically constituting from 0.1 to 5.0 % (w/w) of thallus dry weight, or even more. Typical secondary metabolites of lichens include dibenzofuran derivatives, depsides, and depsidones.

Lichen metabolites have many biological and ecological functions, including mostly antimicrobial activity, allelopathy, antiherbivory, chelating of heavy metals and UV protection of symbionts.

Acknowledgment

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Effect of plant extract *Ginkgo biloba* L. using the CAM model

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This thesis focused on demonstrating the effects of natural extract *Ginkgo biloba* L. on vessels of chick chorioallantoic membrane (CAM). This extraembryonic membrane forms a network of blood capillaries, which is important for absorption of nutrients, gas transport, calcium and storage of waste materials. In our study, we evaluated the effects of various concentrated extracts *Ginkgo biloba* L. (concentration of extract: 1 %, 5 %, 10 %, 15 %, 20 %, 30 %) on vessels during different time periods. On embryonic day 9, experimental samples as well as control were applied on the CAM surface. Immediately changes of vascular activity were evaluated in a certain time periods according Luepke scoring system. Based on the photographs, we evaluated changes in vessels (hyperaemia, haemorrhagia, clotting) and morphometric alterations of vessel diameter. Our results were compared with saline solution, as a negative control, and 30 % ethanol as a positive control. We observed that a predominantly effect was vasodilation. However, at 20 % and 30 % concentrations were observed vasoconstriction. The highest diameter of vessels was observed within 1 % concentration of extract compared to the control and the other extracts as well. Results of this work can help determine more accurately the effect of natural *Ginkgo biloba* L on blood vessels under *in vivo* conditions. Also, these results can contribute to a greater interest in the use of alternative animal models in pharmacological and biomedical research.

Acknowledgment

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Wood-decay fungi – how do we reliably identify them?

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Fungal wood decay is considered a serious tree disease worldwide and correct identification of fungi is of major importance. Identification of fungi has been done using morphological features, but molecular methods allow more precise identification. Methods based on DNA analysis – Internal Transcribed Spacer (ITS) sequencing, Restriction Fragment Length Polymorphism (ITS-RFLP) and the innovative Matrix Assisted Laser Desorption Ionization-Time of Flight Mass Spectrometry (MALDI-TOF MS) based on protein analysis were used in this study to identify selected fungal pathogens. All DNA based methods were shown to be reliable tools for species differentiation. While *Inonotus hispidus* was found to be genetically homogenous species, in several other species e.g. in *Fomes fomentarius*, *Ganoderma resinaceum*, and *Fomitopsis pinicola* a substantial genetic diversity not associated with a morphological diversity was revealed. In contrast, striking morphological variability seen in *Daedaleopsis confragosa* complex was not accompanied by variability at the genetic level. The results obtained also suggest that MALDI TOF MS protein-profiling exhibits a sufficient discriminatory power, similar to DNA-based approaches. The method was able to discriminate between morphologically similar *Ganoderma* species in agreement with ITS sequence and RFLP data. Our data indicate that modern molecular methods provide reliable approach for identifying of wood-decay fungi.

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Through the mountains, across the valleys - Ranunculaceae in the world and in New Guinea

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The Ranunculaceae (buttercup) family is a cosmopolitan group that includes many well-known wildflowers and ornamental plants, as well as several pharmaceutically important taxa. The family is distributed almost worldwide but is most diverse in temperate and colder regions; it is relatively rare in the tropics. According to The World Checklist of Vascular Plants (WCVP) there are 52 accepted genera and 3781 accepted species of Ranunculaceae in the world.

As part of ongoing research into the plant diversity and conservation of New Guinea at the Royal Botanic Gardens, Kew, the genera of Ranunculaceae are being revised on the island as the first stage towards a Flora Malesiana account. In New Guinea, three genera are present: *Clematis* L., *Ranunculus* L. and *Thalictrum* L. The study presented here is based on the examination of specimens from several herbaria. The taxonomy of *Thalictrum* is revised and the results indicate this genus is present in New Guinea with two species and three varieties, including several taxa new to science. Species of *Ranunculus* and *Clematis* remain to be examined. Work is under way to produce keys to the genera and species, full descriptions, distribution maps and conservation assessments.

Regarding the basic principles of genetic diversity protection in the Ukrainian Carpathians

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Preservation of all existing genetic diversity is one of the priorities in the integrated problem of biosphere protection. This problem is extremely important for the Ukrainian Carpathians, which belong to the floristically richest regions of both Ukraine and Central Europe.

To preserve the existing biota in all its diversity, we should provide proper protection for those species that need it. In this regard, we must address at least two tasks: to determine which taxa from all the current diversity need protection and, second, what appropriate measures need to be taken to ensure the survival and further prosperity of these vulnerable taxa.

The first issue is solved by forming different levels registers of endangered species – Red Data Books (mostly at the state level) and regional lists of definite administrative units or geographical regions (at the local level). As for the second task, it is much more difficult. Its complexity lies in two aspects at least. First, it is necessary to determine what conditions must be created for a species for its successful existence. Secondly, how expensive creation of such conditions is.

Of course, mankind has accumulated huge experience in the field of conservation of flora and fauna species, mainly by the creation of protected areas of different status and regime. However, approaches to conservation do not remain unchanged, but are constantly supplemented and improved. But sometimes, admittedly, they can be ineffective. All of this is evidence that we are on the right way in terms of preserving genetic diversity, but the basic principles need to be constantly reviewed and improved.

Fruit, stem *Prunus avium* (L.) and *Cerasus vulgaris* (Mill.) as a source of exogenous antioxidants

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Polyphenols are metabolites of many plants and can be used as exogenous antioxidants for their antioxidant properties. We analyzed eight samples of fruits and stems of *Cerasus avium* (L.) Moench and *Cerasus vulgaris* (Mill.) For the content of flavonoids, total polyphenols and antioxidant activity. By spectrophotometric method using Folin-Ciocalteu reagent, at a wavelength of 750 nm, we measured a higher content of total polyphenols in the stems of *Cerasus vulgaris* ($0.789 \pm 0.032\%$ / 0.5 g of sample) than *Cerasus avium* (0.534 ± 0.020 / 0.5 g of sample). Using the Lamaison and Carnat method, we measured a higher content of flavonoids in the stems of *Cerasus vulgaris* from the online store ($0.245 \pm 0.004\%$ / 0.6 g of sample) at a wavelength of 425 nm than in the stems from free collection ($0.213 \pm 0.003\%$ / 0.6 g samples). The lowest content of flavonoids was measured in *Cerasus avium* fruits from free harvest ($0.048 \pm 0.004\%$ / 0.6 g of sample). When comparing the fruits of *Cerasus avium* and *Cerasus vulgaris* to the polyphenol content, we found that the fruit of *Cerasus vulgaris* has a higher content ($0.385 \pm 0.044\%$ / 0.5 g of sample) than in the fruit of *Cerasus avium* ($0.283 \pm 0.141\%$ / 0.5 g of sample). When evaluating the effect of processing fruit samples on the content of polyphenols, we found that the higher content of polyphenols was measured in lyophilized samples. The results showed that the higher content of total polyphenols was measured in stems than in fruits. Using the FRAP method, we measured the highest antioxidant activity in the stem of *Cerasus vulgaris* from the online store ($8.667 \pm 0.061.100 \mu\text{mol.l}^{-1} \text{Fe}^{2+}$). We found that the values of antioxidant activity of the samples directly correlate with the values of flavonoids and total polyphenols. Based on the obtained results, we can state that the fruits and stems of *Cerasus avium* (L.) Moench and *Cerasus vulgaris* (Mill.) Are a source of polyphenols, flavonoids and antioxidant abilities, they can be used as exogenous antioxidants and for the production of functional foods.

Return of the lost son: *Stipa smirnovii* reconfirmed for the Slovak flora

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Aggregate species *S. dasyphylla* agg. belongs to the so far taxonomically poorly researched Eurasian taxa of the genus *Stipa* requiring further study. In a broad sense, it is divided into two species: *S. dasyphylla* s. str. and *S. zaleskii*, whereas in a narrow sense this aggregate species includes about 6 taxa, *Stipa smirnovii* is one of them. Morphological characteristics of this species are among the species *S. glabrata* and *S. dasyphylla*. *S. smirnovii* is known only from Central Europe (Czech Republic, Slovakia), in Eastern Europe this taxon is not distinguished. In Slovakia, it was reported only from single locality in the Biele Karpaty Mts. (Turecký vrch Hill), but has not been confirmed for a long time and is considered extinct. We confirmed the occurrence of *S. smirnovii* at a new location in the western part of the Malé Karpaty Mts. at the Holubyho lesostep site near the village of Vinosady. The population consists of about 50 tussocks/individuals growing on an area of 20 × 50 m in the grassland community of the association *Astero linosyris-Festucetum rupicolae* (alliance *Koelerio-Phleion phleoidis*, class *Festuco-Brometea*). Based on the above data, we propose to re-evaluate the Red List status of *S. smirnovii* from the category RE (regionally extinct) to the category CR (critically endangered) with criteria C2a(ii); D.

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Revision of distribution and coenology of *Ranunculus pedatus* in Slovakia

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Ranunculus pedatus is a Eurasian species with northern distribution limit in southern Slovakia. In the 1990, it was assumed that the species probably occurs only near Štúrovo town. Sites in the Hron and Ipeľ basins (Pastovce, Tupá, Hrkovce, Šahy surroundings, Ipeľský Sokolec, Slatina) and in the Podunajská nížina lowland between Komárno and Štúrovo were considered as historical. Our research consists of field survey and revision of herbarium collections of 14 herbaria in Austria, the Czech Republic, Hungary and Slovakia. Except for the well-known occurrence on saline habitats north of Štúrovo, we confirmed it around Chľaba village and in the Ipeľ Basin (Pastovce, Tupá). The new, easternmost locality within Slovakia was found near the village of Koláre. Recently, 30% of all known sites were confirmed. We propose to classify the species in Slovak Red List from the category critically endangered (CR) to the category endangered (EN). It recently occurs in salty meadows of the alliance *Festucion pseudovinae* (class *Festuco-Puccinellietea*) as well as in mesic meadows of alliance *Arrhenatherion elatioris* (class *Molinio-Arrhenatheretea*).

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Maple (*Acer* sp.) collection of the Mlyňany Arboretum IFE SAS as a source of perspective plant material for urban plantations

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Mlyňany Arboretum IFE SAS as the largest Slovak woody plant collection cultivates numerous exotic maple (*Acer* sp.) taxa (42 species and 31 subspecies, forms and cultivars) with potential to become an alternative for plantations growing under adverse urban conditions further strengthened by continual climate change. In this work we focussed on morphological and phenological (aesthetical) characterization as well as analysis of urban-environment resistance in the most perspective non-native maple species (besides native species and widely spread *A. negundo* L., *A. saccharinum* L. and *A. palmatum* Thunb.). All these species are very attractive by habitus, bark, twig, leaf, flower and/or fruit. Flowering (BBCH 60-69) of them was positioned into second part of April – beginning of May 2018 but larger diversity was observed in the timing of fruit ripening (BBCH 81-89). In *A. ginnala* Maxim. and *A. monspessulanum* L. it was the first half of August, in *A. griseum* (Franch.) Pax and *A. opalus* Mill. in the second half of August – beginning of September, in *A. cappadocicum* Gleditsch in the second part of September, and in *A. buergerianum* Miq., *A. grosseri* Pax and *A. japonicum* Thunb. in the first part of October. Concerning their resistance to the urban environment, *A. japonicum* represents the most sensitive species, and *A. opalus* together with *A. monspessulanum* the most resistant ones. The rest maple species show intermediate resistance, similar to that of most of the native species. Thus, depending on the local microclimate, species of intermediate to high urban-environment resistance are recommended for city greenery composition.

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Botanical garden - an institution of practical education

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The Botanical Garden of Pavol Jozef Šafárik University in Košice fulfills the status of a research and pedagogical institution, but also of a cultural and an educational one in a broader sense. It strives to mediate and bring its rich collections to the general public, pupils and students thanks to permanent exhibitions, thematic exposition and guide activities. The average number of paying visitors of the Botanical Garden reaches an average of 40,000 per year. Approximately 170 groups are interested in the guided tours every year. In addition to these informal ways of education, Botanical Garden of P. J. Šafárik University focuses on the cooperation with primary schools within the BOTANIKIÁDA project. The project celebrated its tenth anniversary in 2019. BOTANIKIÁDA addresses primary schools throughout the Košice and Prešov autonomous regions. During the 10 years of the project, 27,637 pupils completed the on-line tests in the school round and 2,130 pupils and their teachers personally participated in the regional round in the Botanical Garden.

**Experience with the operation of artificial water elements in the Botanical Garden of Pavol Jozef Šafárik University
Assortment of the genus *Nymphaea* and selected species of macrophytes with ecological and aesthetic benefits for ornamental ponds**

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Part of the construction of the new outdoor exposition before the year 2000 was the connection of the central pool and the existing lakes. The method of implementation and material design corresponded to the possibilities of the time. At present, these implemented modifications are at the end of their service life.

In 2019, therefore, we began the renovation of water features. In the "lower pools", the reservoir itself was rebuilt, new insulation was made, the surface of the pool, the mouth of the stream was modified, a well-thought-out sludge treatment system with a simple root cleaning was built and the water level control and circulation were completely innovated. All modifications respect the requirement to create attractive conditions for the presentation of aquatic, swampy and moisture-loving plants. The reconstruction also contributed to supporting the development of valuable fauna. Long-term operation of water elements under heavy load during intensive visits to the Botanical Garden area has brought several important experiences in ensuring sustainable water quality. Particular attention is paid to the support of noble biological processes.

In the newly created conditions, but also in the original places of the area, a set of plants suitable for the settlement in ornamental water features is presented. Aesthetically attractive plants also perform many important ecological functions. Representatives of the genus *Nymphaea* have a specific position among hydromacrophytes. At PJŠU BG, we are currently presenting an assortment of water lilies in 4 species and 13 varieties.

120th anniversary of the Botanical Garden of Faculty of Science of Charles University in Prague

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The Botanical Garden of the Charles University in the Na Slupi locality on the faculty premises lives to be 120 years old. In addition to educational and cultural significance for Prague and the University, it also has a long "Slovak footprint". Almost throughout the 20th century, it was supplemented with collections and seeds from Slovakia, so it contains rare Slovak species, such as *Lathyrus venetus*, *L. transsilvanicus*, *Beckmania eruciformis*, *Carex brevicollis*, *Fritillaria meleagris* or *Ephedra distachya*. The dominant feature is still the exposition of Central European flora (nicknamed Karlštejn), but significant changes have taken place in recent years: the Serpentine rock and Utility plants exposition was reconstructed, the Peat and Moor exposition was completely relocated and expanded, the Carpathian exposition and Phylogenetic system were newly built. The areas of the tropical greenhouse were rebuilt, where a greenhouse of phylogenetically old groups and geographically defined Paleotropes and Neotropes was created. A number of geographically oriented exhibits in the external subtropical exhibition (Western Mediterranean, Dragon Mountains, Australia, Patagonia and the Andes, southwestern USA) and in the subtropical succulent greenhouse (southern Brazil, Cape, Cuba, Galapagos, etc.) .

Rare, protected and endangered species of vascular plants in the collection of Botanical Garden of the Jagiellonian University

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The process of extinction of species that has intensified in recent years means that more and more species are inscribed on the "Red Lists". One of the forms of protection relevant for extremely rare and endangered species is *ex situ* conservation, i.e. outside the place of natural occurrence. This type of protection is most often implemented by botanical gardens, national parks and arboretums. The cultivation of a sufficiently large population allows the creation of a kind of live bank, maintaining priceless genetic diversity. Thanks to this, it can be used in the future for reintroduction into natural sites.

The collection of the Botanical Garden of the Jagiellonian University contains about 150 species of protected, rare and endangered plants. Particularly valuable are extinct in Poland in natural conditions: *Iris graminea* L., *Marsilea quadrifolia* L., *Primula halleri* Honck and *Pulsatilla vulgaris* Mill., As well as having single stations: *Asplenium adiantumnigrum* L., *Echium russicum* J. F. Gmel., *Erysimum piennanicum* (Zapał.) Pawł., *Juniperus sabina* L., *Lathyrus pannonicus* (Jacq.) Garcke, *Primula farinosa* L., *Ranunculus iliricus* L., *Rhododendron luteum* Sweet and *Spiraea media* Schmidt.

Damage to fruits and seeds of the selected shrub species by insect pests

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During the years 2016 - 2018, 18 shrub taxa were examined in the Botanical Garden of P.J.Š.U. in Košice. The seeds were collected from September to October. The principle of seed collecting from several fertile shrubs was followed, in order to capture the average conditions in the stand group. When only one shrub specimen appeared, all the fruits were harvested. According to the standard methodology, the minimum range of selection was 4 x 100 pieces of fruits, in the case of poor production all available fruits were collected. The inspection of each sample consisted of a visual surface check focusing on relevant external signs of damage (non-standard fruit shape, discolouration, necrotic tissue on the surface, perforation of the fruit after pest leaving and hole shape, possible presence of web fibres, presence and shape of faeces near the fruit perforation). Subsequently, the fruit was analyzed by incision, associated with the removal of dry or fleshy seed cover. The research revealed a total of 18 species of pests belonging to the following taxonomic groups: hymenopterans (Hymenoptera), hemipterans (Hemiptera), beetles (Coleoptera), butterflies (Lepidoptera) and dipterans (Diptera). The largest extent of damaged fruits, up to 47%, was indicated on the scarlet hawthorn (*Pyracantha coccinea* M. Roem., nom. cons.). The pest was cherry fruit fly (*Rhagoletis cerasi* L.), this species also occurred on other shrub species - bearberry cotoneaster (*Cotoneaster dammeri* C. K. Schneid.) and common barberry (*Berberis vulgaris* L.). The second most numerous pest was *Spermophagus sericeus* Geoffr. It caused damage to the seeds of bladder-senna (*Colutea arborescens* L.), common laburnum (*Laburnum anagyroides* Medik.) and wild privet (*Ligustrum vulgare* L.). No pest was found in the fruits of common dogwood (*Cornus sanguinea* L.) and common snowberry (*Symphoricarpos albus* (L.) S. F. Blake). The highest proportion of empty fruits, namely 66, 00% was found on hazel *Corylus laciniata* Hort. ex A.DC.

Antioxidant effect of plants of the genus *Tagetes*

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The aim of research work was determination of selected metabolites and antioxidant activity (FRAP and DPPH assays) by spectrophotometric methods in some *Tagetes* plants (*T. patula* L. *Harmony Boy*, *T. patula Bonanza Yellow*, *T. patula Bonanza Deep Orange*, *T. patula* L. *Bonanza Bee*, *T. patula Bright Yellow*, *T. tenuifolia* Cav. *Red Gem*, *T. erecta* African *Marigold*, *T. erecta* L. *Kilimanjaro White*). The amount of the carotenoids and xanthophylls was on the scale from 0.130 to 0.428 mg/g; the amount of the chlorophyll A from 0.099 to 0.316 mg/g; chlorophyll B in the range of 0.058 and 0.370 mg/g and the total chlorophyll 0.160 – 0.628 mg/g of dry sample. The content of the total polyphenols was between 0.24 – 0.99%. The amount of flavonoids varied significantly depending on the used sample. *Tagetes erecta Kilimanjaro White* did not contain almost any flavonoids (0.05%). On the other side, *Tagetes patula Harmony Boy* was excelling from the other samples (6.16%). The all samples have approximately the same antioxidant activity in the FRAP assay, except the sample *Tagetes erecta Kilimanjaro White*, which was much lower than the other samples. It did not show almost any antioxidant activity by the DPPH assay. The other samples had about the same valuation of antioxidant activity (DPPH assay), except the samples *Tagetes patula Harmony Boy* and *Tagetes patula Hero Orange*, which had almost double antioxidant activity.

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Snowbed vegetation as bio-indicator of climate change

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Snowbeds vegetation is characterized by a long-lasting snow cover. This key abiotic factor controlling plant life in snowbeds is sensitive to anthropogenic climate change. The aim of the research is to identify the population structure of bio-indicators and to investigate the impact of climate change on the biota of alpine snowbeds in the Tatra Mts. Communities of snowbeds belong to the class *Salicetea herbaceae* and are represented by species like *Polytrichum sexangulare*, *Luzula alpinopilosa* subsp. *obscura*, *Gnaphalium supinum* or *Salix herbacea*. We use three methods of data collecting and processing to determine the changes in snowbed vegetation. First, we monitor snow cover duration and do vegetation surveys on permanent plots in Veľká studená dolina, High Tatras. There we see the annual changes in snow and vegetation cover. Second, we determine species composition along the snowmelt gradient on transects in 33 snowbeds. These transects cross the centers of the snowbeds and continue in the neighbouring vegetation. There is an obvious zonation of vegetation to be seen. Third, we compare historical and recent data. We resample relevés from 1970 – 1980 and examine qualitative and quantitative changes in species composition. Our hypothesis is that the vegetation changes in snowbeds are a measurable bio-indicator of climate change.

Evaluation of woody plants in protected area Hrádocké arborétum

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Hrádocké arborétum was established as botanical Park situated in the High School of Forestry complex in Liptovský Hrádok by the end of the 19th century. The area is situated in the built-up area of the town and it is very important part of the urban greenery. Arboretum is designated as protected site with 4th level of protection in accordance with the Act No.543/2002 Coll. on Nature and Landscape Protection. It is also part of the cultural heritage monument designated in accordance with Act No. 49/2002 Coll. on the Protection of Monuments and Historic Sites. The area serves to students of forestry as a living study room of dendrology, and it enables to study ecological conditions and acclimatization of exotic woody plants in given conditions.

The aim of the inventory was creating the database and maps outputs of the woody species vegetation components in order to get detailed information about them from the landscape architecture perspective. Methodology of evaluation was focused on qualitative indicators, such as development stage of individuals, vitality (both physiological and biomechanical aspect) and the summary attribute "landscaping value". On the basis of fieldwork evaluation the required data for suggesting tree care and future renewal operations was obtained. Analyses of the oldest woody species vegetation components according to the annual rings of cut down individuals and comparison of historical maps, archive materials and recent data were made as well.

Introduction of growing medicinal and aromatic plants at the Presov University fields in Presov, Slovakia

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The university fields with an area of 0.55 hectares at Presov University in Presov, belonging to the Department of Ecology, Faculty Humanities and Natural Sciences, University of Presov. It was used mostly for growing vegetables and fruit in previous times. The biodiversity of medicinal plant species, the use of natural drug resources and the experience of folk medicine has been a continuous subject of research and development (R&D) at the University of Presov. The actual R&D results of chamomile (*Matricaria recutita* L.), peppermint (*Mentha ×piperita* L.), lemon balm (*Melissa officinalis* L.), pot marigold (*Calendula officinalis* L.), yarrow (*Achillea collina* Becker ex Rchb.) and poppy (*Papaver somniferum* L.) are presented. On the other hand the leuzea (*Rhaponticum carthamoides* /Willd. / Iljin) and puncture vine (*Tribulus terrestris* L.) are showed, as the introduced new/alternative crops, with their commercially successful. Generally, the Presov university R&D program should contribute to the solution of the following tasks of medicinal plant cultivation in Eastern Slovakia: - to decrease a risk of production, - to improve variable profitability of the single herbal species, - to propose and develop suitable special mechanization, high seed quality, determination of their pollution, etc., - to design progressive trimming lines, store-rooms, extraction and distillation equipment, post-harvest technologies, - to decrease a ratio of manual labor, - to establish functioning relations between suppliers and customers and - to improve skills of people working in special crop production.

Non-formal education in the botanical garden

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Current initiatives aimed at reforming science education require fundamental changes in the teaching of subjects not only in the school environment but also outside it. Institutions dealing with formal and non-formal education should be involved in alternative and innovative ways of teaching science subjects within the education system. Botanical gardens represent an ideal place for the implementation of research methods of teaching science subjects and outdoor educational activities for different age groups of students, in which students can actively participate and thus have the opportunity to develop their knowledge, skills, abilities and attitudes. Botanical gardens enable and provide an environment where students can combine their existing knowledge and experience about plants, their anatomy and morphology, meaning, ecology, conservation and geographical distribution with new information. Inquiry based accompaniment allows students to independently study phenomena, look for answers to questions that they formulate themselves and have the opportunity to experience the feeling of discovery. It was on their basis that we carried out an experiential accompaniment through three sites (Forest Ecosystem, Herb Garden and Citrus) in the UPJŠ Botanical Garden in Košice for pupils in the 2nd grade of primary schools and eight-year grammar schools. We have developed methodological materials for teachers and worksheets for students for individual stations. We had an experiential accompaniment in the summer months and 170 students took part in it, of which 88 were boys and 82 were girls. After the implementation of the experiential accompaniment, the students prepared a worksheet from the given station. Based on the evaluation of worksheets, we found that students were able to answer all tasks. None of the students had below-average results. Teachers should focus more on teaching outside the classroom, in a natural environment, to motivate pupils and enable them to experience the research, discovery and exploration that is a natural part of their development.

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Plant Phylogeny Posters – providing clear and concise overviews of plant phylogeny

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The Plant Phylogeny Posters (PPP) project is a free and regularly updated portfolio of depictions of phylogenetic relationships of extant lineages of plants in a clear and appealing format for the academic and wider audience. The idea was conceived by Theodor C. H. Cole with the intention of providing basic phylogenetic, morphological, geographical, and phytochemical information in a visually and graphically simple and concise manner for teaching plant systematics. The portfolio of the PPP includes the three main (A0) posters: Angiosperm Phylogeny Poster – APP (now in 30 languages!), Tracheophyte Phylogeny Poster – TPP, Bryophyte Phylogeny Poster – BPP, and 30 posters of single orders and families of angiosperms. Each poster provides an overview of a particular group on the order/family/genus levels listing important apomorphic, plesiomorphic and diagnostic traits. The APP has become a recognized sustainable tool for teaching plant systematics. More than 110 botanists from all around the world have joined the project and have provided translations of the posters into their national languages (currently 32 languages). All posters are freely available on ResearchGate on the pages of the authors, and each poster has its own DOI number. The electronic format of these posters enables regular updates based on the latest research, and thus the information presented on the posters is largely current.

Lichen diversity in the Botanical garden of Pavol Jozef Šafárik University in Košice

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Botanical garden UPJŠ in Košice celebrates 70 years of existence. In total 31 species of lichens were found, 13 of them endangered (*Evernia prunastri*, *Flavoparmelia caperata*, *Hypogymnia tubulosa*, *Melanohalea elegantula*, *Melanelixia subaurifera*, *Parmelia submontana*, *Parmelina tiliacea*, *P. quercina*, *Physconia enteroxantha*, *P. perisidiosa*, *Pseudevernia furfuracea*, *Xanthoria parietina* and *X. polycarpa*). Several pollution sensitive species were recorded – *Evernia prunastri* (EN), *Flavoparmelia caperata* (EN), *Parmelia submontana* (CR) or juvenile *Usnea* sp. Nitrophilic species were present but not dominant. Two indicative species for natural oak forest were found – *Cetrelia olivetorum* and *Flavoparmelia caperata*. Rare species *Parmelina quercina* (CR), which is typical for oak forests, was found on the branches fallen from a tree canopy. Given time, lichen flora in the Botanical Garden of Pavol Jozef Šafárik in Košice has a potential to present natural lichen diversity in central European oak forests.

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Biodiversity informatics – global information resources in biodiversity studies

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According to Wikipedia, biodiversity informatics is the application of informatics techniques to biodiversity information for improved management, presentation, discovery, exploration and analysis. Most of us use its products in our every-day life. In the nomenclature practice, probably most important database project is the International Plant Names Index (IPNI), comprising all validly published species names, and for last dozens of years also infraspecific ones. Other databases, providing authoritative lists of accepted names and synonyms, have often limited geographical coverage or they are in the various stages of development. From among them, Tropicos, Euro+Med PlantBase, The Plant List, Plants of the World online or World Flora Online should be mentioned. Of particular importance are digital libraries, as Biodiversity Heritage Library, Biblioteca Digital (Real Jardín Botánico, Madrid) or Botanicus (Missouri Botanical Garden). Herbarium collections are often presented in digital form, either by individual institutions or by the portal JSTOR Global Plants, providing access to almost 3 million type specimens and other important collections from more than 300 institutions worldwide. Database of Global Biodiversity Information Facility (GBIF) comprises more than 1.5 billion distribution records on plants and animals, collection based or observations. Although data are of various quality, it is the most important information resource for biodiversity studies and applications.

Seventy unique years of the Botanical Garden of P. J. Šafárik University in Košice

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The Botanical Garden in Košice (BG) was established owing to the initiative of Dr. Jozef Rácz on May 5, 1950 as the Botanical Institute of the University of Agricultural and Forest Engineering (VŠPLI). Later it belonged to the Slovak Academy of Sciences and the Pedagogical Institute, until it became a part of Pavol Jozef Šafárik University in Košice (UPJŠ) in 1964. From its beginning it has played a role of a scientific and pedagogical institution. A number of plants were planted in the originally almost bare area, greenhouses were built, which were open on October 14, 1958. At that time they belonged among the largest ones in Central Europe. In 1969, the administrative building was completed. At present, BG is a protected area with a total of 30 ha, greenhouses on an area of 3,500 m² and more than 4,000 species, subspecies and cultivars of plants. It is thus the largest BG in Slovakia with the richest collection of cacti and cycads in Slovakia, as well as with various unique plant species from around the world. In accordance with the International Convention on Biological Diversity, the main scope of the activities of the BG is the scientific research aimed at the concentrating and studying of the gene pool of endangered and common species around the world with a special focus on endangered species of the Carpathians and Pannonia. In a synergy with the Faculty of Science, UPJŠ, the Botanical Garden participates in higher education. It also supports the education in primary and secondary schools through permanent expositions, exhibitions and competitions. These activities also play a significant role in the education and development of cultural awareness in the region.

Herbarium of the Botanical Garden of P. J. Šafárik University in Košice – a part of the botanical history of the region of east Slovakia.

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In 1884, Seed Station of the Royal Hungarian Seed Inspection Institute in Budapest and Košice was established in Košice. On its ground probably the first institutional herbarium in this region was established. It gathered collections of wild plants from the vicinity of Košice and eastern Slovakia, including exsiccates of the collectors like Degen, Thaisz and later Deyl. In 1950, the Botanical Garden of the University of Agricultural and Forest Engineering was established in Košice. Plant documentation material from the region of east Slovakia began to be concentrated there and the second institutional herbarium, which was later taken over by the Slovak Academy of Sciences, was established. In 1960, the Botanical Garden in Košice was taken over by the Pedagogical Institute, and the larger herbarium was then reduced to 3,415 herbarium specimens. In the years 1958-1960, however, it was enriched by 9,539 herbarium specimens of the Košice branch of ÚKZUZ (Ústřední kontrolní a zkušební ústav zemědělský - Central Agricultural Inspection and Testing Institute), which passed the herbarium from the years 1897 – 1943 to the botanical garden. In 1964, the botanical garden became a part of the Pavol Jozef Šafárik University (UPJŠ). At that time, the herbarium included 16,000 herbarium specimens of seed plants. For many years, the herbarium had only provisional rooms for its storage. In the early 1990s, a part of the building of the Botanical Garden was rebuilt and herbarium depositary and study room were formed. Later an electronic database has been created and in recent years the herbarium specimens have also been digitized. At the present time, the herbarium includes about 60,000 specimens, of which more than 35,000 are registered in the database and some of them (more than 9,000) are digitized.

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Botanical Garden of P. J. Šafárik University and plant karyology

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Karyological research in the Botanical Garden started in 1990. It was bound to different research projects concerning endangered taxa of Carpathians and Pannonia. Although the intensity of karyological work was significant at that time, the documentation was a problem due to the very old equipment and classical photo. The facilitation and following intensification of karyological research came with the quality microscope and digital camera as a part of laboratory equipment. Since then karyological part of different projects of basic research was carried in the Botanical Garden. The poster presents some survey of different taxa studied in the Botanical garden of P. J. Šafárik University from the point of view of karyology.

Phytoindication of environmental mutagenesis in the *in situ* condition

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Higher plants are a complex integrator of interacting processes and generally meet all the conditions for bioindication. Their advantages are, in particular, that they have a natural integrating function in dynamic media; they live directly in the environment or where standardized model test systems are implanted; are easily identifiable; they give a general or specific response to a change in the environment; they do not escape from the polluted environment; respectively they can be cultivated as needed; allow to monitor the genotoxic effect of a risk factor or several risk factors, the effect of residues or their metabolites.

In the detection of ecogenotoxicity *in situ* conditions, besides of the implantation of standardized indicator models, have been significantly applied pollen grains, mother pollen cells, and pollen tetrads of the selected diploid species of the local flora used as a basic bioindicative material

The advantage of this material is the high sensitivity, which is conditioned by the haploid state and the frequency required for the corresponding statistical analysis of the results. The use of microspores and pollen makes it possible to effectively detect parallel damage at all three structural levels of the genetic apparatus of the cell; the impact of short-term and long-term exposure; impacts of acute and persistent environmental load as well as adaptation mechanisms and the response of the individual and population in different types of environmental load.

Chilli peppers in the collections of the botanical garden of the SUA in Nitra

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Chili peppers are used worldwide in foods for their pungent flavor, aroma, and to prolong food spoilage. With capsaicin contents ranging from zero to millions of Scoville heat units, the different varieties offer a wide range of options for people all over the world. The Andean Region of South America is the centre of origin for many traditional varieties of chilli pepper (*Capsicum*). Peru has the highest diversity of cultivated chilli peppers in the world, while Bolivia is the centre of origin for several cultivated and wild pepper varieties. Chilli peppers in the collections of the botanical garden of the SUA in Nitra, cultivated in the greenhouses respecting totally the seasonal rhythm of the plants, counts 240 chilli pepper varieties from all over the world and is currently, the most extended in Slovakia. Represented from the countries of South America 68 var., Central America 58 var., North America 43 var., Europe 26 var., Asia 28 var., Africa 17 var. The native species such as *Capsicum galapagoense*, *Capsicum lanceolatum*, *Capsicum praetermissum*, *Capsicum rhomboideum*, *Capsicum chacoense* are also interesting.

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Herbarium collections and their role for the study of global environmental change

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Global environmental change, which includes human-induced destruction or alternation of natural habitats, human-triggered biological invasions, human-induced increase in CO₂ concentration, global warming or elevated atmospheric N depositions, has impacted spatial and temporal distribution of plants and their ecophysiological responses. Given their temporal and spatial aspects, and biochemical information they contain, herbarium specimens might provide an important information about long-term effects of particular components of global change on plants.

In my talk, I will show several case studies, I have had an opportunity to be involved in, where herbarium specimens have been used as an essential research tool to (i) document a spatial retreat of one narrow endemic plant, (ii) detect spatio-temporal range dynamics and niche evolution of an invasive and a native species, (iii) understand overall and species-specific ecophysiological responses to elevated CO₂ concentration and global warming.

Acknowledgments

I thank my collaborators and helpers who have been involved in various ways in these studies, and curators of many herbarium institutions for careful curation of their „archives of biodiversity“ and possibility to use their collections for our research.

Endopolyploidy variations in organs and tissues of *Polytrichum formosum*

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Endoreduplication is common process in the plant kingdom; it leads to endopolyploidy, which facilitates growth and allows adaptation to the environment. It is widespread in most plant lineages, and mosses are no exception. Endopolyploidy had only been previously studied in ~60 moss species, which represents less than 1% of known mosses. Nearly all moss species studied so far were endopolyploid. We analysed moss *Polytrichum formosum* to determine the variability of endopolyploidy using flow cytometry, to identify patterns in ploidy levels among gametophytic tissues. Differences in endopolyploidy level between organs (phylloids, cauloids) and among organ parts (basal, middle, apical) were significant. Higher ploidy levels were found in older, proximal parts of organs than in younger, distal parts. According to these results, endopolyploidy is spatially differentiated in the gametophytes of *Polytrichum formosum* and follows a similar pattern, which can be seen in angiosperms.

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Interdisciplinary research on the occurrence and ecophysiology of aquatic macrophytes

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Ecophysiological research was focused to two common water macrophytes with crucial role in water ecosystems. Field data on the occurrence of *Ceratophyllum demersum* L. and *Myriophyllum spicatum* L. in relation of the water ammonium or nitrate content were compared with experiments performed in the laboratory. Ammonium concentrations above 32 $\mu\text{mol L}^{-1}$ in the monitored area were found to be a strong limiting factor for both species. In short-term laboratory experiments, the plants were grown well even at 100 $\mu\text{mol L}^{-1}$ at pH 7.5, but higher concentration were already found to be unfavourable for both species. High ammonium content in water suppressed the growth and affected the accumulation of antioxidative flavonoids. High nitrate was also found to be a limiting factor for *M. spicatum* in natural conditions, but not in laboratory experiments. Such effect of nitrate is rather indirect, related to other factors such as water turbidity.

Antibiofilm activity of selected Lamiaceae species essential oils against *Candida albicans*

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In this study the antifungal and antibiofilm activity of five essential oils (EOs) of the *Lamiaceae* family (*Salvia officinalis*, *Thymus vulgaris*, *Rosmarinus officinalis*, *Origanum vulgare*, *Hyssopus officinalis*) were determined. In the preliminary investigations was tested antifungal effect of each EOs in the concentration range of 200 – 0.4 mg/ml on planktonic *Candida albicans* cells. A total 13 *Candida albicans* clinical isolates were evaluated on biofilm formation. Only 1 strain was found out as strong biofilm producer, 9 isolates showed weak biofilm production and 4 strains were detected as moderate biofilm producers. The EOs of *Thymus vulgaris* and *Origanum vulgare* were seen as strong antifungal agents with the MIC 0.4 mg/ml on planktonic cells. Less effective were EOs of *Hyssopus officinalis* (0.9 mg/ml), *Rosmarinus officinalis* (2.4 mg/ml) and *Salvia officinalis* (23.2 mg/ml). All isolates were used for determination of EOs efficacy on the inhibition of adherence phase and biofilm formation. The biofilm production of *Candida albicans* after exposition by EOs was quantitatively examined by the crystal violet dying. The most effective for adherence phase and biofilm formation were EOs of *Origanum vulgare* (0.1 mg/ml and 0.3 mg/ml) and *Thymus vulgaris* (0.1 mg/ml and 0.4 mg/ml). The obtained results claim that EOs of *Thymus vulgaris* and *Origanum vulgare* are potential agents for antifungal treatment or prophylaxis by reduce the resistance of pathogen.

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Three *Juniperus* species – characteristic differences of essential oils and their properties for the distilling industry

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Juniper species typically grow in rocky, infertile soils, in fields, meadows, pastures, open woods and other settings, almost from sea level to alpine sites. Juniper species are shrubs found in different several forms, up to a height up to 2.0 m. Juniper berries contain essential oil and have been used in several medical ailments. In this study, essential oils from the mature fruit essential oils of three different juniper species: *Juniperus communis* L. (Common Juniper), *Juniperus oxycedrus* L. (Prickly Juniper) and *Juniperus sabina* L. (Savin Juniper) are presented.

Different chemical composition of essential oils from berries of three juniper species were recorded in this study. There are important differences of all monitored characteristics. The *J. communis* had 0.8 % essential oil with α -pinene as major component (61 %). The plants *J. oxycedrus* that grow on dry stone slopes in the mountains of Macedonia had essential oils of 1.30 %, in which β -myrcene was the dominant component. The cypress cones of *J. sabina*, which grow in the valley of the Dunajec River, were reported to have 1.6 % essential oil with sabinene compound 80 % as major component. The differences among weights of 100 juniper berries were presented too. The markedly smallest and lightest fruits ($5.84 \text{ g} \pm 0.15$) of *J. communis* were collected at the locality near the High Tatra Mountains, where juniper plants were grown. Approximate, average weight of *J. oxycedrus* fruit was $29.57 \text{ g} \pm 1.58$, which was 5.0 times more than *J. communis* and *J. sabina*.

Our studies also suggested using *J. communis* berries in manufacture of the Slovak national beverage "Borovicka" because of great contents of α -pinene, which is a donor for required aroma and other inappropriate residues.

Acknowledgment

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The pattern of active substances accumulation in chamomile varieties under growing condition in Chullcuisa, Peru

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Slovakia is one of the European countries in which particular attention has been devoted to research of medicinal, aromatic and spice plants in all its aspects, including the breeding and selection. Based on the study of pharmacodynamics properties of chamomile (*Matricaria recutita* L.), the new chamomile variety 'LIANKA' was bred at the University of Presov, Slovakia, between the years 2008 – 2013. Currently, the variety 'LIANKA' has the certificate by the Community Plant Variety Office in Angers, France (No. 46937).

Thanks of Lush Ltd. Company (Dorset, UK), a comparative investigation of four chamomile varieties ('LIANKA', 'PERUVIAN', 'BODE GOLD' and 'ZLOTY LAN') carried out in Chullcuisa (S 13°40'47.3", W 73°15'15.3", Altitude: from 3,500 to 3,811 m), Province: Andahuaylas, District: San Jerónimo, Peru in 2019. The Slovakian chamomile variety was characterized by its highest percentage of sesquiterpenes (/-/- α -bisabolol [60 \pm 2.00 %], chamazulene [13 \pm 1.00 %], the low contents of /-/- α bisabololoxides A and B [$<$ 2.5 %] and essential oil content was 0.55 \pm 0.05 % of the dry inflorescences. The mean flavonoid content (Σ apigenines) was 0.80 \pm 0.05 %; at which the apigenine-7-glucoside had its amount 0.40 \pm 0.02 %. Pharmaceutical practice and clinical studies have generally used chamomile extracts from high bisabolol varieties. Given the pharmacological properties of /-/- α -bisabolol and chamazulene it is important to use these varieties which are high in designate active constituents and are suitably processed. There is a strong premise that the cultivation of chamomile variety 'LIANKA' throughout the EU and outside it will be expanded in the coming years.

Expression of curly birch origins (*Betula pendula* Roth. var. *carelica* [Merklin] Hämet-Ahti) archived in Borová hora Arboretum

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Curly birch (*Betula pendula* Roth. var. *carelica* (Merklin) Hämet-Ahti) in Slovakia remains rarely naturally occurring tree species – has the natural range limited to approximately middle part of silver birch (*Betula pendula* Roth.) distribution (Vetchinnikova 2004). Its natural range is discontinuous with islets and mosaic-like occurrence, usually in separated micropopulations (2–3 ha), at the north eastern distribution border even of 5–10 ha large (Ljubavskaja, 1978). It is mainly distributed in the northern Europe with the northern most presence in the vicinity of Lake Onega and the Karelia Plateau (Finland, Russia). Its mass occurrence is found in north and northeast Slovakia, most southern in Zemplínske vrchy in the south-eastern Slovakia (Pagan et al., 1994).

This contribution deals with quantitative and qualitative expressions of curly birch origins which were found in the Slovakia (129 origins in total number 430 individuals) and then grafted and planted or sown in Borová hora Arboretum. Main goals are 1) to evaluate quantitative characteristics of all individuals with the vegetative and generative origin and 2) to assess transfer and development of heritable traits, especially colour of bark, swirls and type of growth. We find out that quantitative characteristics are significantly influenced only by growing type (0.05, ANOVA). Transfer of qualitative characteristics on next generation is assessed through pivot tables. In contrast to the colour of the bark, hereditary transmission of swirls highly variety and it appears to be independent of the original form. Transfer of qualitative characteristics on next generation is assessed through pivot tables. We find out that vegetative individuals are usually with white bark (80%) and in shrubby growing type (85%). Arborescent or individuals with dark bark are in the minority. The majority of the population creates agglomerate swirls (44.6%), what is the best quality of the swirls. Despite the high phenotypic variability and linkage of curly birch to extreme environmental factors, our results show that it is possible to grow its high-quality subsequent generations in non-original conditions.

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History of the natural science collections of the East Slovakian Museum and the activities of the Natural Science Club in Košice during years 1932 – 1938

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Upper Hungarian museum association in Košice was established in October 1872 with an aim to create Upper Hungarian Museum as ancestor of today's Eastern Slovakian Museum. Museum was opened on 25th June 1876 with a grand opening ceremony. One of the aims was to develop its national geographical character on the territory of current Eastern Slovakia. People from wealthy families happily dedicated collections of different sorts for museum's use.

During the years 1874 – 1884 yearbooks of Upper Hungarian museum association were printed, where natural science collections were assessed as well. Destiny of natural science collections were mainly influenced by moving of museum to a new building at the former Stalin Square. 21st June was marked by opening the new exposition. We know that since 1903 collections were available for visitors to see, however, years 1909 – 1910 were critical for natural science collections. Collections were liquidated and given away to local schools without any written documentation about delimitation.

Thought of concentration as well as intensifying of natural scientific work in Košice was realised only after creating individual club in 1932. The main focus of the club was concentrated on exploring work, local research, collection activity for archives and museums, propaganda and popularisation of natural science, publishing activity and cooperation in applied branches of natural science. Club actively worked until the year 1938. Their work was evaluated by publishing the proceedings (*Sborník prírodovedeckého klubu v Košiciach*).

Natural or semi-natural elements as an indicator of biocultural value of landscape

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Societies have interacted with nature throughout human history resulting in various types of cultural landscape. Landscape that integrates both interacting natural and cultural elements give a particular character to the biocultural landscapes. Human activities have disturbed natural landscape resulting mostly in semi-natural habitats or destroyed habitats in agricultural, urban or industrial landscape types. On the other hand, human also shaped for centuries different habitats of cultural landscape that support biodiversity and increase biocultural landscape value. Some of them partly depend on human activities; some of them are fully dependant on human management. The aim of our contribution focuses on proposal of various natural indicators that help to assess biocultural value of landscape. They include natural areas depended on human management, including area of historical green infrastructure, trends in development of overall green infrastructure within selected areas, high nature value farmland. Attention is paid also to traditional ecological knowledge that support maintenance of this type of landscape and cultural ecosystem services that provide for society.

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From chemical to biological control - changes in pest management strategy in greenhouses of the Botanical Garden of P. J. Šafárik University in Košice

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In the course of the years 2000 – 2019, the detailed data on pest control in greenhouses with tropical and subtropical flora of the Botanical Garden of P.J. Šafárik University in Košice were collected. The usual chemical control of pests was applied there almost exclusively until 2006 when biological control began to be carried out in most greenhouses accessible to visitors. As a result, no classical pesticides were used in some of these greenhouses for the past 13 years. Actually it is the only botanical garden in Slovakia that uses beneficial predatory and parasitic species of insects, mites and other animals, as well as entomopathogenic fungi and bacteria to such an extent. Due to the same space and nearly unchanged plant species composition all 20 years, the unique comparison of chemical and biological pest control methods was possible in this specific environment. Types, amounts and costs of all pest control measures are discussed in detail.

Biological control here is still associated with several problems like delayed effect of some biological agents against pests causing local damage to certain plants, new pest species, time consuming detailed monitoring of presented organisms, the occasional need to use additional measures in individual cases and limited availability of some biological control products in Slovakia. Despite the mentioned disadvantages, the biological methods of pest control have brought significant benefits compared to conventional chemical treatment. In this way, a healthier environment is created for visitors and employees. Some attractive animals (e.g. fish, exotic butterflies) can be kept in greenhouses and it contributes to a more varied offer of possible attractions. Considering all costs, the biological methods have proven to be more advantageous even from an economic point of view. The relevant greenhouses are now continuously accessible without restrictions that have been connected with chemical interventions in the past. Last but not least, there is potential for educational effects associated with the presentation of relationships between plants, phytophagous animals and their natural enemies known from nature and used in practice.

Bryological research in Slovakia: history, status quo, challenges and perspectives

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Slovakia belongs to botanically very rich regions in Europe, yet bryological research is far from developed. Many parts of the country are still bryofloristically poorly explored or rely on old records, and new taxa are still being reported. Until recently, bryophytes have also been greatly neglected in phytosociology. A relatively intensive bryo-floristic survey was done during former Czechoslovakia, but in recent decades bryological research has been carried out mainly in the most attractive regions such as the Tatra Mts and habitats such as wetlands, or in the close vicinity of bryologists' residence. Recent achievements include a new and revised bryophyte nomenclature in Slovak, as well as an updated checklist and redlist of mosses (Bryophyta) which comprise of 699 species (with 2 additional subspecies and 21 varieties). An updated checklist and redlist of liverworts (Marchantiophyta) and hornworts (Anthocerotophyta) are being published and they comprise of 231 liverwort and two hornwort species. To this day, virtually no identification tool in Slovak exists (only in Czech), however a new atlas of bryophytes of Slovakia is being published. Development of a bryophyte vegetation database (along with species occurrence maps) similar to the Czech model DaLiBor is an ambitious and much-desired venture. Further work should be addressed towards less explored areas and taxa of conservational interest. More students also need to be recruited to increase workforce and carry out research in other disciplines.

Response of phytodiversity and species composition to experimental application of historical management and nitrogen deposition in oak-hornbeam forests

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Biodiversity loss and changes of plant communities in temperate broadleaved forests and their various drivers were identified recently by analyses of resampled historical plots across Europe. To disentangle their particular effects, we established a field experiment in 5 sites of oak-hornbeam forests in Central Slovakia. Reduction of tree canopy, nitrogen fertilizing, litter removing were applied in blocks of 20x20 m plots, where vegetation, soil, climatic and dendrometric properties were sampled in three following years. Significant effect of the treatments was observed already in the first vegetation season after their application and continued at similar rate also in the following year. Rapid increase of species richness was found especially in plots with combination of treatments (on average from 19 to 54 species on 100 m²). Mostly ruderal and annual species (e.g. *Moehringia trinervia* or *Senecio sylvaticus*) occurred immediately in the first year after treatment application, and some perennials (including some characteristic nemoral species of opened oak forests, such as *Poa nemoralis* or *Veronica chamaedrys*) increased their cover and frequency in the second year. Effects on soil and microclimatic properties were identified as well. However, it is only a beginning of long-time experiment, and observations in following years will approve a long-time change of community and environmental properties of the oak-hornbeam forests.

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***Ophiocordyceps sinensis*: “Winter worm-summer grass”**

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Fungi of the genus *Ophiocordyceps sinensis* belong to entomopathogenic fungi, because their growth is contingent by parasitism on insects or other arthropods. *Ophiocordyceps sinensis* is tonic and medicinal product in China for more than 2 000 years. In our country it is known as the Chinese scepter, in Tibet it is called yartsa gunbu and in China it is called dōng chóng xià cǎo, which in both cases can be translated as "winter worm - summer grass". As part of traditional Chinese medicine, *Ophiocordyceps sinensis* has been used in respiratory problems, kidney, liver and heart problems, hyposexuality, hyperlipidemia, and weakening of the immune system. It is also used as a complement to modern cancer treatments (chemotherapy, irradiation and surgery). A number of scientific works describe the clinical use of this parasitic fungus with subsequent biological and pharmacological effects. The various chemical compounds identified in these fungi are responsible for such a wide range of biological activity: cordycepin, cordycepic acid, D-mannitol, polysaccharides, nucleotides, proteins and amino acids, unsaturated fatty acids.

Our research deals with the determination of the biologically active chemical compounds in cultivated *Ophiocordyceps sinensis* using UV/VIS spectrophotometry, IR and NMR spectroscopy. Antioxidant, antifungal and antibacterial activity was determined in the isolated extracts.

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