

## **Questionnaire**

### **Summary of the main activities of a scientific Organisation of the Slovak Academy of Sciences**

*Period: January 1, 2007 - December 31, 2011*

#### ***I. Formal information on the assessed Organisation:***

##### **1. Legal name and address**

Botanický ústav SAV (Institute of Botany SAS)  
Dúbravská cesta 9  
845 23 Bratislava

##### **2. Executive body of the Organisation and its composition**

Directoriat	name	age	years in the position
director	Ivan Jarolímek	58	12
deputy director	Igor Mistrík	63	12
scientific secretary	Anna Guttová	40	3

##### **3. Head of the Scientific Board**

Karol Marhold

##### **4. Basic information about the research personnel**

- i. **Number of employees with a university degree (PhD students excluded) engaged in research and development and their full time equivalent work capacity (FTE) in 2007, 2008, 2009, 2010, 2011 and average number during the assessment period**
- ii. **Organisation units/departments and their FTE employees with the university degree engaged in research and development**

Research staff	2007		2008		2009		2010		2011		average	
	No.	FTE	No.	FTE								
organisation in whole	58,0	50,0	58,0	51,0	63,0	53,5	67,0	51,2	64,0	48,5	62,0	50,8
unit 1 Plant Physiology	20,0	18,0	19,0	16,3	21,0	18,0	24,0	16,9	22,0	15,9	21,2	17,0
unit 2 Non-vascular plants	10,0	9,0	10,0	9,5	10,0	10,0	10,0	9,5	10,0	6,9	10,0	9,0
unit 3 Vascular plant taxonomy	16,0	13,0	15,0	13,0	18,0	13,8	18,0	13,8	18,0	14,8	17,0	13,7
unit 4 Geobotany	12,0	10,0	14,0	12,3	14,0	11,8	15,0	11,0	14,0	10,9	13,8	11,2

## 5. Basic information on the funding

- i. Total salary budget<sup>1</sup> of the Organisation allocated from the institutional resources of the Slovak Academy of Sciences (SAS) in 2007, 2008, 2009, 2010, 2011 and average amount for the assessment period

Salary budget	2007	2008	2009	2010	2011	average
total salary budget (millions of EUR)	0,620	0,665	0,707	0,724	0,700	0,683

## 6. URL of the Organisation's web site

[www.ibot.sav.sk](http://www.ibot.sav.sk)

## *II. General information on the research and development activity of the Organisation:*

### 1. Mission Statement of the Organisation as presented in its Foundation Charter

Research activity of the Institute is focused on basic research in the area of systematic, experimental and environmental botany and ecology. Main focus is on: 1) study of diversity and evolutionary relationships of lower and higher plants and plant communities, preferably in the area of Slovakia, but also the Carpathians, Pannonian lowland, the Alps and other regions. The aims are to acquire as complete knowledge of the flora as possible, gradual understanding of variability and evolution of individual taxonomic groups and plant communities and subsequent solution of issues of taxonomy and nomenclature; and on 2) experimental study of structure and function of plant organisms on different levels of their organisation and their responses to abiotic and biotic factors. The aim is to understand causes, connections and mechanisms of ongoing processes and mechanisms regulating these processes.

<sup>1</sup> Objem mzdových prostriedkov bez odvodov do poisťovní so započítaním sumy miezd pracovníkov THS, ktorú organizácii poskytne ETO Úradu SAV. Rozpočet v Sk prepočítajte na eurá podľa konverzného kurzu 1€ = 30,126. (Podobne aj v ďalších tabuľkách.)

The Institute creates basic knowledge base for the complex research of ecosystems on local, regional and landscape levels and for scientifically justified protection, rational use and management of the nature and landscape. The Institute provides advisory and expert service, connected with the main activities of the Institute, performs PhD study following the relevant laws. The Institute publishes results of research activities in periodical and non-periodical press. The Institute possesses, manages and builds collection of plants internationally registered in the Index Herbariorum under acronym "SAV" and collection of microorganisms.

## 2. Summary of R&D activity pursued by the Organisation during the assessed period, from both national and international aspects and its incorporation in the European Research Area

Research in the **Department of Geobotany** has been concentrated on the following activities:

**(1) Inventory of the vegetation diversity in Slovakia** continued at both regional and national levels. The outputs were summarized in several monographs and numerous papers.

- **Vegetation of Slovakia 4. High-mountain vegetation** a part of multivolume publication on vegetation, cover of Slovak Republic, has followed previous volumes dealing with pioneer, synanthropic and wetland vegetation.
- **Grassland vegetation of Slovak Republic – electronic expert system for identification of syntaxa** contains results of scientific projects aimed at the synthesis of Slovak grassland vegetation and its evaluation according to the recent knowledge on central-European vegetation. The review includes semi-natural communities.
- **Diagnostic, constant and dominant species of the higher vegetation units of Slovakia (2008)**. This study represents the first complete statistical revision of phytosociological data (43 222 relevés) stored in the Slovak national vegetation database. The affinities of vascular plants, bryophytes and lichens occurring in Slovakia to the major syntaxa (alliances and classes) are calculated using a statistically defined coefficient of fidelity. In addition, constant and dominant taxa of particular syntaxa are identified.
- **Saline habitats in Pannonia: ecology and taxonomy of selected halophytes and their communities**. We focus on endangered saline habitats in Pannonia. Model biotopes included usually degraded Slovak saline habitats and relatively natural saline sites in Hungary, Austria and Serbia. The zonation of saline vegetation caused by various salt content was studied on transects. **The non-forest vegetation of the mountain and subalpine belts of the Krivánska Malá Fatra Mts.** We focused on the vegetation research around and above the timberline in the Krivánska Malá Fatra Mts. Some of the units were stated for the first time from the Malá Fatra Mts and several of them were newly described for science.
- **Management models for grassland habitats**. Over the last few years, considerable attention has been paid to the use of grassland habitats and their conservation in Slovakia. This is the result of international commitments which Slovakia is bound to follow in the field of nature conservation. In collaboration with Daphne – Institute for applied ecology, 20 management models for grassland communities were prepared. Field experiments, focused on examining the influence of mowing, grazing and mulching on the species and vegetation structure of plant communities in selected territories of Slovakia, were an inherent part of the project.

**(2) Vegetation dynamics, study of spatial and temporal changes at various levels, modeling and prediction of further development of vegetation.**

- **Island phenomenon of the Carpathian high mountains in relation to environmental factors, synecology of plant communities and phytogeography of selected plant species**. We studied biodiversity in the Carpathians on population and community level focusing on mutual interactions between individual plant species, as well as between communities and abiotic environment in various space-temporal scales. Results were interpreted within wider historical and evolutionary context. Complex research of time-space dynamics of high-mountain vegetation was performed using recent and historical vegetation data (50 years old records) connected with climatic, soil and geology GIS layers in Dolina siedmych prameňov

(Belianske Tatry Mts.). The influence of alien species on mountain habitats, distribution of neophytes and apophytes in the Tatry Mts. and their occurrence in natural and seminatural habitats were investigated. Communities were assessed based on occurrence of endemic and relict taxa.

- **Dynamics and succession of grassland vegetation.** The main goal was to evaluate and elucidate the present state and temporal changes in grassland vegetation using the modern statistical methods. Changes of grassland vegetation were studied in selected regions (Biele Karpaty Mts., Poľana Mts.). The successional changes in vegetation composition after 46 years of abandonment were studied in Devínska Kobyla Nature Reserve. The area of grasslands has been reduced by 61.1% compared with 1949 levels. Using computer modeling in GIS, the suitable management model for dry grasslands was defined.
- **The catalogue of non-native species of vascular plants and the analysis of the level of invasion across habitats of Slovakia.** Research on the invasion of alien plants and animals is of growing importance worldwide, because they may represent threat for the diversity of native species, through changes in community structure, nutrient cycles, competition, hybridization and others, and may even cause high economic losses by reducing yields in crops, promoting allergic reactions and altering the natural environment. The main aim of our study was to assess current distribution of alien plants in Slovakia and create a first complete national catalogue of alien plants. That enables to make broader analyses of both habitat affinity of alien plants and the level of invasion of habitats and their vulnerability to invasion, what is fundamental not only for our knowledge on the ecology of aliens but also for the purpose of the nature conservation.

### (3) Ecology of plant communities and population biology of selected plant species.

- **Demographical, coenological and ecological analysis of *Tephroseris longifolia* subsp. *moravica* - the threatened taxon of European importance.** *Tephroseris longifolia* subsp. *moravica* is a critically endangered endemic taxon of Carpathian flora included in the European list of important species. The marked individuals of studied species were monitored on permanent plots and the data on their survival were obtained. The demographical analysis was made to ensure the relevant information for proposal of optimal monitoring and objective evaluation of the recent knowledge. Cultivation experiments, seed bank survey, estimation of ecological requirements and limiting factors of the taxon were realized. The first consistent information on reproductive biology (mating system, seed production, germination, soil seed bank) was provided and management techniques for effective conservation of studied species were proposed. A granivorous butterfly, *Phycitodes albatella* (family Pyralidae), was identified as a pest reducing seed production by 18 to 28%.
- **The distribution and diversity of aquatic macrophyte vegetation in water-bodies of Slovakia in relation to environmental factors and anthropic disturbance.** The project was focused on distribution and ecology of aquatic and marsh plants in Slovak running waters. We completed knowledge about distribution of the selected rare, endangered or taxonomically problematic macrophytes (e.g. *Ceratophyllum submersum*, *Potamogeton berchtoldii*, macroscopic algae – Charophyta). The hydrological connectivity and land use surroundings of watercourse were determined as the main/major environmental drivers affecting distribution and quantity patterns of macrophytes in the Slovak river (Danube). On the other hand, environmental factors including sediment type, shading of shrubs and trees on the banks, water depth, NO<sub>2</sub>-and water acidity become more relevant for macrophyte composition in Slovak streams. Vegetation study dealing with seasonal dynamics of macrophytes in two streams pointed out statistically significant effect of water depth and air temperature to quality and quantity of plants as well as different behaviour of three species group (hydrophytes, helophytes and amphiphytes). We prepared reference index for assessment of ecological status of running water in sense of European Water Frame directive.

Research in the **Department of Taxonomy of Vascular Plants** has been concentrated on the following activities:

#### (1) Studies on the flora of Slovakia

(a) **The multivolume publication *Flóra Slovenska* (Flora of Slovakia)** represents the first thorough inventory of the plant diversity in Slovakia, and serves as an important tool for biodiversity conservation, forestry, agriculture, but also for all those who deal with plants in basic research. Not only it is deposited in most of the large botanical libraries throughout Europe, but all published volumes are also available online in a **digital format** via Biblioteca Digital del Real Jardín Botánico Madrid (<http://bibdigital.rjb.csic.es/>), thanks to the joint efforts of the IB SAS and RJB CSIC, Madrid. The recent volume, ***Flóra Slovenska* VI/1**, focusing on

the evaluation of the taxa of the orders *Cistales*, *Elatiniales*, *Begoniales*, *Tamaricales*, *Violales*, *Cucurbitales* and *Campanulales* was published in 2008.

**(b) Database of flora of Slovakia – DataFloS ([www.dataflos.sav.sk](http://www.dataflos.sav.sk))** provides, albeit still incomplete, online information on the distribution of vascular plant species in Slovakia both in Slovak and English. The application serves as data archive as well as a management tool for plant distribution data from herbarium specimens, published sources as well as from unpublished manuscripts. DataFloS includes not only distribution data from Slovakia, but also data from herbarium specimens collected abroad and deposited in Slovak herbaria. It is linked also to the global biodiversity information system, GBIF (Global Biodiversity Information Facility, [www.gbif.org](http://www.gbif.org)), providing data via this most important biodiversity gateway. Currently the database includes approximately 120,000 publicly accessible records.

**(c) Karyological database of the ferns and flowering plants of Slovakia ([www.chromosomes.sav.sk](http://www.chromosomes.sav.sk))** was launched in 2007 together with the publication of the book and CD entitled **Chromosome numbers survey of the ferns and flowering plants of Slovakia**. The database, book and CD represent a complete inventory of the chromosome number reports on the ferns and flowering plants from Slovakia, subjected to a critical revision by experts. It is one of the few publications of this kind that is available on-line and is continuously updated.

**(d) Identification key to the vascular plants of Slovakia.** As a single volume it will allow identification of all plants occurring in Slovakia, and thus will be an irreplaceable tool for all those who work with plants in the field, as well as for all levels of education. The work on the Key is in a final editorial stage, with publication expected in early 2013.

## **(2) Participation in the European and global scale biodiversity projects.**

Department of the Vascular Plant Taxonomy had been providing data to the large European collaborative project **Atlas Florae Europaeae** since its first volumes. During the assessed period we have provided distribution data on 133 species of the family *Rosaceae* (*Alchemilla*, *Aphanes* and *Rubus*) to the volumes 14 and 15 of the Atlas, and also data on more than 80 species of the genera *Amelanchier*, *Cotoneaster*, *Crataegus*, *Malus*, *Prunus*, *Pyrus* and *Sorbus* for the volumes 16 and 17, which are currently in preparation.

The Department actively took part also in **projects of the 6th, 7th and CIP-ICT Framework Programmes** dealing with various aspects of the biodiversity research:

- Within the project **ENSCONET – European seed conservation network (2004-2009)** a network of European seed banks and co-operating institutions was established, representing all biogeographical regions of Europe. Main role of seed banks is a long-term storage of seeds of plants under low temperature. Participants of the project finalized and tested seed collecting protocol for seed banks and created physical and virtual infrastructure supporting seed collecting and storage. Priority list of species for future collecting was prepared.
- Project **EDIT – Towards the European Distributed Institute of Taxonomy (2006-2011)** aimed at establishing the network of most important European institutions dealing with biodiversity and taxonomic research, both on plants and animals. Close cooperation was established for the joint software development, coordination of project activities, courses for PhD students and postdocs. After completing the project, activities of the network were taken over by the Consortium of European Taxonomic Facilities ([www.cetaf.org](http://www.cetaf.org)) to which IB SAS was admitted in 2010, and which provides the background for further participation in the activities within European Research Area.
- The main goal of the project **PESI – A Pan-European Species-directories Infrastructure (2008-2011)**, was to establish authoritative registers of all organisms occurring on the European continent, based on three already available data sets: European Register of Marine Species, Fauna Europaea, a Euro+Med PlantBase. The role of IB SAS was editing and quality check of the data on 22 plant families, among them also such large ones as *Brassicaceae* and *Caryophyllaceae*. The register is already used both for research and biodiversity conservation purposes throughout Europe.
- The project **Opening up the Natural History Heritage for EUROPEANA (OpenUp!) (2011-2014)** aims to bring access to the natural history objects from European museums and other collections to the European portal [www.europeana.eu](http://www.europeana.eu). Such objects were very much underrepresented in this portal, nevertheless, already after the first year of the project more than 600 000 objects are already available to view for specialists, but especially to the general public. The role of the IB SAS is in coordination of the botanical part of the project (as a workpackage leader), but also in providing access to its own herbarium collections. From among them, especially specimens collected by František Nábělek in 1909-1911 in the area of Near East are

of particular importance and international interest.

**(3) Detailed studies on taxonomy and phylogeny of selected groups of flowering plants in the Carpathians, Alps, Pannonia, Balkan Peninsula, and in some cases also on European or worldwide scales.** Numerous studies have been carried out in selected genera and species groups, mainly in the families *Brassicaceae* and *Asteraceae*, but also in some other flowering plant groups. These studies have successfully combined thorough work in the field, evaluation of morphological variation using methods of multivariate morphometrics, karyological studies using direct chromosome counting and flow cytometry, as well as a wide spectrum methods of molecular systematics (AFLP analyses, microsatellites, chloroplast and nuclear DNA sequences, and most recently also the next generation sequencing). These studies are relevant not only for a better understanding of the taxonomy and evolution of particular species groups or genera, but are also highly relevant for getting a deeper insight into plant evolution, phenomena of polyploidy, hybridisation, as well as for addressing phylogeographic questions that aim to reveal postglacial history of European vegetation. Broader relevance of such research papers is expressed also in their citations well beyond the studies of the respective genera.

- **Alpine species of the genus *Cardamine* (*Brassicaceae*)** were used as models to address the detailed history of disjunctions in the European alpine system. As an example, for the snow-bed species *C. alpina* we resolved two strongly divergent lineages, corresponding to the Alps and the Pyrenees. Although multiple glacial refugia were invoked in the Pyrenees, we inferred only a single one in the Maritime Alps – from which rapid post-glacial colonization of the entire Alps occurred, accompanied by a strong founder effect.
- **The study on the populations of the complex *Alyssum montanum*-*A. repens***, demonstrated that the variation patterns contradict the current taxonomic concepts held for these taxa. We demonstrated that the traditional delimitation of two subspecies of *A. montanum* is not substantiated and we provided their new circumscription. Genetic patterns suggested different evolutionary histories for the two subspecies: in subsp. *gmelinii* the data supported the scenario of colonization from a single or a few source populations and recent diversification, whereas, in subsp. *montanum* the observed pattern indicated a more ancient genetic structure and a longer, in-situ persistence of populations. Focusing on the Apennine Peninsula and SW Alpine populations, we provided the evidence for the Mediterranean refugia for the studied complex located in central and S Italy. Past extinctions, genetic bottlenecks and recent expansion were inferred in Central Europe, while long-term accumulation of diversity as well as polyploidization occurred in the Apennines.
- The morphometric study of **perennial species of the genus *Cyanus* in Central Europe** supported recognition of three species, namely *C. axillaris*, *C. strictus* and *C. dominii*. In *C. dominii*, restricted to the Western Carpathians, we found considerable variation that justifies the division into three subspecies: subsp. *dominii*, subsp. *slovenicus* and subsp. *sokolensis*. A cultivation experiment confirmed that differences among these taxa are genetically fixed. The pattern of genetic diversity based on AFLP markers revealed striking genetic gap between the Austrian-Czech and the Western Carpatho-Pannonian populations, caused by different glacial refugia and/or postglacial migration routes. A very recent diversification and/or ongoing gene flow caused the weak genetic differentiation of morphologically well-separated taxa within the Western Carpathians and Pannonia.
- **A detailed study of the *Pilosella alpicola* group** was performed with the aim to solve the taxonomic problems and to clarify the role of polyploidization and hybridization in its evolution. *Pilosella alpicola* group comprises four closely related allopatric and morphologically distinct taxa with different karyological variation and breeding systems. In spite of a clear morphological separation, molecular analyses suggest rather recent and monophyletic origin of all studied taxa, with exception of *P. alpicola* s.str. Range shifts and extinctions were likely involved in shaping the evolutionary and modern distributional pattern of the group.
- **Genetic structure of *Cyclamen purpurascens*, a mountainous calcicolous species**, was analysed to test hypotheses regarding its glacial survival in single or multiple refugia and postglacial colonization routes, and to explore how they are congruent with the histories inferred for temperate trees and other mountainous herbs. We suggested that *C. purpurascens* survived the last glaciation in two main regions, the foothills of the Southern Limestone Alps and the Karst area of the Northwestern Dinarides, and most likely also in microrefugia in the Western Carpathians. The glacial persistence and colonization routes of this woodland herb are highly concordant with those inferred for several temperate trees.
- **Polymorphic species *Viola suavis***. Species of the genus *Viola* are commonly grown for their ornamental flowers, but their evolutionary history and taxonomy have been poorly explored so far. In our study we focused on a highly polymorphic species *Viola suavis*. We showed that (1) the European white-flowered populations of uncertain taxonomic assignment that occur in Spain and central and south-eastern Europe

evolved independently and that (2) that the species is in Europe represented by four allopatric, genetically and morphologically differentiated lineages, which were suggested to be recognized at the subspecific level. Populations from SW Balkan Peninsula were described as a new subspecies, *V. suavis* subsp. *austrordalmatica*.

- In the genus *Onosma* (**Boraginaceae**) we confirmed the recognition of three main evolutionary lineages in Europe, suggested previously based on their morphology and karyotype: *Asterotricha*, *Haplotricha* and *Heterotricha*. Using genetic (AFLPs, DNA sequencing), morphological and cytometric data we delimited seven species in the **Asterotricha lineage**. Within *O. heterophylla* s.l. we illustrated a distinct position of *O. viridis* from Romania, but we did not confirm a separate species status for the Slovak endemic *O. tornensis*. Both morphological and genetic data strongly suggest that populations of *O. tornensis* are conspecific with *O. viridis*. The Balkan-Apenine *O. echioides* showed high, but largely continuous genetic and morphological variation, precluding the recognition of previously described subspecies.

Research in the **Department of Non-Vascular Plants** has been focused on the following activities:

**(1) The multivolume publication Flóra Slovenska (Flora of Slovakia).**

As already introduced, the series represents the first thorough inventory of the plant diversity in Slovakia, including fungi, and serves as an important tool for biodiversity protection, forestry, agriculture, but also for all those who are concerned with plants in diverse branches of science. The latest volume **Flóra Slovenska X/2. Mycota (Huby) – Ascomycota** treating Taphrinomycetes fungi was published in 2010. It is the first monographic treatment of microscopic fungi of the order Taphrinales in Slovakia, and the second volume of the edition “Flóra Slovenska” devoted to lower plants. These fungi are biotrophic, parasitizing on ferns and flowering plants, they play important ecological role in phytocenoses and sensitively respond to changing quality of environment. Because some of *Taphrinaceae* deteriorate certain crops, deeper knowledge of the group is significant also from economic viewpoint.

The on-going project **Flora of Slovakia: Cyanobacteria I. – thermophilous species** aims at gathering data for the further volume focused on the group of cyanobacteria. Life cycles, particularly formation of heterocystes and hormogonia, was studied in the group of nostocal taxa *Mastigocladus* and *Hapalosiphon* isolated from thermal spa water in Sklené Teplice and Piešťany.

**(2) Taxonomy, nomenclature and diversity of selected groups of non-vascular plants on the national, Carpathian and Pannonian, European, and in some cases also broader scales.**

Numerous studies on taxonomy and nomenclature have been carried out in selected genera and species groups. These studies have combined thorough work in the field, evaluation of morphological variation using methods of multivariate morphometrics, as well as methods of molecular systematics (nuclear DNA sequences). They are highly relevant for getting deeper insight into fungal evolution, as well as for addressing phylogeographic questions. Below we give a few examples:

- More than 400 of *Russula* species have been recognized in North America. Approximately three quarters of them are autochthonous; remaining species were described from Europe and have been applied for North American taxa. The question of trans-atlantic species distribution is closely related to taxonomy of European members. Main aim of our study has been the revision of systematic position and delimitation of selected North American *Russula* species based on morphological studies of type and other authentic material.
- Research in **geoglossoid fungi of grassland habitats** in Slovakia broaden the knowledge on their species diversity, so far 16 of them have been identified. They are important as they indicate deterioration of grassland habitats (pastures and meadows) due to decay of traditional farming and drainage. First insight into the genetic diversity on nuclear DNA level was done clarifying phylogenetic relationship between the taxa. Studies on **Agaricales** growing in **semi-natural grasslands** in Slovakia was aimed to genera *Pseudobaeospora* and family *Clavariaceae*. For stabilization of species concept, authentic material of C.H. Persoon was studied and analysed. For Persoon's species as well as for other traditional taxa, epi- or neotypes have been designated and species concept have been defined based on morphological and molecular analyses. Knowledge about occurrence and species delimitation of *Pseudobaeospora mutabilis*, *P. bassii* and *P. celluloderma* have been updated. *Pseudobaeospora terrayi* was described as a new species for science from Slovakia.

- Studies on **taxonomy and biogeography** of the genus *Flammulina* in central Europe resulted in several outputs. Morphologically defined groups were compared with results of DNA analyses. Characters used for delimitation of *F. velutipes* and *F. elastica* proved to be insufficient for species delimitation.
- **Taxonomical revision of the genus *Solenopsora*** (lichens, *Catillariaceae*) was aimed at morphological, genetical (nuclear DNA sequences, 3 genes) and chemical variation of European taxa. The studied material represents populations from the periphery of distributional area (e.g. Western Carpathians) as well as from distributional optimum (e.g. Balkan and other parts of the Mediterranean). The taxa differ by the morphological structure of cortex. Partial results point at good delimitation of the species included in the analysis so far in currently applied concept. Genetic markers confirmed identity of Macedonian collection, which corresponded to the diagnosis of *S. carpatica*. Sequences of samples from Adriatic, from where there are published records of *S. liparina*, are placed within *S. carpatica*. Population of *S. carpatica* from the Jeseníky Mts., growing on serpentines is genetically different from the core group "*carpatica*".
- **Diversity of aquatic ecosystems.** We studied localities with well developed assemblages of diatoms, and with taxa which could be considered expansive or invasive. In inundation gravel-pit and sand bows and lakes along the river Morava we observed strong event of expansive occurrence of saline diatom *Actinocyclus normanii* f. *subsalsa*. We gathered data on changes in diatom composition of the lakes in Bratislava, which is closely linked to eutrophication and pollution of the environment as well as global warming of biosphere (e.g. frequent occurrence of the species *Cyclotella balatonis* and *C. pseudocomensis*). Furthermore, due to increase in annual average temperature there are conditions for development of the taxa typical for tropical and subtropical zones, e.g. *Discostella woltereckii*.
- **Diversity of large-scale protected areas.** In the form of monographs and papers we summarized the results of mycological and lichenological research in several orographical units of Slovakia (Slovenský raj Mts, Veporské vrchy Mts, Stolické vrchy Mts, Vihorlat Mts, Veľká Fatra Mts., Nízke Tatry Mts., Belianske Tatry Mts., Muránska planina Mts., Strážovské vrchy Mts., Bukovské vrchy Mts., Záhorie, Slovenský kras karst). We investigated diversity of epiphytic lichens in montane spruce forest in Nature Reserve Fabova hoľa and analysed character of epiphytic lichen with respect to current seral stage of the forest after natural disturbances in 2004 and 2007. We summarized the knowledge on distribution of several important taxa (rare, endangered) of these groups in Slovakia (e.g. *Cudoniella acicularis*, *Plectania melastoma*, *Crepidotus ehrendorferi*, *Parmelina quercina*, *Dimerella lutea*, *Cladonia turgida*, *Vankya vailantii*). We identified several new species of these organisms for Slovakia (e.g. microscopic fungus *Septoria cyclaminis* on a host plant *Cyclamen fatrense*). Our type collections contributed to the description of a genus *Antherospora* new to science and to the description of the new species for science *Antherospora vindobonensis*. We updated the data on the occurrence of bryophyte species included into the system NATURA 2000.

### (3) Biomonitoring

- We studied decrease in air pollution load in urban environment of Bratislava inferred from **accumulation of metal elements in lichens**. The study illustrates the response of epiphytic lichens to changing atmospheric conditions in Central Europe, where the emission of air pollutants has significantly decreased from 1990. Variation in concentrations of seven metal elements (Cu, Cd, Cr, Mn, Ni, Pb and Zn) in the thalli of 3 epiphytic lichens was assessed. The decrease in air pollution (for all studied elements by more than 90%) corresponded to a decrease in the accumulation of elements in lichen thalli, e.g. the contents of Pb decreased by 69% and of Cd by 34% on average. The background values of metal element contents in thalli of *H. physodes* growing in situ were measured in semi-natural sites in Slovakia. These can be used as a reference in large-scale monitoring studies in Central Europe. Analysis of compatible data from the current study, and the study performed at the end of 1990s shows a significant decrease of metal elements in the air pollution load. Then we focused on **physiological response of the lichen *Evernia prunastri* to decreased air pollution** in an urban environment of Bratislava. The lichen is sensitive to air pollution and reacted by total retreat to the worsening of air quality during 1950s–1990. Since 1990, after significant decrease in air pollution, epiphytic lichens initiated recolonization into previously polluted areas, including *E. prunastri*. We investigated the physiological status of *E. prunastri* transplanted for six months in 34 sites in Bratislava under current conditions inferred from several parameters (e.g. assimilation pigments, chlorophyll integrity, the content of cortical and medullar secondary metabolites and soluble proteins). The results showed that the status of the lichen did not significantly change after the exposure. Sites with natural occurrence of *E. prunastri* featured lower share of nitrophilous species in comparison to sites where *E. prunastri* was not present. This suggests that the indicator species may recolonize

sites with low eutrophication also in urban environments under decreased air pollution and can help to assess the pressure caused by nitrogen excess.

- **Elimination of eutrophication process in water basin using composite sorbent.** We participated in the studies of this topic contributing with the study of total species composition of cyanobacteria and algae of studied water body and their seasonal variation. We recorded relatively low diversity of these organisms. We monitored changes in qualitative and quantitative composition of these organisms after application of composite sorbent in phytobenthos and phytoplankton. We recorded significant changes in composition of phytoplankton assemblages after application of composite sorbent. For example, green coenobiotic algae were replaced by picoplankton colony cyanobacteria. Incipient decrease in abundance of phytoplankton after application of the sorbent was followed by its strong development. Instead of expected decrease in abundance, we recorded a „boom“, with progressive tendencies until the end of a vegetation season in autumn.

Research in the **Department of Plant Physiology** concentrated on the following issues:

- **Bridging genomics and agrosystem management: Resource for adaptation and sustainable production of *Lotus* spp. in environmentally constrained South America soils.** In the frame of multilateral cooperation with the institutions of EU and South America the team of the Institute of Botany S.A.S. focused on the study of selected environmental stressors (low soil pH, Al toxicity, and aridity) and their influence on growth and production of biomass of selected species and cultivars of *Lotus corniculatus* and *L. japonicus*. Main goal of the project was to select suitable cultivars of *L. japonicus*, which could bring sufficient and quality biomass for cattle stock raising and development of cattle grazing under the conditions of environmental burden on soils in South America. Our role was linked with the characterization of structural and functional properties of these cultivars, optimization of uptake and utilisation of nutrients, and characterization of the role of particular enzymatic systems in an oxidative stress induced by Al and low pH. *Lotus* sp., compared with other crops (maize, barley), is capable to withstand relatively high concentrations of Al in the root system, on the other hand, it is more sensitive to low pH.

- **Isoperoxidases of barley roots cultivated in the presence of heavy metals and their role on growth and structure of roots.** Our results show, that in most cases the studied metals (Cd, Cu, Hg, Ni, Pb) induced production of reactive oxygen forms, which influenced several growth and metabolic processes. Quantitative analysis of heavy metal uptake and production of reactive oxygen species show significant quantitative differences along the root. Increased uptake of Cd was connected with significant increase in production of reactive oxygen species, reaching their maximum concentrations in elongation zone. Increased production of H<sub>2</sub>O<sub>2</sub> is linked with significant increase in oxalate-oxidase activity, which reached its peak in the area of the apex and gradually decreased towards differentiation zone.

- **Biological forms of carbohydrate hyperaccumulation.** Little or nothing has been known about how microbial emissions may affect primary carbohydrate metabolism in plants. Our original results show that volatile compounds emitted from microorganisms induce reactions in plants leading to changes in central metabolism of carbohydrates and amino acids. We found strongly promoted starch accumulation in leaves of both mono- and dicotyledonous plants. It is new, unreported mechanism for the elicitation of plant carbohydrate metabolism by microbes. Based on data achieved, we proposed a model how the metabolism of plants could be determined by these signals to starch overaccumulation. We proved and documented reaction to microbe-emitted compounds in important agricultural species, like potato and maize. The discovery that microbial volatiles trigger starch accumulation enhancement in leaves provides new opportunities for practical and commercial application of these mechanisms in the industry where starch is used as raw material.

- **Impact of vesicular trafficking in the regulation of carbohydrate metabolism processes.** Production of volatile compounds is typical for growing colonies of different microorganisms including Gram-negative and Gram-positive bacteria and various fungi which strongly stimulate starch accumulation in leaves of plants. This response was recorded in both one- and dicotyledonous plants. Our original results show that in plants these substances cause reactions that lead to changes in the functioning of the central metabolism of sugars and amino acids. Specific changes in metabolism were demonstrated at the level of gene expression and enzyme activity. Based on data achieved, we proposed a model how the metabolism of plants could be determined by these signals to starch overaccumulation.

- **The role of structural sterols in the formation and growth of root hairs.** We performed a detailed characterization of structural sterol distribution in root trichoblasts of *Arabidopsis thaliana*. These data extended complex model of how root hair formation and their tip growth are regulated. We found important role of structural sterols in the initiation of root hairs but also in the regulation of their tip growth.

- **Plants from heavy metal-polluted habitats: specific plant communities and their structural and physiological adaptations.** Plant communities (populations, tolerant species, their structural properties and physiological manifestations) were studied in the localities with a similar heavy metal soil contamination (predominating elements Zn-Pb or Cu) in Slovakia and Austria. The floristic composition and structure of grassland communities in the localities differed in number, species composition, proportion of lichens (some of them being rare and threatened) and mosses, depending on the occurrence and concentration of the heavy metals. The characteristics of population densities, uptake and accumulation of metals in the organs of *Thlaspi caerulescens*, the species known as Zn and Cd hyperaccumulator, which serves as model system for the studies of heavy metal tolerance, supplemented the missing data for Slovakia and Central Europe. New information is the assessed difference in the capability of Zn and Cu accumulation in the leaves of *Acetosella vulgaris* from the localities with high soil heavy-metal concentrations
- **The participation of endomembranes in the maintenance of root hair polarity in response to abiotic stress.** The uptake and distribution of Zn in *Arabidopsis* species depended on the content of Zn in the root medium and the specific type of uptake and distribution strategy of particular species. *A. halleri* known as hyperaccumulator preferred accumulation of Zn in root apoplasm while in *A. thaliana* and *A. arenosa* Zn was determined also in symplasm. High concentrations of Zn (1000  $\mu$ M) in liquid or rigid culture medium significantly influenced the root hairs tip growth. Excess of Zn reduced root hairs tip growth in model cultivar of *A. thaliana* and also in genotype of *A. thaliana* originating from the natural population of the locality Ratkovo. Number of root hairs was also reduced and this reduction was greater in plants growing in liquid medium. Detailed surface analysis revealed morphological deformation of root hairs in *A. thaliana*. On the contrary in *A. halleri* originated from the contaminated locality of Krompachy the growth of root hairs was stimulated by Zn without any morphological abnormalities.
- **Structural and physiological characteristics of roots in three *Arabidopsis* species with diverse strategies in their response to metal toxicity.** The diversity of species varied in the localities with varying Zn, Pb, Cd and Cu contents in the soil and, it was markedly reduced by the enhanced metal concentrations. With respect to heavy metals in the root medium, using tolerance index, cellular resistance tests, and quantitative aspect of root system formation, we assessed the sensitivity of *A. thaliana* in both model ecotype Columbia and natural population from the locality Ratkovo, and the tolerance of the relative species *A. arenosa* and *A. halleri* from the natural localities differing in the soil heavy metal contents. The tolerance of the populations depended on the metal occurrence in the soil. Differences in population responses might indicate their ecotype differentiation.
- **Isoperoxidases of barley roots cultivated in the presence of heavy metals and their role in growth and structure of roots.** Quantitative analysis of Cd uptake in barley roots confirmed that the highest accumulation of Cd is localized in the first 2 mm long apical part of root and declines with distance from the root apex. Increased uptake of Cd was connected with significant increase in lipid peroxidation in production and accumulation of thiol groups which preferentially accumulated in the first apical segment. On the other hand, proline accumulation induced by Cd decreased with increasing distance from the apex of the root. Analysis of 15 genes confirmed a stimulation of expression of genes involved in signaling and detoxification of oxidative stress and drought induced by Cd. Expression of genes was significantly different along the longitudinal axis of the root. Increased uptake of Cd was connected with significant increase in production of reactive oxygen species, especially  $O_2$  and  $OH$ , reaching their maximum concentrations in elongation zone.
- **Novel integrated strategies for worldwide mycotoxin reduction in food and feed chains – MycoRed.** Slovakia lies on the northern border of viticulture in Europe. Due to the fact that until now no serious monitoring of toxigenic fungi occurrence on grapes was conducted in this region our project should be considered as a pilot project. During the growing season in three selected areas of viticulture and two different stages of ripening of berries we monitored the occurrence of toxigenic fungi species. We identified 9-10 potentially toxigenic fungal genera. The most frequent fungi were *Penicillium*, *Aspergillum*, *Fusarium* and *Alternaria*. We found that deoxynivalenone toxin is part of the resistance of vine varieties to toxigenic fungi. This strategy is part of the natural, biological control against the toxin.
- **The effect of selected stress factors on physiological and biochemical characteristics of crop.** Based on our results we can confirmed that seedling plants and also older maize plants as well as rape plants respond to the effects of salinization differently depending on the length and strength of the stress. Antioxidant response representing increase in the activities of antioxidant enzymes (superoxid dismutase, peroxidase and catalase), or increased accumulation of proline and ascorbate was more pronounced in roots and leaves of maize, which responds to salinization more sensitive than rape.

- **New methods of evaluation and mapping biotic harmful agents in urban greenery.** In our research we pointed out to the harmfulness of phytopathogenic fungi on leaves of trees and introduced methods to study this issue. Evaluation of gradual changes of cytoplasmic structures induced by the pathogens fungi of the genera *Erysiphe* and *Mycosphaerella* was conducted using scanning electron microscopy and confirmed the way how pathogens fungi invade the plant host.

### 3. Concept of R&D activity of the Organisation for the next four years

#### i. Present state of knowledge and status of ongoing research related to the subject of the Concept, from both international and national perspective

Species and the ecosystems of which they are part, provide a range of goods and services which support everyday life. This biodiversity is essential for livelihoods and the cultural integrity of people. Yet biodiversity is currently being lost at an alarming rate due to human activities. Species are the most intuitive unit of biodiversity, and one which resonates with the public and about which we have a relatively good understanding. This makes clear that the knowledge of the species and their communities, accurate and current, is of crucial importance for everyday life. This knowledge is based on sound research in taxonomy, which is crucial for further in-depth insight into the processes on-going in the particular species/taxa, their tissues and cells. Thus floras, vegetation surveys, identification keys, and checklists with the accompanying knowledge of physiological and biochemical processes in these species should be widely recognized as important sources that have a central position in research in this field, having crucial importance for related fields of everyday life. Our research addresses indicators of the Strategic plan for Biodiversity 2011–2020 of the Convention of Biological Diversity (CBD), with a focus on status and trends of the components of biodiversity. It contributes to the CBD goal to overcome the so-called “taxonomic impediment”, i.e. the fact that the lack of taxonomic knowledge prevents effective conservation of biodiversity as expressed in all its basic documents and decisions by the signatory countries. We deliver to the topics of species trends, trends in threatened species, the occurrence of invasive alien species and fragmentation/connectivity of biotopes, all providing complementary information on the quality of the ecosystems. We also cover the topics on trends in abundance and distribution of selected species. Tracking the net movement of species through e.g. the Red List categories provides a useful metric of changing biodiversity status. The idea of the free and full on-line access to the biodiversity information promoted by the Global Biodiversity Facility on the world scale brings new dimensions to the biodiversity research, and the world of biodiversity science is quickly changing in this respect.

Since 1990s, application of new, mainly DNA-based, methods has significantly changed **plant systematic and taxonomic studies**; currently, sophisticated methods and specialized equipment are usually required, and multi-methodological approach is preferred. This requires more efficient cooperation among institutions and research groups, joint use of research facilities and exchange of know-how among research teams in different institutions. The networks funded within the EU projects and other international initiatives aim to support this approach. In spite of the methodological developments in systematics and taxonomy, combination of the thorough field work, extensive karyological and morphometric studies with the application of recently developed methods of molecular systematics is still not so widespread, and results of such extensive studies are relatively easy to publish in prestigious journals. The applications of flow cytometry are becoming more and more widespread, giving the possibility to screen a vast amount of plant individuals and to reveal hidden karyological variation within populations. Combination of flow cytometric data with molecular methods also opens new possibilities in the study of the phenomenon of polyploidy. The importance of such studies for basic as well as applied science is underlined by the fact that a vast amount of cultivated crops belong to polyploids, and polyploidisation has played a key role in their evolution.

Only a limited number of experts study the **cryptogams** in Slovakia (and also worldwide). Thus a great amount of scientific problems remain unexplained. This is why an international cooperation on European and world-wide scale, is a prerequisite for sound and successful research and is an inherent part of daily work. The researchers of the Department of Non-Vascular Plants being the only specialized team in Slovakia, disclose unique knowledge on **species richness, taxonomy, variability, ecology, and chorology of algae, cyanobacteria, lichenized and non-lichenized fungi and bryophytes**. Current research profits from the above mentioned advances in development of sophisticated methods for molecular systematics. Another line of the research is

concentrated on bioindication in urban areas, based on species diversity and investigation of selected ecophysiological parameters and accumulation capacities of indicator species. The current research concept addresses above all need for identifying the components of biological diversity in the Carpathian region, clarifying so far inadequate knowledge on selected taxonomic groups and detecting changes in diversity of cryptogams.

**Phytocoenology/phytosociology** was born and developed in Europe as a tool for knowledge and classification of vegetation cover. Outstanding database for storage of phytocoenological relevés (TURBOWIN) facilitates exchange of data, new statistical programs and utilities allow processing and evaluation of large sets of phytosociological data using new specialized statistical approaches. Recent vegetation science is oriented also to dynamic processes in vegetation, changes in vegetation cover as a consequence of global environmental changes and/or human impact, and mapping and modelling of vegetation using GIS-methods. Permanent challenge for frontier phytosociological research is the application of results in the field of nature conservancy, e.g. in building of Natura 2000 network in Europe, or Carpathian Convention. The Department of Geobotany has direct contacts with European phytosociological leaders and leading institutions and carries out activities in all the mentioned topics.

**Research in the field of abiotic stress** is important because of its impact on productivity and quality of agricultural products. Research of physiological processes has been directed to areas of cellular mechanisms involved in perception and transduction of stress-induced signals and proteomic and genomic changes in response to different stress factors. This area, especially the early stress-induced responses at the level of gene expression and molecular and cellular mechanisms involved in tolerance or increased resistance to toxic metals, drought and salinity are the main goals for the future study. Social benefits of our studies might be the broadening of knowledge on the mechanisms responsible for tolerance or resistance of plants against stress factors and toxic xenobiotics. Economic benefits are connected with exploitation of these mechanisms in agricultural practice for production of new plants with improved tolerance to stress conditions which will be able to bring ample and healthy agricultural products even in environmentally contaminated soils. Understanding the means of manipulating metal tolerance could be also important for development of crops for phytoremediation purposes, particularly for highly contaminated soils.

## **ii. Organisation's role or significance in the overall research effort within the field of the Concept on both the national and international scales**

The Institute of Botany is a leading research institution in the study of taxonomy, phylogeny and diversity of plants, both vascular and non-vascular, and fungi and lichens, and structure, syntaxonomy and ecology of plant communities in Slovakia. A high rank of international acceptance has the Institute attained in plant physiology. The Institute significantly contributes to biodiversity studies in the Carpathian and Pannonian areas, as well as in Europe as a whole, and is represented in major European and global projects and initiatives. The results of research are widely used in basic and applied research in botany and in other biological sciences. They are employed in the evaluation of the current state of biodiversity of the Slovak Republic, in the preparation of Red lists of endangered taxa, and in corresponding national and European legislation. Publications of the Institute such as *Flora of Slovakia*, *Vegetation of Slovakia*, *Grassland vegetation of Slovak Republic* – electronic expert system for identification of syntaxa, or *Checklist of non-vascular and vascular plants of Slovakia* are widely used as reference manuals, which cannot be replaced by any other publication from abroad. On the other hand, such publications often represent fundamental information sources on the flora and vegetation of Slovakia for researchers from abroad, who either study some plant species occurring in Slovakia or need information about the country flora to generate a wider image of European biodiversity. The Institute regularly cooperates with the Ministry of Environment of the Slovak Republic (being also represented in the advisory board to the Minister of Environment for the biodiversity issues) and with all levels or organisations of the State Nature Conservancy of the Slovak Republic.

The Institute takes part also in several European and world-scale projects focused on the biodiversity studies, such as *Species Plantarum – Flora of the World*, *Euro+Med PlantBase* (EU-NOMEN, Pan-European Species directories Infrastructure), *Atlas florae europaeae*, *Global Taxonomic Initiative*, *Global Biodiversity Information*

Facility, Natura 2000. The Institute substantially participated in the elaboration of the proposal for Western Carpathian Ecological Network as a precondition for effective cross-border nature protection and in a project Plants and habitats of European cities resulting in the monograph on this topic. Team of stress physiologists was involved in the FP6 projects aimed at a study of participation of endomembranes and components of the cell wall in the maintenance of plant cell polarity. Our experience with Al toxicity in plants is the main reason why we were involved in large cooperation FP6 project among 13 European and South American institutions aimed at solving the problems with agricultural crop productivity in environmentally constrained South American (Brasilia, Chile, Uruguay, Argentina) soils. Institute participates also in the multilateral project of 14 teams from 10 countries, searching novel integrated strategies for worldwide mycotoxin reduction in food and feed chains.

Taxonomic and phylogenetic studies performed at the Department of Vascular Plant Taxonomy contribute to the research field of plant systematics and evolution, addressing taxonomic problems of some genera and species groups, as well as phenomena like polyploidisation, hybridisation, and plant speciation. The results are published in high-ranked international journals and frequently cited by researchers from abroad. During the evaluated period the team actively participated in the multilateral FP7 project ENSCONET - European Native Seed Conservation Network (including 19 institutions from 12 countries), participated in the building of the FP6 network of excellence EDIT – European Distributed Institute of Taxonomy (involving 25 institutions from 11 countries), in the preparation of a Pan-European Species directories Infrastructure (PESI, including 40 institutions from 21 countries), as well as in the CIP-ICT project Opening up the Natural History Heritage for Europeana, which aims to expose natural history objects to the general public via Europeana portal. Institute plays also an important role in the management of the rules governing the nomenclature of all organisms traditionally treated as plants. It is represented in the Editorial Committee of the International Code of Nomenclature for algae, fungi and plants and since 2011, for the next six years, hosts the International Bureau for Plant Taxonomy and Nomenclature (since 1950, this Bureau was located only in three other cities, namely Utrecht, Berlin and Vienna).

Besides solving scientific projects the Institute functions as a nursery to carry out bachelor, master and PhD theses in all botanical disciplines. The scientists of the Institute give lectures, practical courses, pre-master and master degree internships for universities, mostly at the Faculty of Natural Sciences, UK Bratislava, but also abroad (e.g. the Charles University Prague; University of Siena; University of Kyoto). The Institute organizes scientific seminars and symposia, both national and international, e.g. “International Symposium on Biology and Taxonomy of Green algae”, “Plant root structure and function”, “3rd International Symposium on Plant Neurobiology”, “Evolution of Plants in Mountainous and Alpine Habitats – 10th Symposium of the International Organization of Plant Biosystematists”, “7th European Dry Grassland Meeting: Succession, restoration and management of dry grasslands”, “ENSCONET Consortium joint collecting trip in Slovakia”, Symposium “Non-vascular plants in beech forests of Slovakia”. It contributes as organiser also to the meetings abroad, e.g. Biosystematics Berlin 2011 or International Botanical Congress – Symposium “Systematic and evolution of Brassicaceae” (2011).

### **iii. Objectives of the Concept**

Most of the research themes of the Concept represent an integral part of the European research area “Sustainable development, global change and ecosystems”. Application of the results addresses cross-cutting activities, e.g. research for policy support, in terms of national environmental policy. It is a substantial contribution to the “knowledge triangle” – research, education and innovation. The research concept set for the following years commits to address the increasing importance of the knowledge on the biodiversity and its conservation as is recognized by the EU and the member states and enshrined in law as well as international treaties (e.g. Convention of Biological Diversity, Natura 2000, Carpathian Convention). The concept is based on running or currently prepared projects and deals with the following issues:

#### **Department of Geobotany**

- (1) Publication of the books of the series Vegetation of Slovakia, dedicated to meadow, shrub and forest vegetation and finalization of long-term program Plant Communities of Slovakia.
- (2) A map of real vegetation using Geographic information system (GIS); Processing of phytosociological data and their transformation into the maps created by GIS techniques will result in the interpretation of spatial

and temporal changes in vegetation, in the design of vegetation predictive models of succession, and in the application of the appropriate ways of vegetation and habitat management.

(3) The analysis of the level of invasion of alien species across habitats and preparing the catalogue of alien species of vascular plants of Slovakia.

(4) Comparative diversity of macrophytes in various aquatic habitats. Comparing of alpha, beta and gamma diversity of various aquatic habitats, study of effect of selected environmental factors on macrophyte diversity.

(5) Detailed research will be aimed to saline and montane communities.

#### **Department of Vascular Plant Taxonomy**

(1) Continuation of the inventory of the diversity of the vascular plants in Slovakia, resulting in subsequent volumes of the Flora of Slovakia, Identification key of vascular plants of Slovakia, and Checklist of vascular plants of Slovakia.

(2) Participation in the large scale European and global taxonomic projects and initiatives, such as Species Plantarum – Flora of the World, EU-NOMEN, Pan-European Species directories Infrastructure, Atlas florae europaeae, Global Taxonomic Initiative, Global Biodiversity Information Facility, OpenUp!, providing contributions representing our geographical area of research.

(3) Taxonomic and phylogenetic studies of selected genera and species groups, among others *Alyssum*, *Arabidopsis*, *Cardamine*, *Picris*, *Senecio*, *Pilosella*, and *Cyanus* using most advanced methodological approach and combination of methods as karyology, multivariate morphometrics and molecular systematics (including advanced method of next generation sequencing).

#### **Department of Non-Vascular Plants**

(1) Algology: Analysis of diversity and distribution of cyanobacteria in relation to the temperature gradient of thermal springs. The diatom communities living in plankton and benthos of selected gravel and sand-pit lakes in Slovakia with respect to invasive species.

(2) Fungi: a) Nomenclatural studies in macromycetes described from the Western Carpathians. b) Taxonomic and phylogenetic studies of *Russula*, *Clavaria*, *Camarophyllopsis*, geoglossoid fungi and Taphrinales with advanced methodological approach and combination of methods multivariate morphometrics and molecular systematics; c) Type studies of selected taxonomic groups assigning species concept and its delimitation. d) Fungal conservation and species protection in context of global changes in environment, e) inventory of phytopathogenic fungi and their hosts plants in phytogeographical units of Slovakia

(3) Lichens: a) inventory of lichen diversity in Slovakia; b) taxonomic and phylogenetic studies of selected genera and species group with a focus on important phytogeographical elements of the Western Carpathians and their set up in the distributional area, using advanced approach and combination of methods as multivariate morphometrics and molecular systematics; participation in the formation of network focusing on barcoding of selected lichen species; 3) effects of current sources of air pollution on composition on epiphytic lichen diversity and physiological processes in indicator species

#### **Department of Plant Physiology**

(1) Functional anatomy: regulation of the polarity of the growing plant cells like root hairs with these main aspects:  
- developmental role of plasma membrane and cell surface in the control of plant cell elongation by means of regulation of the targeted molecular movement;

- development and maintaining of the particular growth mode under changing conditions of the environment.

(2) Molecular investigations of tolerance mechanisms, especially expression of genes involved in metal tolerance (PCs, MTs), drought stress (PIP, TIP) and genes involved in internal detoxification of plant cells from toxic metals and reactive oxygen species (oxidative stress) produced almost generally by different stresses.

(3) Knowledge of mechanism of protein localisation in the tip of root hairs and signalling background of tip growth. We will characterize integrity of growing tip, interactions of plasma membrane with the cell wall, distribution of structural sterols and cell wall components and involvement of endocytosis in different developmental stages of root hairs.

(4) Analysis of potential relationships between stress-induced morphogenic response, altered hormone homeostasis and ROS accumulation under abiotic stresses in barley root tip.

#### **iv. Proposed strategies and methods to be applied, and time schedule**

In the **Department of Geobotany** the methods of traditional geobotany will be combined by wide spectrum of advanced approaches of numerical classification, gradient analysis, statistical exploitation of large data sets, multivariate analyses etc. For the mapping and modelling of vegetation GIS-methods will be used. We also join

the international effort to create a consistent classification of European grasslands. At the same time, new methods developed in vegetation science, e.g. biodiversity measurement, modelling of vegetation changes and dynamics, and tools for detailed studies of relation between vegetation and environment will be adopted. The crucial role for the next years represents training of young researchers and post-doc students in institutes and universities abroad, and an intensive co-operation with researchers from abroad on preparation of joint projects. Further international co-operation in the form of post-graduate studies and participation in the international projects is aimed at continuation of the highest level of geobotanical science in Slovakia in collaboration with leading vegetation science centres in the Netherlands, Germany, the Czech Republic or Austria.

The research at the **Department of Vascular Plant Taxonomy** combines classical taxonomical approach with the application of the most advanced taxonomical and evolutionary methods. Side by side with that, the application of the most advanced taxonomical methods will aim to solve problems of taxonomy, evolution, phylogenetic and phylogeographic relationships, and hybridisation in critical species groups. From among the methods being applied, karyological ones should be mentioned first. Broadly applied flow cytometry brings a new dimension to the karyological research. Methods of multivariate morphometrics are widely applied and our results are often cited as examples of the proper application of this approach. Methods of molecular systematics (isozymes, cp and nrDNA sequences, PCR-RFLP, AFLP, microsatellites, and most recently also next generation sequencing) already became an integral part of almost any taxonomic study carried out at the Department, thanks to the fully equipped molecular laboratory. Close cooperation with the Charles University in Prague and Central European Institute of Technology in Brno resulted in establishment of the joint international team lead by Karol Marhold and Martin Lysák (Brno), which will concentrate in the next few years on studies of phylogenetic relationships within critical species of the *Brassicaceae* family. The fact that the Institute of Botany hosts for the next six years the Secretariat of the International Association for Plant Taxonomy, gives us the chance to be in a very center of world-wide taxonomic activities.

At the **Department of Non-Vascular Plants** all the methods recently used in Europe for particular problems in all the spheres covered by "cryptogamology" will be applied. In phycology special attention will be paid on taxonomy and diversity of cyanobacteria/cyanophytes from extremely different ecological conditions, and to planctonic and benthic diatom communities from gravel and sand-pit lakes in Slovakia. Important part of taxonomic and phylogenetic studies on lichens (based on mt and nrDNA sequences) is and will be carried out in the Laboratory of Molecular Systematics. The issues of research in the effects of current sources of air pollution on composition on epiphytic lichen diversity and physiological processes in indicator species will be based on transplant studies, following current approaches used in lichen ecophysiology, combined with collection of data on epiphytic lichen diversity following European standard guideline. This aspect will be studied in international cooperation with the colleagues from the University of Siena, Italy. Our studies of macrofungi will continue in stabilization of nomenclature and taxonomy of members of *Russula*, *Taphrina*, geoglossoid fungi and other groups based on precise morphological studies combining molecular studies. We will improve our molecular studies by sequencing of samples of fresh material stored in CTAB buffer and identifying genes suitable for taxonomical and phylogenetical purposes. These will be realized in close cooperation with researchers of Department of Vascular Plant Taxonomy of our institute as well as with colleagues from Mendel University in Brno and Muséum national d'Histoire naturelle in Paris.

At the **Department of Plant Physiology** we have long-lasting experience in studying morphogenesis and stress physiology in plants. We will obtain reference values characterizing the formation and degradation of reactive oxygen species in the cells during abiotic stress. Standard method (e.g. HPLC, PAGE, UV-VIS spectrophotometry, RT-PCR) will be used for isolation and analysis of gene products and enzymes. For the determination of individual reactive oxygen species our laboratory is equipped with fluoro-, lumino- microplate reader which enables us to measure the reaction in very small volumes. The growing root hairs will be characterized using modern, non-invasive methods of cell biology. In visualizing endosomal compartments we will use indicator stains for endocytosis FM1-43 a FM4-64, stable constructs for visualization of early endosomes (Rab GTPses, trans-Golgi markers), and late endosomes (Rab F2a, FYVE). Live cell imaging using enhanced contrast microscopy will enable us to monitor exo-endocytotic vesicles within the tip of root hair, which until recently were known only from electron micrographs. We will use vital fluorescent markers enabling detection of the distribution of the toxic metals within the live cells without artefacts induced by fixation. For this purpose we will use the system combining differential interference contrast (DIC) with fluorescence and confocal

microscopies. The more exact studies such as tracing of individual vesicles in live cells will be carried out in collaboration with research team abroad.

### **III. Partial indicators of the main activities:**

#### **1. Research output**

##### **i. Principal forms of research outputs of the Organisation**

The principal forms of research output are scientific monographs and papers in high quality peer-reviewed journals with impact factor. As there are several different types of research activities carried out in the Institute, there are also different forms of research outputs produced. The type of the output is selected so as the results are presented in the most suitable way. Considerable part of the research at the Institute is devoted to taxonomy of plant and fungal species and syntaxonomy of plant communities. The results of such studies are published either in the form of monographs (mostly, but not exclusively, in the series *Flóra Slovenska* [Flora of Slovakia] and *Rastlinné spoločenstvá Slovenska* [Plant communities of Slovakia]) or as scientific papers. Despite financial, institutional and publishing constraints and changing opportunities provided by new digital media, the value of the monograph, as a print-on-paper record of substantial research summary is recognized and valued, with a unique appeal and status. Important issue is also archiving function of the monograph. Equal importance for us as monographs are the results published in the form of articles published in journals with impact factor, part of our work is also published as chapters in the books (published in Slovakia or abroad), and as articles in non-impact factor journals, and in symposium/conference proceedings. We present the outputs of our work also in educational process – lectures and presentations for university students, secondary and elementary schools. We disseminate the results of our research also for the general public in form of popular contributions in mass-media – interviews (TV, radio), articles in journals, web-sites etc.

##### **ii. List of the selected publications documenting the most important results of basic research. Total number of publications in the whole assessed period should not exceed the average number of the research employees. The principal science**

[1] Marhold K., Mártonfi P., Mered'a P. jun., Mráz P., Hodálová I., Kolník M., Kučera J., Lihová J., Mrázová V., Perný M., Valko I. 2007: Chromosome numbers survey of the ferns and flowering plants of Slovakia. Veda, Bratislava, 650 pp. ISBN 978-80-224-0980-3

[2] Kliment J., Valachovič M. (eds) 2007: *Rastlinné spoločenstvá Slovenska. 4. Vysokohorská vegetácia/Plant communities of Slovakia. 4. High-mountain vegetation.* Veda, Bratislava, 386pp. ISBN 978-80-224-0951-3

[3] Jarolímek I., Šibík J. (eds), Tichý L., Kliment J., Šibíková I., Hegedúšová K., Valachovič M., Micháliková D., Škodová I., Sadloňová J., Zaliberová M., Májeková J. 2008: Diagnostic, constant and dominant species of the higher vegetation units of Slovakia. *Vegetation of Slovakia.* Veda, Bratislava, 332pp. ISBN 978-80-224-1024-3.

[4] **Goliašová K., Hodálová I., Kmet'ová E., Mártonfi P., Mered'a P. jun., Micháliková E., Miháliková T., Mráz P., Peniašteková M., Šípošová H., Eliáš P. jun., Danihelka J., Štrba P., Ťavoda O. (Goliašová K., Šípošová H., eds.) 2008: *Flóra Slovenska, VI/1.* Veda, Bratislava, 419 pp. ISBN 978-80-224-1002-1**

[5] **Bacigálová K. 2010: Mycota (huby), Ascomycota (vreckaté huby). Taphrinomycetes: Taphrinales (grannikotvaré). *Flóra Slovenska X/2.* Veda, Bratislava, 183 pp. ISBN 978-80-224-1096-0**

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**vi. List of patents registered abroad, incl. revenues**

none

**vii. List of patents registered in Slovakia, incl. revenues**

none

**viii. Table of research outputs**

*Table **Research outputs** shows research outputs in number of specified entries; these entries are then divided by FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).*

Research outputs	2007			2008			2009			2010			2011			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
chapters in monographs, books published abroad	3	0,060	0,00	2	0,039	0,00	4	0,075	0,01	6	0,117	0,01	3	0,062	0,00	18	3,6	0,071	0,01
chapters in monographs, books published in Slovakia	12	0,240	0,02	24	0,471	0,04	4	0,075	0,01	5	0,098	0,01	5	0,103	0,01	50	10,0	0,197	0,01
WOS publications	34	0,680	0,05	47	0,922	0,07	40	0,748	0,06	40	0,782	0,06	48	0,991	0,07	209	41,8	0,822	0,06
scientific publications indexed by other databases (specify)	6	0,120	0,01	8	0,157	0,01	0	0,000	0,00	0	0,000	0,00	0	0,000	0,00	14	2,8	0,055	0,00
scientific publications in other journals	38	0,760	0,06	34	0,667	0,05	29	0,542	0,04	60	1,172	0,08	48	0,991	0,07	209	41,8	0,822	0,06
publications in proc. of international scientific conferences	21	0,420	0,03	10	0,196	0,02	32	0,598	0,05	65	1,270	0,09	59	1,217	0,08	187	37,4	0,736	0,05
publications in proc. of nat. scientific conferences	3	0,060	0,00	32	0,627	0,05	20	0,374	0,03	13	0,254	0,02	46	0,949	0,07	114	22,8	0,449	0,03
active participations at international conferences	48	0,960	0,08	53	1,039	0,08	52	0,972	0,07	73	1,426	0,10	79	1,630	0,11	305	61,0	1,200	0,09
active participations at national conferences	31	0,620	0,05	40	0,784	0,06	45	0,841	0,06	38	0,742	0,05	32	0,660	0,05	186	37,2	0,732	0,05
patents registered in Slovakia	0	0,000	0,00	0	0,000	0,00	0	0,000	0,00	0	0,000	0,00	0	0,000	0,00	0	0,0	0,000	0,00
patents registered in abroad	0	0,000	0,00	0	0,000	0,00	0	0,000	0,00	1	0,020	0,00	0	0,000	0,00	1	0,2	0,004	0,00

#### ix. List of patents and patent applications

- [1] **Invention – application signed-in abroad:** P201000499, Authors: **Ovečka Miroslav**, Miren Edurne Baroja Fernández, Jun Li, Francisco José MuñozPérez, Javier Pozueta Romero, Ignacio Ezquer Garín, Abdellatif Bahaji; Title: Procedimiento para alterar el patrón de desarrollo, aumentar el crecimiento y la acumulación de almidón y alterar la estructura del almidón en plantas; Owner / co-owner: Iden Biotechnology S.L., Spain

## x. **Supplementary information and/or comments on the scientific output of the Organisation**

Expert teams oriented to the biodiversity research in non-vascular, vascular plants and plant communities publish their research results in a wide spectrum of scientific media. Most significant results are published in the peer reviewed, impacted international journals included in the ISI databases (WOS, SCOPUS, etc.), being the crucial indicator of the fundamental research activities. Important information on the flora and vegetation of Slovakia is published in monographs (Floras, checklists, identification keys, vegetation surveys, etc.). They are related to the local flora and vegetation, for the conservation of which Slovakia has an ultimate responsibility, and as such cannot be replaced by any other publications from abroad. At the national scale they serve as reference manuals for botanists and those working in other branches of science (e.g. zoology, ecology, forestry, etc.), for teachers and students at high schools and universities, and for practical purposes of the nature conservancy. On the other hand, they serve at international scale as important information sources on the flora and vegetation of Slovakia for researchers from abroad who either study some plant species occurring in Slovakia or need information about the country flora and vegetation to generate a wider picture of European biodiversity. Recently several important publications presenting syntheses of the regional biodiversity information were made available for the home and oversee cooperating institutions, universities, libraries and nature conservancy bodies. Results of regional scale biodiversity research are published in Slovak language to cultivate national botanical terminology and to approach the main target groups of readers. Nevertheless, most important information from these publications is accessible also to those whose mother tongue is other than Slovak via lists of taxa and localities, distribution maps, synonymies, etc. International interest in such publications is documented also by the fact that a full digital copy of all 13 published volumes of *Flóra Slovenska* was prepared in cooperation of IB SAS and Real Jardín Botánico, C.S.I.C., Madrid and included in one of the most important European digital libraries of botanical literature, Biblioteca Digital del Jardín Botánico C.S.I.C. (<http://bibdigital.rjb.csic.es/spa/index.php>, search for “*Flóra Slovenska*”). Expert teams oriented to experimental research in plant physiology publish nearly all results in well-impacted international journals. At the national and the international scale the results are important to focus agricultural activities to the production of crop suitable for current conditions, including specific environmental burdens related mostly to the soil quality.

Notice: List of all research outputs of monitored assessment period of structure of the Organisation’s annual report is included in the separate annex

## 2. **Responses to the scientific output**

*Table **Citations** shows specified responses to the scientific outputs; these entries are then divided by the FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).*

Citations	2006			2007			2008			2009			2010			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
Web of Science	429	8,6	0,7	575	11,3	0,9	771	14,4	1,1	983	19,2	1,4	852	17,6	1,2	3610	722,0	14,2	5,3
SCOPUS (if not listed above)	35	0,7	0,1	76	1,5	0,1	72	1,3	0,1	136	2,7	0,2	137	2,8	0,2	456	91,2	1,8	0,7
Other publicatons	357	7,1	0,6	414	8,1	0,6	422	7,9	0,6	471	9,2	0,7	462	9,5	0,7	2126	425,2	8,4	3,1
in monographs, conf. proceedings and other publications abroad (if not listed above)	104	2,1	0,2	38	0,7	0,1	37	0,7	0,1	25	0,5	0,0	24	0,5	0,0	228	45,6	0,9	0,3
in monographs, conf. proceedings and other publications in Slovakia (if not listed above)	43	0,9	0,1	127	2,5	0,2	148	2,8	0,2	21	0,4	0,0	99	2,0	0,1	438	87,6	1,7	0,6

**i. List of 10 top-cited publications and number of their citations in the assessment period (2006 – 2010)**

- [1] McNeill, J., Barrie, F. R., Burdet, H. M., Demoulin, V., Hawksworth, D. L., **Marhold, K.**, Nicolson, D H., Prado, J., Silva, P. C., Skog, J. E., Wiersema, J. H., Turland, N. J. International Code of Botanical Nomenclature (Vienna Code) adopted by the Seveteenth International Botanical Congress Vienna, Austria, July 2005. Ruggell : A. R. G. Gantner, 2006. 658 p. Regnum Vegetabile, 146. ISBN 0080-0694. **648 citations**
- [2] Marhold K., Hindák F. (eds.). Zoznam nižších a vyšších rastlín Slovenska. 1. vyd. Bratislava : Veda, 1998. 687 s. **Including chapters citations: 331 citations**
- [3] Baláž, D., **Marhold, K.**, Urban, J. (eds), Červený zoznam rastlín a živočíchov Slovenska. In *Ochrana prírody*. Banská Bystrica. č. 20, Suppl. 1 (2001), 160 s. **including chapters citations 155 citations**
- [4] Mucina, L., **Maglocký, Š.** (eds) (Balátová-Tuláčková, E., Berta, J., **Banášová, V.**, Dúbravcová, Z., **Fajmonová, E.**, Hadač, E., Hejný, S., **Jarolímek, I.**, Kontriš, J., Krippelová, T., **Oťahel'ová, H.**, Michalko, J., Šomšák, L., Špániková, A., **Zaliberová, M.** *List of vegetation units of Slovakia*. In *Documents Phytosociologiques. N. S. Vol. 9* (1985), p. 175-220. **64 citations**
- [5] Katalóg biotopov Slovenska. Editori Viera Stanová, **Milan Valachovič**. Bratislava : Daphne, Inštitút aplikovanej ekológie, 2002. 225 s. **63 citations**
- [6] **Jarolímek, I.**, **Zaliberová, M.**, Mucina, L., Mochnacký, S. Rastlinné spoločenstvá Slovenska : 2. synantropná vegetácia. 1. vyd. Bratislava : Veda, Vydavateľstvo SAV, 1997. 420 s. ISBN 80-224-0522-1. **57 citations**

- [7] Valachovič, M., O'ahel'ová, H., Stanová, V., Maglocký, Š. Rastlinné spoločenstvá Slovenska. 1. Pionierska vegetácia. Ed. Milan Valachovič. Bratislava : Veda, 1995. 184 s. **47 citations**
- [8] Bielczyk U., **Lackovičová A.**, Farkas E., Liška J., Breuss O., Kondratyuk S. Ya. 2004. Checklist of lichens of the Western Carpathians. Kraków: W. Szafer Institute of Botany, 181 pp. **39 citations**
- [9] **Ovečka, M.**, Lang, I., **Baluška, F.**, Hayek, F. A. von, **Illéš, P.**, Lichtscheidl, I. Endocytosis and vesicle trafficking during tip growth of root hairs. In Protoplasma. - Wien : Springer Verlag, 2005, vol. 226, no. 1, p. 39-54. (1.625 - IF2004). (2005 - Current Contents). ISSN 0033-183X. **33 citations**
- [10] Hattori, T., Inanaga, S., Araki, H., An, P., Morita S., **Luxová, M.**, Lux, A. Application of silicon enhanced drought tolerance in Sorghum bicolor. In Physiologia Plantarum : International Journal for Experimental Plant Biology. - Wiley Blackwell, 2005, vol. 123, no. 4, p. 459-466. (2.017 - IF2004). ISSN 0031-9317. **30 citations**

**ii. List of top-cited authors from the Organisation (at most 10 % of the research employees) and their number of citations in the assessment period (2006 – 2010)**

- [1] Karol Marhold – 1023  
 [2] František Hindák – 425  
 [3] Milan Valachovič – 416  
 [4] Richard Hrivnák - 277  
 [5] Miroslav Ovečka – 157  
 [6] Miroslava Luxová – 129

**iii. Supplementary information and/or comments on responses to the scientific output of the Organisation**

Full lists of responses to the scientific output of the Institute of Botany SAS is available in the annexes of annual reports. The annual reports are available on [www.ibot.sav.sk](http://www.ibot.sav.sk). The responses to the scientific output is increasing. Several monograph outputs have steadily high number of citations. These are mainly internationally important "International Code of Botanical Nomenclature" (since the edition prepared in 2011 and now in print known as "International Code of Nomenclature of algae, fungi a plants" and managed by the International Bureau for Plant Taxonomy and Nomenclature, hosted by the Institute of Botany SAS), which have global audience and then both nationally and internationally important census of plants and fungi growing in Slovakia – "Checklist of non-vascular and vascular plants". Expert teams producing detailed studies on taxonomy and phylogeny of selected groups of flowering plants in the Carpathians, Alps, Pannonia, Balkan Peninsula, and in some cases also on European or worldwide scales, produce high quality research outputs which are of international importance, thus collecting increasingly high number of quality citations in impacted journals. Teams working in taxonomy within the narrow fields out of mainstream botany, mainly mycology and lichenology receives adequate attention from the teams working on similar topics abroad. Positive trend in citations is evident in the area of plant vegetation studies and plant physiology.

**3. Research status of the Organisation in the international and national context**

- **International/European position of the Organisation**

- i. **List of the most important research activities documenting international importance of the research performed by the Organisation, incl. major projects (details of projects should be supplied under Indicator 4). Collective membership in the international research organisations, in particular within the European Research Area**

The importance of research activities as well as the engagement of the Institute in the international research on plant sciences can be referred from the following survey of projects revealing the scientific subjects and the results/publications resulting from international collaboration:

#### **A. Multilateral projects of the International Scientific and Technical Collaboration**

##### **7th Framework Programme:**

- **A Pan-European Species-directories Infrastructure – PESI 223806, 2008–2011.** Authoritative register of all organisms occurring on the European continent was established in the course of the project. IB SAS carried out editing and quality check of the data on 22 plant families, among them also such large ones as *Brassicaceae* and *Caryophyllaceae* (for details on plant families see: [ww2.bgbm.org/EuroPlusMed/query.asp](http://ww2.bgbm.org/EuroPlusMed/query.asp)). The register is already used both for research and biodiversity conservation purposes throughout Europe.
- **Novel integrated strategies for worldwide mycotoxin reduction in food and feed chains – MycoRed KBBE-2007-2-5-05, 2009–2013.** Institute of Botany plays role of “Scientific Alliance” in the project ([http://www.mycored.eu/d/18/Global\\_Network/](http://www.mycored.eu/d/18/Global_Network/)). During the growing season in three selected areas of viticulture and two different stages of ripening of berries we monitored the occurrence of toxigenic fungi species. We identified 9-10 potentially toxigenic fungal genera. We found that deoxynivalenone toxin is part of the resistance of vine varieties to toxigenic fungi. This strategy is part of the natural, biological control against the toxin. The results indicate the need to monitor the presence of potentially toxigenic fungi under different climatic conditions that significantly affect their distribution and pathogenicity.

##### **CIP-ICT**

- **Opening up the Natural History Heritage for Europeana (OpenUp!), 270890, 2011–2014.** The project is bringing access to the natural history objects from European museums and other collections to the European portal [www.europeana.eu](http://www.europeana.eu). During the first year of the project more than 600 000 objects were made available to view for specialists, but especially to the general public. The role of the IB SAS, as a workpackage leader, is in coordination of the botanical part of the project, but also in providing access to its own herbarium collections.

##### **6th Framework Programme:**

- **Towards the European Distributed Institute of Taxonomy (EDIT) GOCE-CT-2006-018340, 2006–2011.** A network of most important European institutions dealing with biodiversity and taxonomic research, both on plants and animals was established as part of this network of excellency project. Close cooperation was established for the coordination of project are research activities, joint software development, courses for PhD students and postdocs. After completing the project, activities of the network were taken over by the Consortium of European Taxonomic Facilities ([www.cetaf.org](http://www.cetaf.org)), where IB SAS is a regular member.
- **European Native Seed Conservation Network RICA-CT-2004-506109, 2004–2009.** A network of European seed banks and co-operating institutions was created in the course of this project in support for a long-term storage of seeds of plants under low temperature, for plant conservation,

breeding and other purposes. Common seed collecting protocol for seed banks was developed and physical and virtual infrastructure supporting seed collecting and storage was established.

- **Bridging genomics and agrosystem management: Resources for adaptation and sustainable production of Lotus spp. in environmentally constrained South – American soils FP6 – 517617, 2005–2009.** In the frame of multilateral cooperation with the institutions of EU and South America the team of the Institute of Botany S.A.S. focused on the study of selected environmental stressors and their influence on growth and production of biomass of selected species and cultivars of *Lotus corniculatus* and *L. japonicus*. Main goal of the project was to select suitable cultivars of *L. japonicus*, which could bring sufficient and quality biomass for cattle stock raising and development of cattle grazing under the conditions of environmental burden of soils in South America. Our role was linked with the characterization of structural and functional properties of these cultivars, optimization of uptake and utilisation of nutrients, and characterization of the role of particular enzymatic systems in an oxidative stress induced by Al and low pH. *Lotus* sp., compared with other crops (maize, barley), is capable to withstand relatively high concentrations of Al in the root system, on the other hand, it is more sensitive to low pH.

- **Participation of endomembranes and components of the cell wall in the maintenance of plant cell polarity MERG-CT-2005-031168, 2006–2007.** We studied differences in response of three *Arabidopsis* species (*A. halleri* – a hyperaccumulator and *A. thaliana* and *A. arenosa*) to Zn content in cultivation medium, particularly whether it affects the growth of roots and root hairs tip. Excess of Zn reduced root hairs tip growth in model cultivar of *A. thaliana* and also in genotype of *A. thaliana* originating from the natural population of the locality Ratkovo. Number of root hairs was also reduced and this reduction was greater in plants growing in liquid medium. Detailed surface analysis revealed morphological deformation of root hairs in *A. thaliana*. On the contrary in *A. halleri* originated from the contaminated locality of Krompachy the growth of root hairs was stimulated by Zn without any morphological abnormalities.

#### European Social Fund (ESF)

- **National Taxonomic Centre, European Social Fund, JPD BA13120200105, 2006–2008, IB SAS co-investigator, coordinator IB SAS K.I Marhold.** Close cooperation between IB SAS and the Faculty of Science, Comenius University, Bratislava, which was also recipient of financial funding, was established, number of seminars and lectures were organized, concentrated on the application of molecular methods in plant and animal systematics and taxonomy. The cooperation resulted also in admittance of both partner institutions into the Consortium of European Taxonomic Facilities ([www.cetaf.org](http://www.cetaf.org)).

#### SYNTHESESYS - FP 7 project supporting mobility of scientists in taxonomy and systematic biology

- **Diatoms in stagnant waters with respect to invasive species DE-TAF-4677, 2008, Alica Hindáková.** The aim of the project was to examine the diatom flora from selected stagnant waters (e.g. lakes, ponds), particularly taxa that could be considered as invasive species. Diatoms were studied mainly by electron microscopy. Survey of diatom diversity was done with the help of relevant literature and all available data. Knowledge about taxonomy of diatoms, primarily about the range of their morphological variability and distribution was extended.

- **Taxonomical studies on *Ramariopsis crocea* and *R. helvola* based on original material of Persoon NL-TAF-3886, 2008. Slavomír Adamčík.** Based on authentic material held in Persoon's herbarium in Leiden was compared recent interpretation of Clavariaceae taxa described by Persoon with original.

- **Taxonomical studies North-West American taxa of *Russula* sect. *Xerampelinae* based on material held in herbarium of Museum Histoire Naturelle Paris FR-TAF 5110, 2008. Slavomír Adamčík.** Type studies of two species of North American *Russula* compared with observations on

recently collected material from California. The study contains also molecular analyses of 72 samples of *Russula* sect. *Xerampelinae* originated from various regions of northern hemisphere.

- **Taxonomic revision of the *Alyssum montanum*-*A. repens* group, based on material held in the Natural History Museum in Vienna (AT-TAF-4244, 2008) and Hungarian Natural History Museum in Budapest (HU-TAF-4276, 2008), Stanislav Španiel.** Detailed studies of material of the *Alyssum montanum*-*A. repens* group were performed. The material studied included type specimens of a number of taxa and was used for the preparation of papers to American Journal of Botany, Plant Systematics and Evolution, Botanical Journal of Linnean Society (now in print) as well as for the PhD thesis.

#### **Multilateral - others:**

- **Building of Carpathian Biodiversity Information system and design of the ecological network for the Western Carpathians DBU 24829-33/0, 2007–2010.** The vegetation experts of the Institute of Botany prepared a full list of non-forest and forest biotopes included in the system Natura 2000 in Slovakia. For this the data on their occurrence in orographical units in the Western Carpathians from the Central Database of Phytosociological Relevés were used. The national concept was discussed on international level with the teams from other Carpathian countries (Poland, Czech Republic, Hungary, Ukraine, Romania, Serbia) with the aim to consolidate the understanding of biotope definition and to clarify the distributional data. The resulting database enabled further analyses which were then published.

#### **B. Bilateral projects – a survey of the common projects and collaborating institutions/countries:**

This type of projects does not finance the research activities as a such but contribute to the international cooperation with mobility support. Mobility support helps substantially our work on national projects, increases their effectivity and we need it. We find this tool very useful and accurate.

- **Investigation of plant cover biodiversity and scientific principles of its protection in the Slovak Republic and Ukraine, 2006–2015,** collaborating institution: State Museum of Natural History Lviv
- **Contribution of IB SAS to the international project Millenium Seed Bank, 2007–2013,** collaborating institution: Royal Botanic Gardens Kew
- **Taxonomy and geography of taxa of the flora of Russia and Slovakia, 2009–2013,** collaborating institutions: Komarov Institute of Botany, Russian Academy of Sciences, St. Petersburg, Institute of Biology and Soil Sciences Russian Academy of Sciences, Vladivostok, and Institute of Marine Geology and Geophysics, Russian Academy of Sciences, Yuzhno Sakhalinsk, Russia.
- **Phylogeny and taxonomy of the *Alyssum montanum* – *A. repens* complex (Brassicaceae), 2010–2011,** collaborating institution: Real Jardín Botánico, CSIC) Madrid, Spain
- **Impact of vesicular trafficking in the regulation of carbohydrate metabolism processes, 2007–2011,** collaborating institution: Instituto de Agrobiotecnología, Universidad Pública de Navarra, Spain
- **International Visegrad Found (IVF), 51100753, 2011–2012.** The project enables Czech colleague Mgr. Jan Vondrák, PhD. to study several questions connected to the phenomenon of lichenicolous lichens with the lichenological team of the Institute of Botany. He can study the material from the Western Carpathians and is focused on the members of rarely occurring parasitising lichens of biotopes in higher altitudes belonging to the genus *Caloplaca* with the phenotype of *C. epithallina*.
- **Perspectives in lichenological research - biodiversity, lichen chemistry, OTKA 81232, 2010–2014,** collaborating institution: Centre for Ecological Research (former Institute of Ecology and Botany), Hungarian Academy of Sciences, Vácrátót a Botanical Department of the Hungarian Natural

History Museum, Budapest, Hungary. Historical collections of the members of the genus *Solenopsora* from Hungary were revised. Information on the occurrence of *Solenopsora* species in Hungary was corrected – so far 1 species (*S. Candicans*) occurs in the country, occurrence of *S. olivacea* is doubtful. Fresh material from all known localities of *S. candicans* in Hungary was collected and 3 nuclear genes were sequenced for broader phylogenetic study. Two articles were published in peer-reviewed journal.

- **Origin and evolution of calcareous fens and their biota in the Western Carpathians: the question of glacial relicts and refuges, 2008–2010**, collaborating institution: Faculty of Science, Masaryk University, Brno, Czech Republic. The project dealt with origin and development of calcareous fens and their biota in the Western Carpathians. Calcareous fens are traditionally considered as refuges of glacial relicts. Though generally assumed, this is hardly supported by any hard data about fens' origin and history. The aim was to assess the relationship between fens' age, pattern of their distribution since the Last Glacial, number of relicts and current species richness. Analysis of fossil mollusc shells, pollen and macrofossils showed which fens have existed continually in treeless form since the Last Glacial and contrastingly, which acted rather as a mosaic of sites gradually forming and diminishing in space and time. Bonds of the relict fen species to their locality were analysed, namely if they occurred at the same locality since the Last Glacial or migrated among relatively shortly-existing sites in space and time. The results brought consequences for landscape history, site management and conservancy.
- **Biosystematic studies of selected genera of the families Brassicaceae and Asteraceae in Central Europe and Balkan Peninsula, 2008–2010**, collaborating institution: Bulgarian Academy of Sciences
- **Diversity of selected groups of fungi in Slovakia and Poland, 2007–2009**, collaborating institution: W. Szafer Institute of Botany, Polish Academy of Science, Krakow, Poland. Project objective was fungal diversity. With special emphasis were studied species of the genus *Russula* in High Tatra Mts.
- **Diversity of selected groups of cyanophytes and alga in Slovakia and Poland, 2007–2009**, collaborating institution: W. Szafer Institute of Botany, Polish Academy of Science, Krakow, Poland
- **Root hair tip growth and adaptation to environmental stress conditions, 2007–2009**, collaborating institution: Faculty of Life Sciences, The University of Vienna, Austria
- **Euglenophyceae of Slovakia and Poland with special regard to boundary regions, 2007–2009**, collaborating institution: W. Szafer Institute of Botany, Polish Academy of Science, Krakow, Poland
- **Monitoraggio biologico dell'area industriale di Termoli attraverso la biodiversità dei licheni epifiti, 2006–2008**, collaborating institution: Università degli Studi di Siena, Dipartimento di Scienze Ambientali, Unità di Ricerca di Lichenologia, Siena, Italy
- **Diversity of flora of Slovak Republic and Czech Republic II – vascular and non vascular plants, SK-CZ-01806, 2006–2007**, collaborating institution: Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice, Czech Republic. The project supported cooperation and mobility of researchers focused on taxonomical and caryological revision of several critical groups of vascular plants studied for the volume of Flora of Slovakia which was under preparation (*Flóra Slovenska VI/1*) as well as for caryological atlas and identification key of ferns and seed plants of Slovakia. The project also enabled to common research in diversity of cryptogams in Slovakia together with our Czech colleagues and summarize the results (e.g. lichens of the Eastern Carpathians, distribution of a phytogeographical element, the lichen *Physcia aipolioides* in Europe).
- **Phytopathogenic fungi and their host plants in the Tatry National Parks, 2005–2007**, collaborating institution: Department of biology and mycology, M. C. Skodowska University, Lublin, Poland
- **Phytoplankton of the Morava River, 2006–2008**, collaborating institution: Institute of Botany, Academy of Sciences of the Czech Republic, Třeboň, Czech Republic
- **Effects of heavy metal stress on cell architecture of tip-growing plant cells: Intracellular localization of metal ions, 2006–2007**, collaborating institution: Consejo Superior de Investigaciones

Cientificas, Centro de Investigaciones Biologicas, Laboratory of Plant Development and Nuclear Organization, Madrid, Spain

### **C. Collective memberships in the international research organization**

**International Association for Plant Taxonomy** – Institute of Botany is a collective/institutional member; Karol Marhold serves as an IAPT Secretary-General, Eva Senková as an IAPT Managing Secretary and Matúš Kempa as a member of the IAPT Publishing Committee and an IAPT webmaster. In a related mechanism of the International Bureau for Plant Taxonomy and Nomenclature, Karol Marhold serves as a member of the General Committee as well as a member of the Editorial Committee of the International Code of Nomenclature of algae, fungi and plants.

### **D. Document of international importance**

**1. Memorandum of Collaboration** between Institute of Botany, Slovak Academy of Sciences and The Board of Trustees of the Royal Botanic Gardens, Kew, United Kingdom. Memorandum of collaboration between the Institute of Botany, Slovak Academy of Sciences and the Board of Trustees of the Royal Botanic Gardens, Kew, United Kingdom, signed in December 2006, opened new possibilities of cooperation between these two institutions. The Royal Botanic Gardens in Kew is one of the world largest and most important institutions in biodiversity research, not only because of its extensive herbarium collections and libraries, but especially because of its excellent research studies in biodiversity from the molecular level to ecosystems. The Memorandum envisages exchange of data, plant material and cooperation in a wide spectrum of biodiversity studies.

2. During the 7th European Dry Grassland Meeting (Smolenice 2010), the text of Smolenice **Grassland Declaration** was formulated. 321 scientists, representatives of NGOs, ministries, politicians, farmers and other persons interested in nature conservation from 40 countries have signed the declaration until now (the list of signatories is available at the conference homepage [http://www.edgg.org/edgg\\_meeting.html](http://www.edgg.org/edgg_meeting.html)). The Declaration calls for a strong and comprehensive Convention on Grassland Conservation in Europe within the framework of the Pan-European Landscape and Biodiversity Strategy, to secure the future of grasslands which provide vital ecosystem services to human society, are home to biodiversity, sources of natural beauty and cultural values.

#### **ii. List of international conferences (co-) organized by the Organisation**

- [1] **BioSystematics Berlin 2011** – symposium "Biosystematics of polyploid plant complexes: progress, challenges, and prospects", Berlin, Germany, 23.02.-24.02.2011
- [2] **International Botanical Congress** - symposium "Systematics and evolution of Brassicaceae", Melbourne, Australia, 23.07.-30.07.2011
- [3] **7th International Symposium on Structure and Function of Roots**, Nový Smokovec, Vysoké Tatry, Slovakia, 05.09.-09.09.2011
- [4] **Symposium** "Cryptogams in beech forests of Slovakia", Nová Sedlica - Banská Štiavnica, Slovakia, 24.09.-01.10.2011
- [5] **2nd Czech and Slovak mycological conference**, Smolenice, Slovakia 25.10.-28.10.2011
- [6] **7th European Dry Grassland Meeting: Succession, management and restoration of dry grasslands**, Smolenice, Slovakia, 28.05.-01.06.2010
- [7] **1st Czech and Slovak mycological conference**, Brno, Czech Republic, 27.08.-29.08.2009
- [8] **Evolution of Plants in Mountainous and Alpine Habitats – Xth Symposium of the International Organization of Plant Biosystematists**, Vysoké Tatry, Slovakia, 02.07.–04.07. 2008

- [9] **International Symposium on Biology and Taxonomy of Green Algae V.** Smolenice, Slovakia, 25.-29.6 2007
- [10] **3rd International Symposium on Plant Neurobiology,** Štrbské Pleso, Slovakia, 14. – 18. 5. 2007
- [11] **Plants from heavy-metal polluted habitats,** Smolenice, Slovakia, 28.11.2007

**iii. List of journals edited/published by the Organisation:**

1. **WOS (IF of journals in each year of the monitoring period)**
2. **SCOPUS**
3. **other database**
4. **not included in the databases**

[1] **Biologia (Section of Botany)** IF (2006): 0.213, IF (2007): 0.207, IF (2008): 0.406, IF (2009): 0.617, IF (2010): 0.609

International Association for Plant Taxonomy, which is hosted since 2011 by the Institute of Botany, publishes the journal **Taxon**, which has now an official publishing place Bratislava, IF (2010): 2.364

**iv. List of edited proceedings from international scientific conferences and other proceedings**

- [1] 7th International Symposium on Structure and Function of Roots, Nový Smokovec, High Tatras, Slovakia, September 5-9, 2011 : programme & proceedings. Editors: Alexander Lux...[et al.]. - Bratislava : Mgr. Pavol Cibulka, Copycentrum PACI, 2011, s. 88-89. ISBN 978-80-89257-33-1.
- [2] Modern Plant Biosystematics (Proceedings from the Xth Symposium of the International Organization of Plant Biosystematists, Vysoké Tatry, Slovakia, 02. 07.–04. 07. 2008). Editors: **Marhold, K.** & Stuessy, T.F., *Taxon* 60 (2): 317-470, 2011.
- [3] **Janišová, M.**, Wellstein, C., Willner, W. & Dengler, J. (2011): Succession, restoration, and management of dry grasslands – Special Feature with contributions from the 7th European Dry Grassland Meeting 2010 in Smolenice. *Tuexenia* 31: 227-234. 7th European Dry Grassland Meeting: Succession, management and restoration of dry grasslands, Smolenice, Slovakia, 28.05.-01.06.2010
- [4] Jančovičová S., **Lizoň P.** (eds.) (2011): 2. Česko-Slovenská vedecká mykologická konferencia. Smolenice, 25. – 27. október 2011, Súhrny príspevkov. *Sprav. Slov. Mykol. Spol.* 38: 1-84

• **National position of the Organisation**

- i. **List of selected most important national projects (the EU Structural Funds, Slovak Research and Development Agency (APVV), State Research Programmes, Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA), Centres of Excellence, National Reference Laboratories and others)**

**A) EU structural funds – OP Science and research (OP Veda a výskum):**

**KRA-BIO Center of excellens for protection and use of landscape and for biodiversity, NFP26240120010, 2009–2011**, IB SAS co-investigator. Coordinator: Karol Marhold. The Institute of Botany SAS participated in the following project activities. 1.1. building-up the centre for Geographic Information Systems and remote sensing; 2.1 building-up Identification and Documentation Centre for Biodiversity; and 3.1. building-up the centre for systematic, taxonomy, phylogeny, phylogeography and evolution biology.

### **B) EU structural funds – OP Environment (OP Životné prostredie):**

**Natura 2000 in lifelong education, NFP24150120003, 2009–2010**, IB SAS co-investigator. Coordinator: Ivan Jarolímek. The book „The atlas of species of European interest for NATURA 2000 sites in Slovakia“. The aim of the monograph is to present, in a visually engaging form, all plant and animal species of European interest, „NATURA 2000 species“, occurring in Slovakia. The authors from the Institute of Botany, Slovak Academy of Sciences were responsible for the chapters on methodology, bryophytes and vascular plants. The book is full-colored, written both in Slovak and English and in 520 pages it gives basic information about NATURA 2000 network in Slovakia and about 231 species (or subspecies) of European interest occurring in Slovakia (47 plant and 184 animal species). The special part of the book dedicated to the plant and animal species includes information about their morphology, ecology, terminology, general distribution, distribution in Slovakia, threatening factors and various curiosities from their life.

### **C) APVV projects:**

**Impact of changes in air quality of urban agglomeration Bratislava on lichens APVT-51-040805 2006-2009.** The project results confirmed positive reaction of epiphytic lichens to the evolution of air pollution in Bratislava. All over the territory of the town an increased diversity of epiphytic lichens was recorded, so as the decrease of accumulation of heavy metals, constant a/b chlorophyll ration and low degree of damage of transplanted lichen thalli were. These signals point at significant decrease in air pollution and the ability of living organism to respond to these changes relatively promptly. We recorded recolonisation of nitrophilous lichens in the sites, where they were absent or occurred in minimal quantities for several decades: in town centre, near the roads with heavy vehicular traffic, road junctions and plants. Currently, 81 epiphytic lichen species grow on the territory of Bratislava, out of them 45 species are persisting from the past and 36 species are newly recorded in the territory. We found out, that 58 taxa could be considered extinct or missing. Frequency of the species, their abundance and vitality across the study area is different. This fact was used for the calculation of Index of atmospheric purity at 457 sites and for indication of zones of different levels of emission burden. The significance of this project is not only the record of initial stages of recolonisation of habitats with epiphytic lichens butt also in creation of a baseline for the future ecological studies in our capita.

**EVO-PICRIS, Taxonomy and phylogeny of the European representatives of the genus *Picris* LPP-0239-09 2009-2012.** We have studied taxonomic relationships of two subspecies of highly polymorphic *Picris hieracioides*, particularly subsp. *hieracioides* and subsp. *umbellata*, and their phylogenetic relatedness to closely allied species, *P. hispidissima*, *P. japonica*, *P. olympica* and *P. nuristanica*. Karyological analyses involving direct chromosome counting, estimation of DNA ploidy level and absolute DNA content; and genetic analyses, particularly sequences of coding and non coding regions of nuclear and chloroplast DNA were applied to resolve outlined questions. Concerning the karyological variation are all studied species diploids with  $2n=2x=10$ . The exception presented two populations of *Picris hieracioides* subsp. *umbellata* which harboured triploid ( $2n=3x=15$ ) and tetraploid individuals ( $2n=4x=20$ ). Absolute DNA contents of diploids, triploids and tetraploids varied considerably.

Genetic markers revealed large and complex variation within both subspecies of *P. hieracioides*, which most probably reflects evolution of this species during and after Pleistocene glaciations. In addition, hybridisation between both subspecies and among their internal genetic lineages was proved. Genetic and karyological variation of other analysed taxa (*P. hispidissima*, *P. japonica*, *P. olympica* and *P. nuristanica*) indicated very close relationship of all those species to polymorphic *P. hieracioides*.

**Formalized classification system for identification of grassland vegetation APVT 51-015804 do 2006.** Principal investigator: Monika Janišová. The main aim of the project was revision of grassland vegetation in Slovakia and preparing publication **Grassland vegetation of Slovak Republic and** electronic expert system for identification of syntaxa. The publication contains synthesis of Slovak grassland vegetation and its evaluation according to the recent knowledge on central-European vegetation. The review of Slovak grassland vegetation includes semi-natural communities ordered to three phytosociological classes: the *Festuco-Brometea*, the *Molinio-Arrhenatheretea* and the *Nardetea strictae*. We focused on the critical revision of hitherto described syntaxa and on elaboration of a formalized, concise and unprejudiced user-friendly electronic system for identification of grassland vegetation. The base for the study and evaluation of grassland vegetation was the Central Phytosociological Database of Slovakia. Sociological species groups together with dominance of important species have been used to formulate the definitions of associations, which were used in electronic expert system for identification of syntaxa. Slovakia became the second country in Europe using own formalized electronic system for identification of grasslands, which helps users to classify phytosociological relevés more objectively.

**Identification key of vascular plants of Slovakia and solving the problems of critical species groups in Central European area APVT-51-026404 2005-2008.** Project focused on the solution of taxonomic problems of several critical groups of plants in Central Europe as well as on the preparation of the book *Diagnostic, constant and dominant species of the higher vegetation units of Slovakia* and the first version of the manuscript of the *Identification key of vascular plants of Slovakia*. In studies of several critical plant groups a wide spectrum of methodological approaches was employed, namely multivariate morphometrics, chromosome counting, ploidy level evaluation using flow-cytometry, and last but not least, methods of molecular systematics as PCR-RFLP, amplified fragment length polymorphism (AFLP) and DNA sequences. Object of our studies included several groups of the family *Asteraceae* (*Hieracium alpinum*, *Pilosella alpicola*, *Centaurea stoebe*, *Cyanus triumfettii*, *Picris hieracioides*, *P. hispidissima*), *Brassicaceae* (*Cardamine impatiens*, *C. pectinata*, hybrids of *C. glanduligera* and *C. enneaphyllos*), *Boraginaceae* (*Onosma*), *Violaceae* (*Viola*) and some other groups of flowering plants.

**Limitation of Eutrophication Process in Water Basin Using Composite Sorbent APVV-0566-07 2008-2010.** In the scope of the project the phytoplankton and phytobenthos of a small water basin at Modra, W Slovakia, before and after application of a composite sorbent were investigated. Unfortunately, no evident effect on reduction of phytoplankton biomass was stated. However, diversity of cyanophytes and algal communities was interesting and published in several articles.

**MICRO-EVO, Microevolutionary processes in Asteraceae APVV-0320-10 2011-2014.** The aim of the project that started in 2011 is to address principal questions concerning microevolutionary processes, including speciation and polyploid evolution, in selected representatives of the family *Asteraceae*. We will also address confusing taxonomic treatments of the studied species complexes and propose new taxonomic concepts reflecting their evolutionary history. Molecular methods and flow cytometric applications, together with the methods of multivariate morphometrics and hybridisation experiments will be employed in the course of the project. We expect to obtain significantly new insights and a comprehensive view on the evolution of the studied representatives of the genera *Cyanus*, *Jacobaea*, *Picris*, *Pilosella* and *Taraxacum*. The results obtained will have a

broader impact beyond the individual study cases, contributing towards a better understanding of various aspects of evolution in this highly variable plant family.

**New methods of evaluation and mapping biotic harmful agents in urban greenery APVV 0421-07 2008-2010.** In our research we pointed out to the harmfulness of phytopathogenic fungi on leaves of trees and introduced methods to study this issue. Evaluation of gradual changes of cytoplasmic structures induced by the pathogens fungi of the genera *Erysiphe* and *Mycosphaerella* was conducted using scanning electron microscopy and confirmed the way how pathogens fungi invade the plant host.

**Phylogenetic relationships of the *Alyssum montanum*-*A. repens* complex (Brassicaceae) LPP-0085-06 2006-2010.** The project focused on the *Alyssum montanum*-*A. repens* complex in Central Europe and neighbouring regions. We examined taxonomic positions and evolutionary patterns of several species and subspecies from this highly polymorphic, polyploid species complex. Based on amplified fragment length polymorphism (AFLP) markers, cpDNA sequences as well as morphometric and flow-cytometric data, we demonstrated that the variation patterns contradict the current taxonomic concepts held for the studied taxa. The presented results suggested a new circumscription of two subspecies of *A. montanum*. The previously assumed habitat specificity of *A. montanum* subsp. *montanum* (calcareous and serpentine rocks, grasslands) and subsp. *gmelinii* (sandy sites) was rejected, and we showed that the two subspecies are allopatric. *A. repens*, represented by populations from Austria and Romania, were confirmed to be distinct from *A. montanum*. We suggested rejecting the recognition of *A. montanum* subsp. *brymii*, an assumed endemic of a small region in Slovakia and Hungary. We showed a distinct position of the Croatian-Slovenia endemic *A. montanum* subsp. *pluscanescens* and illustrated its allopolyploid origin. The Italian and SW Alpine populations form two well-delimited groupings, distinct from *A. montanum*. All the analysed Italian populations should be treated as *A. diffusum*, and those from SW Alps correspond to *A. orophilum*, a previously described but recently not accepted species. *A. diffusum* comprises three cytotypes and exhibits high, geographically structured genetic variation (Abruzzo, Gargano, Calabria) that is in accordance with morphological variation. We recognize three subspecies within *A. diffusum*.

**PHYLO-TAXON, Phylogeography, postglacial history and taxonomy of model groups of taxa in Europe RPEU-0003-06 2007-2010.** We clarified phylogeographical structure of alpine species *Cardamine alpina* (Alps, Pyrenees) and *C. resedifolia* (Sierra Nevada, Alps, Pyrenees, Corsica, South Carpathians) using AFLP markers. Further we reconstructed survival and migrations of populations during Pleistocene climatic changes and clarified relationships of *C. alpina* and *C. resedifolia* with *C. bellidifolia*. Analysis of genetic variation using AFLP data within the *C. maritima* group, represented by numerous taxa in Balkan and Apennine Peninsula, showed clear geographical separation of studied populations and previously described taxa. World checklist of the genus *Cardamine*, comprising names, synonyms, data on distribution and chromosome numbers, was finalized in the first draft, which is now subject of discussion in the international working group.

**Plant ionome modification by silicon for improvement of the crop nutrition quality APVV -0140-10 2011-2014.** Silicon, as an important component of plant nutritional, belonged to the long overlooked elements. Its impact on plant growth and development, and its role in plant defense against stress did not receive adequate attention. The originality of the project lies in the idea of further analysis of cell wall components and their ability to avoid the uptake of certain mineral, often toxic elements, as well as understanding the role of silicon in the stress avoidance or amelioration of the phytotoxicity of heavy metals increasing crop nutrition quality. Our results confirms that silicone induced changes in cell wall composition and earlier root cell differentiation are involved in reduction of radial movement of ions in root apoplasm.

**Taxonomy of selected groups of vascular plants of the Carpathians and adjacent APVV-0368-07 2008-2011.** We finalized the manuscript of *Flóra Slovenska VI/3* that has been accepted for final editorial processing and printing. For this volume we elaborated descriptions of all genera and species of the families *Cactaceae*, *Phytolacaceae*, *Aizoaceae*, *Nyctaginaceae*, *Portulacaceae* and *Caryophyllaceae*, generated identification keys in both Slovak and English, and revised present distributions for most of the treated taxa. The most significant results of the studies on polymorphic species groups include the taxonomic and chorological revision of the *Cerastium pumilum* complex in Central Europe, distribution patterns of diploid and tetraploid cytotypes of the *C. arvense* complex in the Western Carpathians, and a description of a new subspecies, *Minuartia glomerata* subsp. *pannonica*. Molecular analyses of *Cyclamen purpurascens* s. l. in its whole distribution range revealed four genetically differentiated lineages, which reflect species' evolutionary history during and after the last glaciation. Morphological analyses indicated certain differentiation trends among the populations from the Western Carpathians, the Alps, the Jura Mts, and the Dinarides, which were, however, not sufficient for separate classifications either at the species or subspecies levels. All the studied populations of *Cyclamen purpurascens* s. l. were diploid and exhibited only negligible variation in DNA content. Within the genus *Viola*, we analysed morphological, karyological and genetic variation patterns of *Viola suavis* s. l. in the western Balkans. In this area, we distinguished two endemic subspecies - a subspecies previously described as *V. suavis* subsp. *adriatica*, and a new subspecies described here, *V. suavis* subsp. *austrodalmatica*. We completed the development of the Database of the Flora of Slovakia (DataFloS), which is freely accessible at [www.dataflos.sav.sk](http://www.dataflos.sav.sk), comprising so far ca 100 000 records on vascular plants.

**The participation of endomembranes in the maintenance of root hair polarity in response to abiotic stress APVV-0432-06 2007-2009.** There were differences in response of three *Arabidopsis* species to Zn content in cultivation medium. Zinc did not affect the growth of roots of *A. thaliana*, but the root hair tip growth was significantly inhibited in the presence of 1000  $\mu\text{M}$  Zn. In contrast, in *A. halleri* the same Zn concentration stopped the growth of the root, while the root hair tip growth was not significantly affected. The uptake and distribution of Zn in *Arabidopsis* species depended on the content of Zn in the root medium and the specific type of uptake and distribution strategy of particular species. *A. halleri* known as hyperaccumulator preferred accumulation of Zn in root apoplasm while in *A. thaliana* and *A. arenosa* Zn was determined also in symplasm. High concentrations of Zn (1000  $\mu\text{M}$ ) in liquid or rigid culture medium significantly influenced the root hairs tip growth. Excess of Zn reduced root hairs tip growth in model cultivar of *A. thaliana* and also in genotype of *A. thaliana* originating from the natural population of the locality Ratkovo. Number of root hairs was also reduced and this reduction was greater in plants growing in liquid medium. Detailed surface analysis revealed morphological deformation of root hairs in *A. thaliana*. On the contrary in *A. halleri* originated from the contaminated locality of Krompachy the growth of root hairs was stimulated by Zn without any morphological abnormalities.

#### **D) EEA Grants:**

**Management models for grassland habitats**, SK 0115, 2009–2011, IB SAS co-investigator. Coordinator: I. Škodová. Over the last few years, considerable attention has been paid to the use of grassland habitats and their conservation in Slovakia. In collaboration with Daphne – Institute for applied ecology, 20 management models for grassland communities were prepared. Field experiments, focused on examining the influence of mowing, grazing and mulching on the species and vegetation structure of plant communities in selected territories of Slovakia, were an inherent part of the project. Each model offers complete information on the habitat ecology, its distribution in Slovakia, and its development trends and threats. It recommends measures for appropriate management, and summarizes the ecological and management demands of specific species of fauna and flora. The proposed procedures for management and restoration of a habitat's natural value provide information on the appropriate

regime of mowing or extensive grazing, based on the latest knowledge from research completed both in Slovakia and elsewhere in Europe. References to the financial tool, which has a significant impact on the state of habitats in Slovakia - the Agro-environmental program, a part of the Rural development program, are provided too. All models for non-forest habitats and information brochure in Slovak and English language were provided to staff of state nature protection and other stakeholders.

### **E) VEGA projects:**

**Taxonomic revision and species delimitation of European members of *Russula* sect. *Maculantinae***, VEGA 2/0028/11, 2011–2013, IB SAS principal investigator, Slavomír Adamčík. Collections originated from various areas in Slovakia were used as comparative material and tissue samples conserved in CTAB buffer were gathered for molecular studies. Based on types studies compared with recently collected material were defined 9 species of *Russula* sect. *Maculantinae*. Similar or related North American taxa are compared with European.

**Diversity and taxonomy of diatoms of selected gravel and sand-pit lakes in Slovakia with respect to invasive species**, VEGA 2/0113/11, 2011–2014, IB SAS principal investigator, Alica Hindáková. According to analyses of the phytoplankton and phytobentos of several gravel- and sand-pit lakes in W Slovakia, suitable localities for our investigations have been chosen. The main criteria of this selection were focused to the current development of diatom populations and the taxa which may be specified of expansive or invasive character. The massive occurrence of saline diatom *Actinocyclus normanii* f. *subsalsus* in inundations gravel- and sand-pit lakes of the Morava River and in Morava River either, was again noticed after 15 years records. The changes of diatom communities in gravel- and pit-lakes within Bratislava were apparent, what was connected with progressive development of the water eutrophication and the environment pollution in connection with global warming of biosphere. Thus, the dominant position of *Cyclotella balatonis* and *C. pseudocomensis* in waters can be served as an example. According to the distribution of diatoms can be also stated the increase of average annual temperature. This situation is suitable for the expansion of taxa growing in subtropical or tropical regions, e.g. for the species *Discostella woltereckii*. In addition, due to salinization of water biotopes the expansion of diatoms typical for saline waters, e.g. representatives of the genus *Thalassiosira*, is evident.

**Evolutionary and ecological significance of polyploidy in genera *Cyanus* and *Pilosella* (Asteraceae) – study on two systematic levels and two spatial scales**, VEGA 2/0075/11, 2011–2014, IB SAS principal investigator, Iva Hodálová. In the first year of the project, we detected ploidy level for more than 1000 plants from two model ploidy mixed populations of *P. rhodopea* in order to elucidate microspatial distribution and microhabitat differentiation among cytotypes. According to our results, cytotypes grow completely intermingled and do not display niche differentiation. For the genus *Cyanus*, collection of plant material was completed. The sampling covers populations from Greece, Bulgaria and Italy. All plants were analysed karyologically (in total 415 individuals from 130 populácií). New chromosome numbers were detected for several species  $2n=22$ : *C. achtarovii*, *C. pinnatifidus*, *C. triumfetti* s.l.;  $2n=44$ : *C. montanus* a *C. mollis*,  $2n=20$ : *C. orbelicus*, *C. velenovskyi*, *C. nysanus*, *C. tuberosus*, *C. napulifer*.

**Comparative diversity of macrophytes in various aquatic habitats**, VEGA 2/0004/11, 2011–2013, IB SAS principal investigator, Richard Hrivnák. In the first year of the project solution, we focused on our activities to sampling of vegetation and ecological data in two model regions, Borská nížina lowland (REG1; 80 sampling sites) and Turčianska kotlina basin (REG2; 80 sampling sites). Our preliminary results showed that 52 and 57 macrophytes in Pannonian and Carpathian region were found, respectively. Alpha diversity pattern was evaluated in terms of the species richness and Berger-Parker

dominance index with followed results: i) significant effect of habitat on species richness was revealed, while species richness was consistent across regions. The highest mean number of macrophytes was in both regions recorded in ditches (REG1 = 5.4 and REG2 = 4.4), followed by ponds, streams and rivers with the lowest average species richness (2.5); ii) the pattern in Berger-Parker dominance was different among regions. In Pannonia, rivers showed significantly lower dominance than ponds, whereas in Carpathians, Berger-Parker dominance of ditches was lower than in any other habitat.

**Determinants of rarity within *Tephroses longifolia* agg.: biosystematic and population-biological approach**, VEGA 2/0074/11, 2011–2014, IB SAS principal investigator, Monika Janišová. The project continues and extends the previous studies focussing on populations of rare endemic subspecies *Tephroses longifolia* subsp. *moravica* in order to specify our knowledge on taxon life cycle and demography based on a long-term field observations. Experimental estimation of optimum conditions for seed germination and seedling establishment can serve to project the support of small populations. In order to understand the processes underlying the rarity of the Carpathian subspecies we would like to extend the previous study by observation of four other subspecies of *Tephroses longifolia* agg. We suppose that the revealed differences between narrow endemic subspecies and widespread subspecies could explain the potential significance of geographically peripheral and ecologically marginal populations in the process of evolution of narrow endemism. The evaluation of morphological and karyological interspecific variation in *T. longifolia* agg. will elucidate the mutual evolutionary relationships of individual subspecies.

**Plant communities of Slovakia. Forest and shrub vegetation**, VEGA 2/0059/11, 2011–2014, IB SAS principal investigator, Milan Valachovič. The development of syntaxonomical survey of all vegetation units from the forest and shrubby vegetation occurred at territory of Slovakia. The project represents a last part and finalization of long-term program Plant Communities of Slovakia, which started at the beginning in last decade of 20th Century. The result of whole program will be a comprehensive Slovak vegetation survey – a work of highest national importance. At the same time this work will be a part of international efforts under the program European Vegetation Survey and modern tool and practical instrument for nature conservation and landscape management. The aims of project are (i) differentiation of vegetation units with application of relevant approaches and statistical methods, (ii) analyses of floristical and ecological variability and chorological characteristics, (iii) solution syntaxonomy of forest and shrubby communities in broadly Central-European region under international co-operation and by help of case studies.

**The catalogue of non-native species of vascular plants and the analysis of the level of invasion across habitats of Slovakia**, VEGA 2/0098/11, 2011–2014, IB SAS principal investigator, Mária Zaliberová. Research on the invasion of alien plants and animals is of growing importance worldwide, because they may represent threat for the diversity of native species, through changes in community structure, nutrient cycles, competition, hybridization and others, and may even cause high economic losses by reducing yields in crops, promoting allergic reactions and altering the natural environment. The main aim of our study was to assess current distribution of alien plants in Slovakia and create a first complete national catalogue of alien plants. That enables to make broader analyses of both habitat affinity of alien plants and the level of invasion of habitats and their vulnerability to invasion, what is fundamental not only for our knowledge on the ecology of aliens but also for the purpose of the nature conservation. Gathered knowledge has numerous uses not only on national level, but enables valuable comparisons also on European level.

**Diversity of phytopathogenic fungi in selected biocentres of Slovakia**, VEGA 2/0106/10, 2010–2012, IB SAS principal investigator Kamila Bacigálová. We focus on diversity of phytopathogenic micromycetes – parasitic and saprophytic biota in selected biocentres in Slovakia (Devínska Kobyla,

Vysoké Tatry). We contributed to the collection of new original information on current state of occurrence of components of microscopic phytopathogenic fungi, achieved by own mycofloristic research – from Devínska Kobyla we list 1100 species, out of which 16 were new for the mycoflora of Slovakia (Peronosporales, Ascomycetes and mitosporic fungi). We concentrated on the phenotypic and genotypic (D1/D2 domain of 26s rRNA) characterization of 12 taxa of the genus *Taphrina* growing on *Rosaceae*.

**Systematics and biogeography of the genus *Solenopsora* (lichenized fungi) in the Carpathians**, VEGA 2/0071/10, 2010–2012, IB SAS principal investigator, Anna Guttová. We study taxonomy of placodioid taxa of the lichen genus *Solenopsora* with a focus on the species occurring in the Carpathians – *S. candicans* and *S. carpatica*. For delimitation of the species we use combination of classical approaches (morphometric data and chemistry) as well as molecular approaches (study of three nuclear genes ITS nrDNA, PKS1 – KS and MCM7). The material covers the part of the European distributional area – Mediterranean, Balcan, Turkey and Central Europe. First preliminary analyses point at the fact that the taxa are well delimited, they form well supported monophyletic clades. The taxa of *S. liparina* from the Adriatic coast cluster with the group of *S. carpatica*.

**Diversity and distribution of cyanobacteria and algae of thermal springs at Piešťany and Sklené Teplice in relation to the temperature**, VEGA 2/7069/27, 2007 - 2009, IB SAS principal investigator František Hindák. **Flora of Slovakia: Cyanobacteria I., thermophilous species**, VEGA 2/0130/10, 2010–2012, IB SAS principal investigator František Hindák. Life cycle of several representatives of cyanobacteria/cyanophytes occurring in the thermal springs at Piešťany and Sklené Teplice was studied in laboratory cultured material (pure cultures or subcultures). Some species were investigated also from other localities in Slovakia to confirm their taxonomic identification. In this connection a heterocytous species *Hapalosiphon fontinalis* found in investigated thermal springs and in the *Sphagnum* peat-bog in Klin was investigated. According to molecular data the specimens from thermal springs belong to *Mastigocladus laminosus*, while acidophilic species should be named *Hapalosiphon fontinalis*, although their filaments are morphologically very similar. In addition, in *H. fontinalis* we observed formation of hormogonia, monospores and a *Nostochopsis*-like heterocytes. Besides, diversity of cyanobacterian/cyanophytes flora of a cooling tower of power-station at Belchatow, C Poland, was identified with cooperation with a Polish phycologist. Isolated cultures from this extremely hot locality (similar to hot springs) were sent to the Institute of Botany in Kraków for experimental studies. One new genus and species, *Cronbergia paucillularis* Komárek, Zapomnělová et Hindák, was described from the vicinity of Bratislava. This nostoclean species is very similar to those found in thermal springs.

**Geoglossoid fungi of non-forest stands**, VEGA 2/0062/10, 2010–2012, IB SAS principal investigator Viktor Kučera. On the territory of Slovakia, in cooperation with colleagues from Scandinavia we found occurrence of the *Geoglossum uliginosum*, taxon described from northern Europe. Also *Trichoglossum octopartitum*, a new fungus for Slovak mycoflora were found. Collections were also confronted with the type material. We collected comparative material *Microglossum viride* and *M. lutescens*. We obtained other collections of *M. olivaceum* and related taxa. Methodology for molecular studies of the ITS region were tested, we analyzed a group of first preliminary results. We summarize the results of mycological research in the Slovenský raj National Park and the Veporské and Stolické vrchy Mts. Determination key for taxa of the genus *Geoglossum* was finished.

**The effect of different silicon concentrations on plants exposed to stress**, VEGA 2/0024/10, 2010–2012, IB SAS principal investigator Miroslava Luxová. In the recent years, attention is paid to silicon, which is present in the soil solution in the form of  $H_4SiO_4$ . The importance of Si on structural and functional parameters of plants is based on its ability to act as anti-stress agent in plants exposed to stress condition. We found that Si positively influences the growth parameters and structural

adaptations to oxidative stress in sorghum, and mitigates the toxic effect of Cd in maize. It is also known that Si positively influences the growth of plants exposed to saline conditions and our results confirmed that silicon in combination with Zn significantly reduced the inhibitory effect of Zn on the root growth but did not positively affect biomass production of roots and shoots.

**Tip growth of the cells: its regulation and modifications under heavy metal influence**, VEGA 2/0200/10, 2010–2012, IB SAS principal investigator Miroslav Ovečka. Root growth, root hair formation and efficiency of the tip growth of root hairs was observed in *Arabidopsis* plants affected by increased concentrations of Zn. Along with the reduction of growth and production parameters, we determined the efficiency and speed of endocytosis and distribution of structural sterols. We have developed a methodology to enable us to compare these parameters between sensitive species *Arabidopsis thaliana* and resistant species *A. halleri* and *A. arenosa*. We have shown that the structural sterols are one of the early markers of the initiation of root hairs, and local changes in the properties of the cytoplasmic membrane and there are involved in regulation of the tip growth.

**Time and spatial distribution of reactive oxygen species in extracellular spaces of apical part of barley roots exposed to abiotic stress**, VEGA 2/0050/10, 2010–2012, IB SAS principal investigator Ladislav Tamás. The short-term exposure of barley roots to low Al concentration caused significant root growth inhibition and radial swelling of roots. During Al treatment, the radial expansion of root cells occurred in root tissues representing elongation zone and meristem. Both low pH and Al treatments caused significant disruption of cell membranes in swollen roots. In contrast to Evans blue uptake callose formation was observed only at higher Al concentrations and was detected in both swollen and adjacent root areas. Similarly to Al, exogenous short-term application of indole-3-acetic acid, polar transport inhibitor triiodobenzoic acid, ethylene precursor 1-aminocyclopropane-1-carboxylic acid or H<sub>2</sub>O<sub>2</sub> evoked root growth inhibition and radial cell expansion in barley root tip too. Using short-term treatments, the aim of this study was to analyze the role of hydrogen peroxide in the regulation of AAO activity during Cd, Cu or IAA treatments in barley root tips. For analysis individual barley root segments were obtained by the gradual cutting of each root from the tip to the base 1, 2, 3 or 6 h after short-term treatments. Already a short 30 min exposure of barley roots to Cd induced significant root growth inhibition in a Cd concentration dependent manner, which was accompanied by a marked reduction of AAO activity. At Cu concentration which had no effect on the root growth a significant increase in AAO activity was observed. This increased AAO activity was detected only in ionically-bound CW fraction. In contrast, Cu at higher concentration and IAA inhibited both ionically-bound CW AAO isozymes. Prompt inhibition of AAO activity immediately after short-term treatment was observed only in the case of H<sub>2</sub>O<sub>2</sub> treatment suggesting that H<sub>2</sub>O<sub>2</sub> may act as an inhibitor of AAO. This was further supported by the observation that all Cd-, Cu- or IAA-induced root growth and AAO activity inhibition in barley roots was connected with an elevated production of H<sub>2</sub>O<sub>2</sub>.

**Saline habitats in Pannonia: ecology and taxonomy of selected halophytes and their communities**, VEGA 2/0030/09, 2009–2011, IB SAS principal investigator Daniel Dítě. The focus of the project was on endangered saline habitats in Pannonia. Model biotopes included usually degraded Slovak saline habitats and relatively natural saline sites in Hungary, Austria and Serbia. The zonation of saline vegetation caused by various salt content was studied on transects. There were more than 750 phytosociological relevés made in communities of class *Festuco-Puccinellietea*, *Scorzonero-Juncetea*, *Crypsietea aculeatae* and in vegetation of river banks and belt of salt lakes. Experimental restoration of *Camphorosmetum annuae* community was tested in the field experiment on permanent plots in the Kamenínske slanisko Nature Reserve. Ecological and phytosociological research of halophytic communities *Artemisio santonici-Festucetum pseudovinae*, *Camphorosmetum annuae*, *Hordeetum hystricis*, *Puccinellietum limosae*, *Beckmannon eruciformis*, *Hordeetum hystricis* and *Pholiuro pannonicum-Plantaginetum tenuiflorae* were realized in Pannonia region. Distribution of selected halophytes in

Slovakia and Pannonia was investigated: *Beckmannia eruciformis*, *Camphorosma annua*, *Hordeum geniculatum*, *Chenopodium chenopodioides*, *Peucedanum officinale*, *Pholiurus pannonicus*, *Puccinellia limosa*, *P. distans*, *Trifolium angulatum* and *T. retusum*.

**Biosystematic study of the critical taxa of the families Caryophyllaceae and Asteraceae**, VEGA 2/0026/09, 2009–2012, IB SAS principal investigator Kornélia Goliašová. Within this project we conducted taxonomic revision of selected critical species groups and genera of the families Caryophyllaceae in Slovakia: *Arenaria*, *Minuartia*, *Stellaria*, *Silene*, *Dianthus*, and of the family Portulacaceae: the genus *Portulaca*. We also prepared the manuscript of the next issue of Flora of Slovakia, VI/3, that covers part of the order Caryophyllales (families Cactaceae, Phytolacaceae, Aizoaceae, Nyctaginaceae, Portulacaceae and Caryophyllaceae). Within this research we examined biology and ecology of the studied species, generated identification keys, distribution maps and illustrations. Within the study of the *Cerastium pumilum* complex, we elucidated taxonomy and chorology of the group of *Cerastium pumilum* – *C. glutinosum* in Central Europe. We showed that two species can be distinguished, based on morphology and karyology: *C. glutinosum* ( $2n = 72$ ) and *C. pumilum* ( $2n = 108$ ). Furthermore, we assessed absolute DNA content for representatives of the *Cyanus triumfetti* and *Cyanus montanus* groups in Central Europe. In the genus *Stellaria* we determined and published chromosome numbers in the populations of *S. nemorum* ( $2n = 26$ ) and *S. holostea* ( $2n = 26$ ). We also finished karyological and morphometric analyses of the *Stellaria graminea* complex. The obtained results confirmed the chromosome number  $2n = 26$ , and will be published soon. Flow cytometric studies in the *Arenaria serpyllifolia* complex showed that tetraploid plants prevail in Slovakia. We did not confirm the occurrence of diploid species *A. leptocados* in Slovakia. We also published new distributional data for the genera *Phytolacca* and *Scleranthus*.

**Dynamics and succession of grassland vegetation**, VEGA 2/0181/09, 2009–2011, IB SAS principal investigator Ivan Jarolímek. The main goal was to evaluate and elucidate the present state and temporal changes in grassland vegetation using the modern statistical methods. Species-rich grasslands are threatened by numerous factors and their biodiversity in some regions decreases gradually. Changes of grassland vegetation were studied in selected regions (Biele Karpaty Mts., Poľana Mts.). The successional changes in vegetation composition after 46 years of abandonment were studied in Devínska Kobyla Nature Reserve. The area of grasslands has been reduced by 61.1% compared with 1949 levels. Using computer modeling in GIS, the suitable management model for dry grasslands was defined. Phytosociological research of grasslands in Slovakia and also in Ukrainian Carpathians was made. Results of phytosociological research will be summarized in the fifth volume of edition Plant communities of Slovakia, which is in preparation at present days. It will contain detailed characteristics of meadow, pasture, halophilous and fringe vegetation. The Slovak electronic expert system for identification of grasslands was updated and formal definitions of several associations were additionally formulated.

**Phylogenetic relationships in the polyploid complex *Alyssum montanum* - *A. repens* (Brassicaceae)**, VEGA 2/0087/09, 2009–2012, IB SAS, principal investigator Judita Lihová. Within this project we employ a combination of morphometric, molecular and flow cytometric approaches to disentangle evolutionary history and phylogenetic relationships in the polyploid complex *Alyssum montanum*-*A. repens*. The Apennine populations, which according to our taxonomic revision should be classified as *A. diffusum*, were found to exhibit extensive and geographically structured variation. We assume that this pattern reflects long-term population isolation and allopatric diversification during the last glaciation. Indeed, the three regions that we outlined - the central Apennines (Abruzzo, Umbria), Gargano (part of Apulia), and southern Apennines/Calabrian Mts. – are known as hotspot refugial regions that harbour many endemics. Thus, we provided evidence for the presence of Mediterranean refugia for the studied *Alyssum montanum*-*A. repens* complex located in central and southern Italy,

which, however, did not contribute to the postglacial colonization of Central Europe. Our results are also in congruence with the 'refugia-within-refugia' hypothesis, suggesting complex evolutionary processes in the Mediterranean area. Haplotype sharing between Apennine *A. diffusum* and some Balkan representatives suggest either incomplete lineage sorting of ancestral variation, or more recent secondary contacts between the peninsulas. Detailed studies on the Balkan species, which are currently in progress, will help to distinguish between these two competing hypotheses. Data from cpDNA also showed that different evolutionary processes shaped the variation patterns and speciation in this species complex. Past extinctions, genetic bottlenecks and recent expansion were inferred in Central Europe occupied mainly by *A. montanum* subsp. *gmelinii*, while long-term accumulation of diversity as well as polyploidization occurred in the Apennines (*A. diffusum*) and SW Alps (*A. orophilum*).

**Island phenomenon of the Carpathians' high mountains in relation to environmental factors, synecology of plant communities and phytogeography of selected plant species**, VEGA 2/0121/09, 2009–2011, IB SAS principal investigator Principal investigator: Jozef Šibík. The aim of the research was the study of biodiversity in the Carpathians on population and community level. We focused on mutual interactions between individual plant species, as well as between communities and abiotic environment in various space-temporal scales. Results were interpreted within wider historical and evolutionary context. To increase objectiveness and complexity of our results, significant part of the data were collected in other European mountain ranges (e.g. the Alps). Based on knowledge about ecological factors of recent localities of *Carex rupestris* the deductive model of potential occurrence were proposed, from which new localities were defined. Complex research of time-space dynamics of high-mountain vegetation were realized using recent and historical vegetation data (50 years old records) connected with climatic, soil and geology GIS layers in Dolina siedmych prameňov (Belianske Tatry Mts.). The influence of alien species on mountain habitats, distribution of neophytes and apophytes in Tatras and their occurrence in natural and seminatural habitats were investigated. Communities were assessed based on occurrence of endemic and relict taxa. Coenology, ecology and chorology of vegetation with relict species *Carex rupestris* and *Elyna myosuroides* were studied.

**Toxigenic fungi and their metabolites**, VEGA 2/0002/09, 2009–2011, IB SAS, principal investigator Antónia Šrobárová. Toxigenic fungi, beside their pathogenic effect produce a wide range of secondary metabolites. The most known genera are *Aspergillus*, *Penicillium*, *Alternaria* and *Fusarium*. Some of their secondary metabolize - mycotoxins can affect animals and human health. The excellent knowledge of their life cycle and mechanisms of toxin action may be a very important base for their control. The occurrence of potentially toxigenic fungi has been done in the Malé Karpaty Mts, South-Slovak and Nitra region on the vine berries. The incidence of ochratoxigenic fungi of genus *Aspergillum* were identified during the growing seasons in the vineyards of Slovakia. We have observed the impact of climate on biodiversity of these fungi. Fusariotoxin fusaproliferin in relatively low concentrations significantly depolarize a membrane potential of cortical cells of roots, especially sensitive cultivars. The low concentration of deoxynivalenone in all cultivars of oats, in the case of *Fusarium* ear rot, does not exceed the EU limit. In a short review about taxonomy of *Fusarium* spp. we described where and way began study of toxins. Some metabolites and fusariotoxins were identified on fruit of grape during the last two vegetative phase. We studied their mechanism of action on enzymes and membranes on different cultivars. The plasma membrane is not only a selective barrier which provides selective transport of nutrients, it is also a target of toxic metabolites produced by fungi. Both maize cultivars showed higher sensitivity of root cells to FUS in cells localised in root zone I. The analysis of enzyme activities revealed that FUS significantly stimulated POD activity in both maize cultivars. SOD activity was significantly increased only in susceptible cv. Pavla, while APX activity was not affected by the presence of FUS. GST activity was specifically induced by FUS only in tolerant cv. Lucia.

**Taxonomical studies on selected species of *Russula* sect. *Xerampelinae***, VEGA 2/0140/08, 2008–2010, IB SAS principal investigator Slavomír Adamčík. Morphological and genetical delimitation of taxa within *Russula* sect. *Xerampelinae* taxa have been verified, these species are considered as well delimited: *R. xerampelina*, *R. favrei*, *R. faginea*, *R. clavipes*, *R. subrubens*, *R. pasqua* a *R. nuoljae*. Type studies of North American taxa as well as studies on recently collected material do not approved presence of European species on both continents. Studies on European taxa helped to recognize North American relatives. The project contains type studies of 10 North American species of the section. Only two North American species were confirmed as members of the section *Xerampelinae*. Two species were described as new for science. All morphological observations were supported by molecular studies.

**Origin and evolution of mountain and alpine flora of the Carpathians**, VEGA 1/0028/08, 2008–2010, IB SAS principal investigator Patrik Mráz. New insights into evolutionary history and thus phylogenetic relationships were obtained for *Pilosella* sect. *Alpicolina*, a group of species with polydisjunctive occurrence across highest European mountain ranges. The results serve not only as basis for taxonomic revision of the group, but contribute also to general knowledge on plant evolution in the Carpathians and European mountains. We have solved delimitation of the *P.* sect. *Alpicolina*, which previous concepts were questionable. We have proved, based on wide spectrum of approaches including molecular systematics, that *P. alpicola* group is monophyletic with exception of *P. alpicola* s.str., originating from polytopic allopolyploidization. In *P. rhodopea* diploid-polyploid complex, we have revealed primary contact zone of cytotypes, which was supported genetically in literature only a few times till now. Study of fertility within the *Daphne* subsect. *Cneorum* did not confirm decreased fertility of stenoendemic *D. arbuscula* when compared to taxa with wider range.

**The distribution and diversity of aquatic macrophyte vegetation in water-bodies of Slovakia in relation to environmental factors and anthropic disturbance**, VEGA 2/0013/08, 2008–2010, IB SAS principal investigator Richad Hrivnák. The project was focused on distribution and ecology of aquatic and marsh plants in Slovak running water. We completed knowledge about distribution of the selected rare, endangered or taxonomical problematic macrophytes (*Ceratophyllum submersum*, *Potamogeton berchtoldii*, *P. pusillus*, macroscopic algae – Charophyta). The hydrological connectivity and land use surroundings of watercourse were determined as the main/major environmental drivers affecting distribution and quantity patterns of macrophytes in the Slovak river (Danube). On the other hand, environmental factors including sediment type, shading of shrubs and trees on the banks, water depth, NO<sub>2</sub> – and water acidity become more relevant for macrophyte composition in Slovak streams. Vegetation study dealing with seasonal dynamics of macrophytes in two streams pointed out statistically significant effect of water depth and air temperature to quality and quantity of plants as well as different behaviour of three species group (hydrophytes, helophytes and amphyphites). Based on macrophyte studies performed in several Slovak rivers (Hron, Slatina a Klatovske rameno), we prepared reference index for assessment of ecological status of running water in sense of European Water Frame directive. Our results could be applicable for (1) directing and better planning of water management in running waters, (2) management of some rare and endangered aquatic plant species and habitats in Slovakia, (3) creation of European habitat-net of NATURA 2000 and (4) educational process relating to botany and ecology.

**Demographical, coenological and ecological analysis of *Tephroses longifolia* subsp. *moravica* - the threatened taxon of European importance**, VEGA 2/0017/08, 2008–2010; IB SAS principal investigator Monika Janišová. *Tephroses longifolia* subsp. *moravica* is a critically endangered endemic taxon of Carpathian flora included in the European list of important species. Altogether 9 localities are known, 5 of them in the Moravia and 4 in Slovakia. The marked individuals of studied species were monitored on permanent plots and the data on their survival were obtained. The demographical analysis

was made to ensure the relevant information for proposal of optimal monitoring and objective evaluation of the recent knowledge. Cultivation experiments, seed bank survey, estimation of ecological requirements and limiting factors of the taxon were realized. The first consistent information on reproductive biology (mating system, seed production, germination, soil seed bank) was provided and management techniques for effective conservation of studied species were proposed. Based on results from isolation, hybridization and castration experiments, *T. longifolia* should be treated as allogamous taxon without apomictic reproduction. Five populations of *T. longifolia* subsp. *moravica* were studied in detail for seed production and germination characteristics. A granivorous butterfly, *Phycitodes albatella* (family Pyralidae), was identified as a pest reducing seed production by 18 to 28%. In natural conditions, the taxon formed a short-term persistent soil seed bank. The taxon was found not to be strictly stenotopic as the ranges of several environmental variables studied were rather wide. We suppose that the narrow limits of recent taxon occurrence are consequences of its low competitive ability and demographical processes related to germination and seedling establishment. Vascular plant-based ecological indicator values were set for *Tephrosia longifolia* subsp. *moravica*.

**Plants from heavy metal polluted habitats: their communities, structural and physiological adaptations**, VEGA 2/5086/25, 2005–2007, IB SAS principal investigator Vedučí projektu: Milada Čiamporová. **Structural and physiological characteristics of roots in three *Arabidopsis* species with diverse strategies in their response to metal toxicity**, VEGA 2/0149/28, 2008–2010; IB SAS principal investigator Milada Čiamporová. In the tissue organization of the *Arabidopsis thaliana* root (grown on agar medium) there were no differences between the model ecotype Columbia and the genotype originating from a natural population (the locality Ratkovo). The root tissue pattern of the other two species, the heavy metal tolerant *A. arenosa* and *A. halleri*, differs from that of *A. thaliana* only quantitatively: in higher number of both cortical tissue layers and cells in tissue layers. These differences were more conspicuous under high Zn concentration in the tolerant species, regardless of their origin from populations growing in metalliferous or non-metalliferous soils. The diversity of species varied in the localities with varying Zn, Pb, Cd and Cu contents in the soil and, it was markedly reduced by the enhanced metal concentrations. With respect to heavy metals in the root medium, using tolerance index, cellular resistance tests, and quantitative aspect of root system formation, we assessed the sensitivity of *A. thaliana* in both model ecotype Columbia and natural population from the locality Ratkovo, and the tolerance of the relative species *A. arenosa* and *A. halleri* from the natural localities differing in the soil heavy metal contents. The tolerance of the populations depended on the metal occurrence in the soil. Differences in population responses might indicate their ecotype differentiation. High concentrations of Zn and also Al cause growth inhibition of roots and root hairs. With Al the relationship between metal uptake followed by vacuolar accumulation, and the process of endocytosis has been proved. Differences in structural responses to enhanced Al concentration in acidic solution and to the acidity alone were assessed.

**Evolutionary trends and taxonomy of the genus *Onosma* (*Boraginaceae*)**, VEGA 1/0012/08, 2008–2010, IB SAS co-investigator Zodpovedný riešiteľ za Botanický ústav: Judita Lihová. Within this project we conducted taxonomic and evolutionary studies focused on the poorly explored, but highly diversified genus *Onosma*. We confirmed the recognition of three main evolutionary lineages in Europe, suggested previously on the basis of their morphology and karyotype: Asterotricha, Haplotricha and Heterotricha. Using genetic (AFLPs, DNA sequencing), morphological and karyological data (ploidy levels, genome size estimations, karyotypes) we delimited seven species in the Asterotricha lineage. Within the widely conceived *O. heterophylla* s.l. we illustrated a distinct position of *O. viridis* from Romania, but, on the other hand, we did not confirm a separate species status for the assumed endemic of Slovenský kras, *O. tornensis*. Both morphological and genetic data strongly suggest that populations of *O. tornensis* are conspecific with *O. viridis*. Furthermore, our data did not support any of the previously suggested taxonomic concept of the Balkan-Apennine species *O. echioides*. Both genetic and morphological

variation is considerably high in this species, but largely continuous, precluding recognition of previously described subspecies. Within the *Heterotracha* group, two species complexes, *O. arenaria* s.l. and *O. pseudoarenaria* s.l., were assumed to be allopolyploids combining divergent chromosome sets. Indeed, we found discordant patterns in maternally inherited cpDNA on one side, and the nuclear ITS and AFLP markers on the other, supporting the hybrid origin of the stabilized *Heterotracha* lineage.

**Taxonomic revision of the *Cyanus triumfettii* group (Asteraceae) in the Carpathians and Pannonia**, VEGA 2/0053/08, 2008–2010, IB SAS principal investigator Iva Hodálová. The aim of the project was to evaluate complex taxonomic relationships in the *Cyanus triumfetti* group in the Carpathians and Pannonia. Treatment of the taxa from this group was highly controversial in national floras and identification keys from this area. The taxonomic revision was based on evaluation of morphological and karyological variation of populations from the studied area, including the localities of the nomenclatural types. Results of these analyses were compared with AFLP data, which we intended to use also for inferring evolutionary relationships among the studied taxa. The project also included determination of reproduction modes and reproductive isolation among the taxa. Synthesis of the data resulted in the taxonomic classification of populations from the *C. triumfetti* group in the Carpathians and Pannonia, including preparation of an identification key.

**Habitat requirements of Otter (*Lutra lutra* L.) on Slovak streams**, VEGA 1/0836/08, 2008–2010, IB SAS co-investigator Deputy head of the project from SAS: Richard Hrivnák. The project was aimed at the study of distribution, sprainting behaviour and selected factors, influencing the Eurasian otter. This species is permanently present in all three river basins (Hron, Turiec Rajčianka). Its distribution is uneven, as reflected in changes to the spraints (including scent marks). The most appropriate features for occurrence of otter at selected localities were: continuous or semicontinuous riparian vegetation, banktop and bankface vegetation structure assessed within a 10 m wide transect with 3 - 4 vegetation types. Suitable cover and breeding places provides well-developed bankside vegetation with many exposed bankside and underwater tree roots and presence of large woody debris (LWD). Key factors of otter distribution are food availability and diet. We did not find this species on streams with small biomass of fish.

**Study of the changes in plant species, communities and habitats diversity in the contact zones of agrocoenoses**, VEGA 1/0672/08, 2008–2010; IB SAS co-investigator Deputy head of the project from SAS: Milan Valachovič. The aim of project was knowledge of the status and/or plant diversity changes, species pool and vegetation shift from natural and semi-natural steppes, meadows, and salt marches in the Pannonian bioregion. Elucidation of the biology of the selected taxa from the families *Rosaceae*, e.g. *Amygdalus nana*, *Cerasus* sp. div., *Crataegus* sp. div., *Prunus* sp. div., *Rosa* sp. div.; *Lentibulariaceae*: *Drosera* sp. div., *Pinguicula* sp. div.; *Lamiaceae*: *Phlomis tuberosa*, *Salvia aethiopsis*; as well as rare halophytes were studied. The results of the project were scientific publications and proposals, which could help to protect local plant populations and biotopes, and to safeguards unique landscape diversity.

**Species structure of lichens as important biodiversity components of selected areas in Slovakia**, VEGA 2/7068/27, 2007–2009, IB SAS principal investigator: Anna Guttova. The project was focused on a complex study of lichens, their species structure, taxonomic and nomenclature questions and phytogeography in selected areas in Slovakia. Substantial contribution was acquisition of unique information on lichen species structure in seven areas gathered by field work (Bratislava, Bukovské vrchy Mts, Slovenský kras Mts, Muránska planina Mts, Štiavnické vrchy Mts., Záhorie, Zoborské vrchy Mts.). All relevant historical entries on the occurrence of lichens were summarized as a complement to the knowledge of total lichen diversity in the selected areas. We resolved taxonomic and nomenclature problems linked to the species *Lecanora carpathica* Zahlbr. and *Physcia aipolioides*, which enabled to

refine the knowledge on their occurrence in Slovakia, the Carpathians and south-east Europe. The obtained results may be applied for habitat status assessment in Slovakia and for solving of further obligations of Slovakia resulting from its membership in European Union.

**Macrofungi described from the Western Carpathians**, VEGA 2/7071/27, 2007–2009, IB SAS principal investigator: Pavel Lizoň. Full annotated list of fungal taxa described from the territory of Slovakia was completed and published. Based on our own research and studies by other authors, numerous taxa were recognized and delimited. Nomenclatural lectotypes were designated for *Agaricus argyreus* Kalchbr., *Agaricus punctulatus* Kalchbr., *Agaricus thraustus* Schulzer, *Collybia fodiens* Kalchbr. a *Marasmius schoenopus* Kalchbr. Taxonomic analysis was focused on taxa described by Carl Kalchbrenner and on members of the genera *Crepidotus*, *Pluteus*, *Amatodon* a *Flammulina*.

**Taxonomy and Biogeography of the Genus *Flammulina* in Central Europe**, VEGA 2/5087/25, 2005–2007, IB SAS principal investigator: Slavomír Adamčík. Five species of the genus *Flammulina* occur in Central Europe. *F. fennae*, *F. ononidis* and *F. rossica* are uncommon species, but they are easily distinguishable. Bavarian collections of *F. rossica* are first known from area of Central Europe. Our recent collections of *F. ononidis* represent first reports about occurrence of this rare species in Slovakia. *F. velutipes* and *F. elastica* are very common species, but they had not been hitherto distinguished because of problems with determinations. Accordingly, frequency, proportion and even occurrence of *F. elastica* in nature had not been known in most countries of Central Europe. Large part of collections of both species has spores with similar shape and size of spores, according to our observations. Characters measured on ixophyphidia in pileipellis were used to support delimitation of the taxa. Average values of 9 measured characters were statistically evaluated and compared with DNA sequences. Approximately 25% percent of observed collections have overlapping values of measured characters and were undeterminable. The delimiting values for collections which can be clearly determined were statistically estimated.

**Diversity of selected orders of phytopathogenic fungi in Slovakia**, VEGA 2/7067/27, 2007–2009, IB SAS principal investigator: Kamila Bacigálová. We studied the species spectrum, variability and chorology of selected taxonomic groups of phytopathogenic fungi and their host plants in Slovakia. We contributed to the knowledge on species and genus diversity of fungi within the orders Taphrinales, Erysiphales, Exobasidiomycetes, Uredinales, Ustilaginales and Hyphomycetes in Slovakia. We revised problematical polymorphic groups will be realized, including nomenclature, typification, morphometrics and distribution of differentiated taxa.

**Lowland and submontane bryophyte flora and bryocoenoses in Slovakia. present state and threat**, VEGA 2/7070/27, 2007–2009, IB SAS principal investigator: Anna Kubinská. We monitored and mapped bryologically important habitats in selected areas in Slovakia – Borská nížina lowland, Podunajská nížina lowland and Spišská Magura Mts. We studied the distribution of poorly known and rare bryocoenoses, especially hygrophilous, epiphytic, epixylic and antropogenous bryophyte communities as well as chorology and dynamics of rare and endangered bryophytes focusing on the species included in the Appendix I of the Bern Convention, Habitat Directive, on the European important species, relic and endemic species of Slovakia.

**Critical taxa of the flora of Slovakia from orders Asterales, Campanulales, Diantiales, Liliales, Poales and Violales**, VEGA 2/6054/06, 2006–2008, IB SAS principal investigator Veduci projektu: Kornélia Goliašová. We completed morphometric and cytological studies of the *Viola suavis* group from Slovakia, Czech Republic, Hungary and Austria. Diploid *Avenula* taxa (*A. compressa*, *A. pubescens* and *A. versicolor*) from central Europe, polyploid complex of *Senecio jacobaea* in central and eastern Europe (especially karyologically variable Ukrainian populations), and the aggregate species *Cerastium*

*alpinum*, *C. latifolium* and *C. fontanum* were analyzed by flow cytometry. We explored cytotype variation in the *Pilosella officinarum* complex in the Czech Republic, Slovakia, Hungary, Bulgaria, Georgia, Ireland, Italy, Romania and Ukraine, and its recent spread in Europe. Taxonomic revision of the *Hieracium nigrescens* agg. resulted in the recognition of three endemics - *H. jarzabczynum*, *H. vaponicanum* and *H. mlinicae*, recording also their occurrence on the Slovak-Polish border. Hybridization experiments in *Taraxacum* sect. *Ruderalia* (crosses between diploid mother plants and tetraploid pollen donors) were karyologically evaluated.

**Selected evolutionary and taxonomic questions within the genus *Cardamine* (*Brassicaceae*) in different parts of its distribution area**, VEGA 2/6055/06, 2006–2008, IB SAS principal investigator Veduci projektu: Judita Lihová. In this project we obtained new insights into taxonomy, phylogeny and evolution of the genus *Cardamine*, contributing also to better understanding of processes and mechanisms of plant evolution. We resolved taxonomy of the *C. maritima* group in the Balkans (including the description of a new species), and revised interpretation and circumscription of Eastern Asian species (*C. fallax*, *C. torrentis*, *C. yezoensis*, *C. schinziana*). We explored evolutionary processes associated with hybridization and polyploidization. We confirmed extensive gene flow between *C. pratensis* and *C. raphanifolia*, and underlined the complexity and evolutionary potential of hybrid swarms. High polyploidy and cytotype variation were found in Eastern Asian *C. torrentis*, *C. yezoensis* and *C. schinziana*. Attention has also been devoted to diploid speciation, and the impact of Pleistocene climatic oscillations on genetic variation patterns. We got insights into the evolution of the diploid *C. maritima* group, and inferred phylogeographic scenaria of alpine species *C. resedifolia* and *C. alpina*.

**Diversity of macrophytes along ecological gradients of watercourses and alluvial wetlands in Slovakia**, VEGA 2/5083/25, 2005–2007, IB SAS principal investigator Principal investigator: Richard Hrivnák. During our research, 1) we spread knowledge on occurrence and ecology of some macrophyte species and their communities in Slovakia, including the first note of *Nitelletum syncarpae*, 2) we prepared and tested Reference index of macrophytes to estimate the ecological status of running water according to the EU Water Frame Directive, 3) we detected factors affecting structure of macrophyte vegetation as well as macrophytes-environment relationships in selected Slovak watercourses (eg. Hron, Slatina, Dunaj), 4) we found relatively equal species composition of macrophytes and slight deterioration of ecological water quality in Klátovské rameno stream, 5) we detected a strong effect of water depth and air temperature to macrophyte abundance as well as different behaviour of various groups of macrophyte life forms while studying the seasonal dynamics of macrophytes in two streams, 6) we detected traces of Zn, Pb, Cd, Cu in macrophytes and water of some Slovak rivers.

**Classification and ecological differentiation of the mesophilous and xerophilous grassland communities in the Slovak part of Western Carpathians**, VEGA 2/5084/05, 2005–2007, IB SAS principal investigator Veduci projektu: Monika Janišová. Mesophilous and xerophilous grassland vegetation covers substantial area of Slovakia and recently has been subjected to marked changes related to land use alteration. Since the introduction of Zurich-Montpellier phytosociological approach many plant communities were described mostly in regional context without a broader evaluation of their relationships to the existing syntaxonomical system. The main task of the project was to summarize the recent knowledge on grassland vegetation in Slovakia and to make it accessible for international synthesis as well as for practical utilization (nature conservation and landscape planning). The Slovak Phytosociological Database of grassland vegetation was extended by all individual unpublished relevés from insufficiently known regions (1500), unpublished relevés gained from external sources (2000) and compiled published relevés (2500). In addition, the geographical position of 3000 relevés was included. The field phytosociological survey focussed on selected regions of Slovakia and a substantial set of relevés was collected: Starohorské vrchy Mts. (320 relevés), Biele Karpaty Mts. (320 relevés), Poľana Mts. (670 relevés) and Javorie Mts. (70 relevés). Firstly, the current approach to grassland classification

and to evaluation of the relevancy of the syntaxa description was revised. A new national classification has been proposed based on the results of modern analytical and synthetic methods. The project resulted in proposing criteria for the identification of grassland communities which served as a basis for the elaboration of a widely used computerized expert system.

**Nonforest vegetation of mountain and subalpine belt of Krivánska Malá Fatra Mts, VEGA 2/6057/27, 2006–2008, IB SAS principal investigator** Principal investigator: Ivan Jarolímek. The project was focused on the vegetation research around and above the timberline in the Krivánska Malá Fatra Mts. Insufficiently explored or unexplored non-forest plant communities from the classes *Mulgedio-Aconitetea*, *Betulo-Alnetea viridis*, *Elyno-Seslerietea*, *Loiseleurio-Vaccinieta* and *Roso pendulinae-Pinetea mugo* were studied by phytosociological methods. The phytosociological relevés gained in the area of the Malá Fatra Mts (approximately 1,300 relevés) were stored in database programme Turboveg. The list of vegetation units of the area was compiled on the basis of gained phytosociological data. Some of the units were stated for the first time from the Malá Fatra Mts and several of them were newly described for science. Gained regional data was compared with phytosociological data from the rest of Slovak and European mountain ranges, and evaluated in broader phytogeographical, chorological and ecological context.

**The effect of selected stress factors on physiological and biochemical characteristics of crop, VEGA 2/7072/07, 2007–2009, IB SAS principal investigator** Veduci projektu: Miroslava Luxová. Based on our results we can confirmed that seedling plants and also older maize plants as well as rape plants respond to the effects of salinisation differently depending on the length and strength of the stress. Antioxidant response representing increase in the activities of antioxidant enzymes (superoxid dismutase, peroxidase and catalase), or increased accumulation of proline and ascorbate was more pronounced in roots and leaves of maize, which responds to salinisation more sensitive than rape.

**The role of toxins in pathogenesis of their producents, VEGA 2/6056/20, 2006–2008, IB SAS principal investigator** Veduci projektu: Antónia Šrobárová. *Fusarium* species are pathogenic organisms which are able to produce different fungal toxins. Good knowledge of the penetration of fungal toxins in plants and mechanisms of their action can be the basis for protection against their producer. Significant differences in concentrations of toxins between species of the genus *Fusarium* were found in the production of deoxynivalenon and nivalenon, toxins that are the main toxic substances of this pathogen and allow him colonization of germs and flowers of infected wheat.

**Isoperoxidases of barley roots cultivated in the presence of heavy metals and their role on growth and structure of roots, VEGA 2/7073/27, 2007–2009, IB SAS principal investigator.** Our results show, that in most cases the studied metals (Cd, Cu, Hg, Ni, Pb) induced production of reactive oxygen forms, which influenced several growht and metabolic processes. Quantitative analysis of heavy metal uptake and production of reactive oxygen species show significant quantitative differences along the root. Increased uptake of Cd was connected with significant increase in production of reactive oxygen species, reaching their maximum concentrations in elongation zone. Increased production of H<sub>2</sub>O<sub>2</sub> is linked with significant increase in oxalate-oxidase activity, which reached its peak in the area of the apex and gradually decreased towards differentiation zone. Activation and specific expression of particular peroxidases in the root segments became ultimately evident in inhibition of elongation growth of the root and in accelerated differentiation of root cells exposed to heavy metals.

**Participation of endomembranes and components of cell wall in the maintenance of plant cell polarity, VEGA 2/5085/25, 2005–2007, IB SAS principal investigator** Miroslav Ovečka. The process of endocytosis and recycling of membranes in root hairs shows rapid membrane internalization and different manners of distribution and mobility of endosomal compartments. Using the methods of

contrast-enhanced microscopy and confocal microscopy has brought details on the structure and dynamics of membrane components and their internalization during cell growth maintenance. The spatial and temporal separation of early and later stages of endocytosis in growing root hair has been demonstrated.

**Plant communities of the Muránska planina National Park 2. The forest vegetation,** VEGA 1/4349/07, 2007–2009, IB SAS co-investigator Deputy head of the project from SAS: Ivan Jarolimek. Despite high diversity and attractiveness, the vegetation of the Muránska Planina Mts has not been studied thoroughly up to now. Extraordinary habitat diversity, position on the boundary of important biogeographic units, at the crossroad of migration routes and, consequently, also great species richness characterize the Muránska Planina Mts as one of the most interesting and most valuable territories in the Western Carpathians. It represents an outstanding region which is a candidate for the European Union NATURA 2000 Network of Protected Areas. During the project, in the studied territory several rare and threatened species were found. Also several species new for this area were registered (e.g. *Asplenium adianthum-nigrum*, *Chenopodium pedunculare*, *Epipactis leptochila*). Phytocoenology and ecology of shrub vegetation of the alliance *Salicion cinereae* and forest vegetation of the classes *Quercio-Fagetea*, *Alnetea glutinosae*, and clearing vegetation of the class *Epilobietea angustifolii* was evaluated and published. Expert assessment of the real and potential forest vegetation of the National nature reserve Fabova hoľa with management recommendations was elaborated for the Administration of the National Park.

**Diversity of vegetation in the Veľká Fatra Mts. in relation to the neighbouring regions. Non-forest phytocoenoses,** VEGA 1/2347/05, 2005–2007, IB SAS co-investigator Deputy head of the project from SAS: Monika Janišová. The Veľká Fatra Mts. represents the region with a high diversity of all, climate, relief, flora and vegetation. Numerous syntaxa have been described from this region. Nevertheless, numerous vegetation types still remain insufficiently known. The widening of knowledge on their structure and distribution contributed to a more professional management and conservation of rare and vulnerable plant communities. At the same time the project had contributed to population mapping of the phytogeographically interesting and endangered taxa of vascular plants with optimum in non-forest communities.

#### ii. List of national scientific conferences (co)-organized by the Organisation

- [1] Biodiverzita húb Slovenska 11 (Biodiversity of Fungi of Slovakia 11), Bratislava, 07. 12.2011
- [2] Biodiverzita húb Slovenska 10 (Biodiversity of Fungi of Slovakia 10), Bratislava 07.12.2010
- [3] 9. zjazd Slovenskej botanickej spoločnosti pri SAV (9<sup>th</sup> Congress of the Slovak Botanical Society SAS), "Flóra a vegetácia Oravy" (Flora and vegetation of Orava region), Námestovo-Slanická Osada, 15.- 18.9. 2009
- [4] Biodiverzita húb Slovenska 9 (Biodiversity of Fungi of Slovakia 9), Bratislava 08.12.2009
- [5] Biodiverzita húb Slovenska 8 (Biodiversity of Fungi of Slovakia 8), Bratislava 09.12.2008
- [6] Biodiverzita húb Slovenska 7 (Biodiversity of Fungi of Slovakia 7), Bratislava 04.12.2007

#### iii. List of edited proceedings of national scientific conferences/events

[1] none

#### • International/European position of the individual researchers

- i. List of invited/keynote presentations at international conferences, documented by an invitation letter or programme

- [1] **Marhold, K., Španiel, S., Zozomová-Lihová, J.**, Phylogenetic relationships and microevolutionary patterns in *Alyssum* (Brassicaceae). XVIII International Botanical Congress (symposium Sym097: Systematics and Evolution of Brassicaceae), Melbourne, Australia, 23-30 July 2011
- [2] **Šibíková, I., Svitok, M.** Venezuela - cesta za strateným svetom. Prednáškový cyklus Českej botanickej spoločnosti, 5. 12. 2011
- [3] Leong-Škorničková, J., Šída, O., **Marhold, K.**, Suda, J. Recent developments in *Curcuma* systematics. XI International Conference of International Organization of Plant Biosystematists: Evolution of plants from tropical to high-mountain ecosystem: focus on Asia, Aurangabad, India, 2.-4.9.2010
- [4] **Marhold, K.** Využití současných morfometrických, karyologických a molekulárních metod, jejich výhody a nevýhody na příkladu rodu *Cardamine*. Pracovní konference České botanické společnosti "Evoluční aspekty biologie rostlin", Praha, 27.-28.11.2010
- [5] **Marhold, K.** Have cytology and morphometrics already been absorbed into traditional systematics? International workshop ob Biosystematics, Centre for Environmental Management of Degraded Ecosystems, School of Environmental Studies, University of Delhi, India, 6.-15.9.2010
- [6] **Marhold, K.** Have cytology and morphometrics already been absorbed into traditional systematics? XIII OPTIMA Meeting, Antalya/Türkiye, 22.-26.3.2010
- [7] **Marhold, K., Kudoh, H., Zozomová-Lihová, J.** Biosystematic studies in polyploid complexes in Asia: examples from the genus *Cardamine* (Brassicaceae). XI International Conference of International Organization of Plant Biosystematists. Evolution of plants from tropical to high mountain ecosystem: Focus on Asia. Aurangabad, India, 2.-4.9.2010
- [8] **Šibík, J., Šibíková, I., Hennekens, S. M.** Vegetation database - facilities and utilities. The Anniversary Conference of the Institute of Biology. 50 Years of Academic Research in Biology, Bucharest, Romania, 29.9.-1.10.2010
- [9] **Marhold, K., - Lihová, J.** - Species diversity and speciation in *Cardamine* (Brassicaceae) -examples from the Balkan Peninsula. Balkans - hotspots of ancient and present genetic diversity, 17-20 June 2009, Sofia, Bulgaria
- [10] **Hindák, F.** Filamentous Green Algae. 18. Summer Algological School, Poznan, Poland, 28.6.-4.7.2009
- [11] **Hindáková, A.** "What are diatoms". "Ecohydrology and Ecosystems Biotechnologies in Water Resources Management", Lodz, Tresta, Poland, 14.-22.9.2009
- [12] **Hindák F., Hindáková A.** Biodiversity of cyanophytes and algae of gravel pit lakes in Slovakia. XXVII International Phycological Conference, Łódź-Spala, Poland, 12-15 June 2008
- [13] Lux A., Vaculík M., Tanimoto E., **Luxová M.**, Kulíková Z., Lichtscheidl I. Silicon improves growth and increases root cell wall extensibility of cadmium treated maize. , 4th International Conference Silicon in Agriculture, South Afrika 26.-31.10.08, 2008
- [14] **Ovečka M.** MAPKs-mitogen activated protein kinases. Seminar der Arbeitsgruppen Cell Imaging and Ultrastructure Research, Universität Wien, 4. 11. 2008
- [15] **Banásová V., Lackovičová, A., Guttová, A.** Response of vegetation components to the decreasing pollution around the copper smelter Krompachy (East Slovakia). Miedzynarodowa konferencia "Porosty Karpat. Stań poznania i perspektywy Badań". 24.-26. septembra, 2007, Krakow, Pofsko
- [16] **Franková, L., Papoušková, B., Gašparíková, O., Pšenák, M.** Nitrogen metabolism and the level of colchicinoids in relation to the life cycle of *Colchicum autumnale* L. Konference experimentalni biologie rostlin a 11. dny fyziologie rostlin, Olomouc, 9. -12. 7. 2007
- [17] **Hindák F.** Cyanobacteria producing water blooms. 2nd Slovene Workshop on Freshwater Algal Taxonomy. Piran, 28. 8. 2007
- [18] **Hindák F.** Taxonomy of chlorococcal algae. 2nd Slovene Workshop on Freshwater Algal Taxonomy. Piran, 28. 8. 2007
- [19] **Hindák F.** Zriedkave a nove sinice zo Slovenska. 48. Konference Česke algologicke spoločnosti, Nivnice, 11. 9. 2007
- [20] **Hindák F.** K problematike tvorby akinet u nostokalnych sinic. 48. Konference Česke algologicke spoločnosti, Nivnice 11. 9. 2007
- [21] **Hindák F., Hindáková, A., Hašler, P.** Phytoplankton of the rivers Morava (Czech Republic, Slovakia) and Dyje (Czech Republic). XXVI. Spotkanie PTF, Lublin, 2007

- [22] **Hindáková A.** Taxonomy of freshwater diatoms. 2nd Slovene Workshop on Freshwater Algal Taxonomy. Piran, 28. 8. 2007
- [23] **Lackovičová, A., Pišút, I.** Exploring lichens in the Slovak part of Carpathians. International Conference: Lichens of the Carpathians. Knowledge and prospects. W. Szafer Institute of Botany, Polish Academy of Sciences, Krakow, 24-26 September 2007
- [24] Toth, D., **Bacigálová, K.**, Eftimova, J., Brindza, J. Microbial communities of Tokay vine varieties. 30th OIV World Congress of vine and wine, Budapest, 10-16 June 2007

**ii. List of employees who served as members of the organising and/or programme committees for international conferences**

- [1] Adamčík S.: 2010, 2011  
 [2] Baluška F.: 2007  
 [3] Banášová V.: 2007  
 [4] Čiamporová M.: 2007  
 [5] Dítě D.: 2008  
 [6] Gurinová E.: 2007  
 [7] Hegedúšová K.: 2010  
 [8] Hindák F.: 2007  
 [9] Hindáková A.: 2007  
 [10] Illéš P.: 2007  
 [11] Janišová M.: 2010  
 [12] Jarolímek I.: 2010  
 [13] Kučera V.: 2007  
 [14] Lizoň P.: 2008, 2009, 2011  
 [15] Marhold K.: 2008, 2010, 2011  
 [16] Melečková Z.: 2010  
 [17] Mistrík I.: 2010, 2011  
 [18] Nadubinská M.: 2007  
 [19] Ovečka M.: 2007  
 [20] Podroužková-Medvecká J.: 2010  
 [21] Šibík J.: 2008  
 [22] Šibíková I.: 2008  
 [23] Šingliarová B.: 2011  
 [24] Škodová I.: 2010  
 [25] Valachovič M.: 2008

**iii. List of employees who served as members of important international scientific bodies (e.g. boards, committees, editorial boards of scientific journals)**

**Editorial boards of scientific journals:**

**Milada Čiamporová** – Biologia (WOS, Slovakia)  
**Otília Gašparíková** – Biologia (WOS, Slovakia), Biologia Plantarum (WOS, Czech Republic)  
**František Hindák** – Algologia (Ukraine), Algological Studies (Germany), Annales de Limnologie (WOS, France), Biologia (WOS, Slovakia), Fottea (WOS, Czech Republic)  
**Iva Hodálová** – Biologia (WOS, Slovakia)  
**Monika Janišová** – Tuexenia (WOS, Germany)  
**Ivan Jarolímek** – Ukrainian Phytosociological Collection (Ukraine)

**Pavel Lizoň** – Acta Mycologica (Poland), Polish Botanical Journal (Poland), Czech Mycology (Czech Republic)

**Karol Marhold** – Biologia (WOS, Slovakia), Folia Geobotanica (WOS, Czech Republic), Journal of Plant Development (Romania), Komarovia (Russia), Lagasalia (Spain), Polish Botanical Journal (Poland), Taxon (WOS, Slovakia), Willdenowia (WOS, Germany)

**Igor Mistrík** – Biologia (WOS, Slovakia)

**Patrik Mráz** – Biologia (WOS, Slovakia)

**Marián Perný** – Biologia (WOS, Slovakia)

**Jozef Šibík** – Biológia (WOS, Slovakia)

**Barbora Šingliarová** – Biológia (WOS, Slovakia)

**Milan Valachovič** – Biologia (WOS, Slovakia), Phytocoenologia (WOS, Germany)

**Judita Zozomová** – Folia Geobotanica (WOS, Czech Republic)

**Mária Zaliberová** – Monographie Botanicae (Poland)

### Other bodies:

#### **Monika Janišová**

- International expert evaluating project applications for ERA. NET RUS, Joint Call

#### **Karol Marhold**

- Organization for the Phyto-Taxonomic Investigation of the Mediterranean Area, Member of the International Board (2001–)
- International Organization of Plant Biosystematists, President-Elect (2004–2008), President (2009–2013)
- Member of the Steering Committee of the project Euro+Med PlantBase (Flora Europaea successor) (1999–)
- Member of the Steering Committee & Editorial Committee of the project Species Plantarum – Flora of the World (IOPI project) (2000–)
- Global Taxonomy Initiative – National focal point for the Slovak Republic (2001–), member of the GTI co-ordination mechanism for Central and Eastern Europe (2006–)
- Global Biodiversity Information Facility, person in charge of the national node for the Slovak Republic and member of the GBIF Governing Board (2001–)
- International Association for Plant Taxonomy, Secretary-General (2011–), Member of the General Committee for Plant Nomenclature (2011–)
- Member of the Editorial Committee of the International Code of Botanical Nomenclature (now International Code of Nomenclature for algae, fungi and plants) (2005–)
- International Organization for Systematic and Evolutionary Biology (IOSEB), Council member (2011–).
- Member of the Committee for Botany of the Council for PhD study in Biology at the Faculty of Science, Masaryk University, Brno, Czech Republic
- Member of the Council for PhD study in Botany at the Faculty of Science, Charles University, Prague, Czech Republic
- International expert evaluating project applications for FP7, E-Infrastructures (CP-CSA), FP7 - INFRA-2007-1.2.2, periodical review; FP7 - INFRA-2008-1.2.2, periodical review; FP7 - INFRASTRUCTURES-2008-2, periodical review; FP7 - INFRASTRUCTURES-2010-2-RI-Structuring the European Research Area; Grant Agency of the Czech Republic (GAČR); Grant Agency of the University of South Bohemia, České Budějovice; The Icelandic Research Fund

#### **Judita Zozomová**

- International expert evaluating project applications for Grant Agency of the Czech Republic (GAČR)

**iv. List of international scientific awards and distinctions**

[1] **Oľga Erdelská:** Award of International Association of Sexual Plant Reproduction Research (IASPRR), for Outstanding Service to the IASPRR, Presented at XX International Congress on Sexual Plant Reproduction, 8. 8. 2008, Brasilia DF, Brasil, Scott D. Russel, President IASPRR, University of Oklahoma

[2] **František Hindák:** Diploma of Agriculture University in Lublin, Poland for long-term cooperation with algologists in Poland, 25.-29.6.2007; Letter of Acknowledgement by Secretary of Ambassador of Ukraine in Slovakia appreciating long-term co-operation of Slovak and Ukrainian algologists

**v. List of employees with the highest H – index indicating field of science by WOS**

- [1] Karol Marhold (1959): 16 (researcher ID B-4699-2011)
- [2] Miroslav Ovečka (1967): 12
- [3] Judita Zozomová (1976): 12 (researcher ID B-5011-2011)
- [4] Igor Mistrík (1949): 12
- [5] Ladislav Tamás (1967): 11
- [6] Miroslava Luxová (1954):11

**Comment:** H-index is highly dependent on the age of the researcher that is why we include also this information. Within the institute, the values of H-index are biased by the fact that WOS citations of book publications are not taken into account. This clearly favours those who concentrate on publishing in the high impacted international journals, as opposite to those who are publishing monographic studies and deal with the problems of the flora on a local scale. Generally, the lower impact of publications, caused by the nature of the research and not by its quality, in our specialisations contributes as well. This was recognized, e.g., in the evaluations of the teams by Academic Rating and Ranking Agency in 2011, where the H-index was re-scaled (in our case from the value of 12 to that of 20) to enable comparison with the other branches of science.

- **National position of the individual researchers**

**i. List of invited/keynote presentations at national conferences documented by an invitation letter or programme**

- [1] **Hindák F.** Fenotypová a ekologická charakteristika potenciálne toxických planktónových siníc na Slovensku. Konferencia Sinice 2011, Bratislava, 13.-14. 10. 2011
- [2] **Hindák F.** Evolúcia, ekológia a taxonómia siníc/cyanobaktérií. Konferencia Sinice, Bratislava, 13.-14.10.2011
- [3] **Šibík J.** Život horských rastlín. Katolícka univerzita v Ružomberku, Pedagogická fakulta, Katedra biológie a ekológie, 31. 1. - 1. 2. 2011
- [4] **Šibíková, I., Šibík, J.** Skalnaté hory a Veľké pláne (O potulkách Spojenými štátmi a Kanadou). Botanické dni, Slovenské múzeum ochrany prírody a jaskyniarstva Liptovský Mikuláš, 6.6.2011
- [5] Wolowski, K., Buczek-Sledzinska, M., **Hindák, F.** Algae and Arts. - Zjazd SBS, Slanická Osada-Námestovo, 15.-18.9.2009
- [6] **Šibík J.** 2012. Zonácia TANAPu – stav, problémy a riešenia. In: Baláž M. (ed), Biológia v škole dnes a zajtra, 30. január - 31. január 2012 Katolícka univerzita v Ružomberku, Pedagogická fakulta, Ružomberok, p. 5

ii. **List of employees who served as members of organising and programme committees of national conferences**

- [1] Hindák F.: 2011  
 [2] Lizoň P.: 2007, 2008, 2009, 2010, 2011  
 [3] Meredá P.: 2009

iii. **List of employees serving in important national scientific bodies (e.g. boards, committees, editorial boards of scientific journals)**

**Editorial boards:**

- Lenka Franková** – Bulletin Slovenskej botanickej spoločnosti pri SAV  
**Kornélia Goliašová** – Bulletin Slovenskej botanickej spoločnosti pri SAV  
**Anna Guttová** – Bulletin Slovenskej botanickej spoločnosti pri SAV  
**František Hindák** – Bulletin Slovenskej botanickej spoločnosti pri SAV  
**Alica Hindáková** – Bulletin Slovenskej botanickej spoločnosti pri SAV  
**Ivan Jarolímek** – Bulletin Slovenskej botanickej spoločnosti pri SAV, Thaiszia - Journal of Botany  
**Eva Lisická** – Annotationes Zoologicae et Botanicae  
**Pavel Lizoň** – Catathelasma, Spravodajca Slovenskej mykologickej spoločnosti pri SAV  
**Karol Marhold** – Thaiszia - Journal of Botany  
**Igor Mistrík** – Bulletin Slovenskej botanickej spoločnosti pri SAV  
**Jozef Šibík** - Bulletin Slovenskej botanickej spoločnosti pri SAV  
**Antónia Šrobárová** – Acta Phytotechnica et Zootechnica

**Other bodies:**

**Karol Marhold**

- Head of Scientific Collegium SAS for Biological-Ecological Sciences
- Member of the Committee of Ministry of Environment of the Slovak Republic for Biodiversity Conservation
- Member of the Council for PhD study in Botany at the Faculty of Science, Comenius University, Bratislava
- Member of Committee SAS for environment
- Member of the Working group for natural sciences 4, Biology, Slovak Research and Development Agency (APVV)

**Ivan Jarolímek**

- Member of the Council for PhD study in Botany at the Faculty of Science, Comenius University, Bratislava
- Member of the Scientific board at the Faculty of Science, Comenius University, Bratislava
- Member of the Scientific board at the Faculty of Science, Matej Bel University, Banská Bystrica
- Committee of the National Bank of Slovakia for selection of motifs for Slovak banknotes, coins and memorial coins
- member of advisory board SAS for biological-ecological sciences
- member of Scientific board of the Institute of zoology SAS

**Otília Gašparíková**

- Member of Working group of Accreditation Committee of Slovak Republic, Life sciences 1

**František Hindák**

- Member of the Council for PhD study in Botany at the Faculty of Science, Comenius University, Bratislava
- chair of advisory board SAS for biological-ecological sciences
- member of editorial board of SAS

- member of Committee SAS for promotion of researchers
- member of Committee SAS for strategic scientific development
- member of the Scientific board of the Water research Institute, Bratislava

#### **Antónia Šrobárová**

- Member of the Council for PhD study in Plant Conservation at the Faculty of Agrobiolgy and Food Supply, Slovak Agriculture University, Nitra

#### **Milada Čiamporová**

- Member of the Council for PhD study in Plant physiology at the Faculty of Science, Comenius University, Bratislava
- Member of Committee SAS for bibliography
- Member of the Committee no 9 for biological and ecological sciences of Scientific Grant Agency (VEGA)
- Member of Presidency of Scientific Grant Agency (VEGA)

#### **Anna Lackovičová**

- Member of the Council for PhD study in Mycology at the Faculty of Science, Comenius University, Bratislava

#### **Pavel Lizoň**

- Member of the Board of Assembly of Slovak Academy of Sciences
- Member of the Committee no 4 for biological sciences of Scientific Grant Agency (VEGA)

#### **Miroslava Luxová**

- Member of the Committee no 10 for agriculture, forest and veterinary sciences of Scientific Grant Agency (VEGA)

#### **Igor Mistrík**

- Member of the Council for PhD study in Plant physiology at the Faculty of Science, Comenius University, Bratislava

#### **Miroslav Ovečka**

- Member of the Council for PhD study in Plant physiology at the Faculty of Science, Comenius University, Bratislava

#### **Ján Pavlovkin**

- member of advisory board SAS for molecular biology
- Member of the Committee no 8 for agriculture, forest and food sciences of Scientific Grant Agency (VEGA)

#### **Marián Perný**

- Member of the Committee no 4 for biological sciences of Scientific Grant Agency (VEGA)

#### **Ivan Pišút**

- Member the Scientific board of the Slovak museum of nature protection and speleology, Liptovský Mikuláš

#### **Milan Valachovič**

- Member of the Committee no 9 for biological and ecological sciences of Scientific Grant Agency (VEGA)

#### **Jozef Šibík**

- Member of Working group for zonation of Tatry National Park, Ministry of Environment SR

#### **iv. List of national awards and distinctions**

[1] **Bacigálová Kamila**: Holuby medal of Slovak Botanical Society SAS 2011

[2] **Dúbravková Daniela**: Pavel Sillinger prize for young botanists, awarded by Slovak botanical society SAS, for outstanding original scientific work published in scientific journal

- [3] **Goliašová Kornélia:** SAS Award for the results of research work in 2008 – award for the volume of the series Flora of Slovakia (Flóra Slovenska) VI/1, and Prize of the Literary Fund for scientific literature for 2008; both awards for the whole team of authors (H. Šípošová, I. Hodálová, E. Kmeťová, P. Meredá jun., E. Michalková, T. Miháliková, P. Mráz, M. Peniašteková, O. Ťavoda);
- [4] **Hindák František:** Award by Literary Fund for life time contribution 2011; Silver medal of VÚVH (Water Research Institute) on the occasion of 60<sup>th</sup> anniversary of foundation of the Institute, 2011
- [5] **Lihová Judita:** Award of the vice-Premier and Minister of Education SR for science and technology 2009 under 35, vice-Premier and Minister of Education SR
- [6] **Peniašteková Magdaléna:** Holuby medal of Slovak Botanical Society SAS
- [7] **Šibík Jozef:** Literary foundation award for the best original scientific literature in 2007 in the category of biological and medical sciences – on behalf of the whole team; Certificate of merit 2010 for outstanding original scientific work of young researchers under 35, Presidency SAS; Holuby medal of Slovak Botanical Society SAS 2011
- [8] **Šingliarová Barbora:** Award of President of Slovak Republic to young scientists of SAS, 2011; Pavel Sillinger prize for young botanists, awarded by Slovak botanical society SAS, for outstanding original scientific work published in scientific journal
- [9] **Šípošová Helena:** Jozef Miloslav Hurban prize in the category of original biographic works published in 2010 for the book “Osobnosti botaniky na Slovensku”, awarded by Slovak National Library, National Bibliographic Institute, Martin, 2011; Holuby medal of Slovak Botanical Society SAS 2010

#### v. **Supplementary information and/or comments documenting international and national status of the Organisation**

The Institute builds up, maintains, and manages herbarium with the international acronym “SAV”, registered in the Index Herbariorum (world index and database of herbarium collections), and collections of microorganisms (cyanobacteria, algae, and microfungi). The herbarium and microorganism collections are of great scientific, cultural-historical, and financial value. They serve to all botanists from both Slovakia and abroad as an evidence of the plant diversity of the country in the past as well as for their comparative taxonomic studies. The herbarium contains also considerable amount of specimens from abroad. The most important of them, is the collection is that of František Nábělek, collected in the Near East in 1909-1910. This herbarium collection is of an outstanding historical and scientific value with numerous type specimens documenting the biodiversity of the area of Turkey, Israel, Iran and Iraq, which has not been sufficiently known until these days. In 2006 the herbarium SAV was enriched with new acquisition of the herbarium specimens originally deposited in the Arboretum Mlyňany (22.500 specimens). This new collection contains mainly herbarium specimens of trees from both natural localities and culture.

The Institute builds up, fills up and manages several important databases: Database of chromosome numbers of the ferns and flowering plants of Slovakia (available on-line), Checklist of non-vascular and vascular plants of Slovakia (available on-line, new edition under preparation), the Database of data on the distribution of the ferns and flowering plants of Slovakia, which includes also data on herbarium specimens, and CDF (Central database of phytocoenological relevés in TURBOWIN).

## 2. **Project structure, research grants and other funding resources**

- **International projects and funding**

**i. List of major projects within the European Research Area – 6th and 7th Framework Programme of the EU, European Science Foundation, NATO, COST, INTAS, CERN, etc. (here and in items below please specify: type of project, title, grant number, duration, total funding and funding for the Organisation, responsible person in the Organisation and his/her status in the project, e.g. coordinator, work package leader, investigator)**

- [1] **Towards the European Distributed Institute of Taxonomy (EDIT)**, GOCE-CT-2006-018340, 2006–2011, 6th Framework Programme, total funding 11 900 000 EUR, funding for the organisation 80 911 EUR, responsible person Karol Marhold, status - investigator
- [2] **European Native Seed Conservation Network (ENSCONET)**, RICA-CT-2004-506109, 2004–2009, 6th Framework Programme, total funding 2 535 638 EUR, funding for the organisation 78 120 EUR, responsible person Karol Marhold, status – investigator
- [3] **Opening up the Natural History Heritage for Europeana (OpenUp!)**, 270890, 2011–2014, CIP-ICT (EU Competitiveness and Innovation Framework Programme - The Information and Communication Technologies), total funding 3 499 721 EUR, funding for the organisation 80 804 EUR, responsible person Karol Marhold, status – work package leader
- [4] **A Pan-European Species-directories Infrastructure (PESI)**, 223806, 2008–2011, 7th Framework Programme, total funding 2 515 330 EUR, funding for the organisation 42 792 EUR, responsible person Karol Marhold, status – investigator
- [5] **Bridging genomics and agrosystem management: Resources for adaptation and sustainable production of *Lotus* spp. in environmentally constrained South – American soils** FP6 – 517617, 2005–2009. Total funding: 879 256 EUR, funding for the organisation: 55 344 EUR, responsible person: Igor Mistrík, status – investigator.
- [6] **Participation of endomembranes and components of the cell wall in the maintenance of plant cell polarity** MERG-CT-2005-031168, 2006–2007. Funding: 40 000 EUR (EU- M. Curie), state budget SR: 59 815 EUR, responsible person: Miroslav Ovečka, status – investigator.

**ii. List of other international projects incl. total funding and funding for the Organisation**

none

**iii. List of other important projects and collaborations without direct funding**

- [1] **Monitoraggio biologico dell'inquinamento atmosferico nell'area interessata dalla presenza del nucleo industriale della Valle del Biferno (Campobasso)**. 2005-2008, Dipartimento di Scienze Ambientali, Università degli Studi di Siena, Italy. Responsible: Anna Guttová.
- [2] **Rete di biomonitoraggio della qualità dell'aria con l'indice di lichenica (IBL) nell'area interessata dalle ricadute dell'impianto Energonut S.P.A. sito in Pozzilli (IS)**. 2011. Dipartimento di Scienze Ambientali, Università degli Studi di Siena, Italy. Responsible: Anna Guttová.
- [3] **Effetti biologici delle polveri emesse durante la produzione del cemento sui licheni**. 2011–2012. Dipartimento di Scienze Ambientali, Università degli Studi di Siena, Italy. Responsible: Anna Guttová.

- **National projects and funding<sup>2</sup>**

- i. **List of State Research Programmes, and their funding**

none

- ii. **List of project supported by APVV**

Start	Project title	Project number	Duration in months	Funding for the Organisation (EUR)	Role of the Organisation
2004	Formalized classification system for identification of grassland vegetation	APVT 51-015804	36	15800	principal investigator
2005	Identification key of ferns and flowering plants of Slovakia and solving the problems of critical species groups in Central European area	APVT-51-026404	42	74089	principal investigator
2006	Impact of changes in air quality of urban agglomeration Bratislava on lichens	APVT-51-040805	48	54773	principal investigator
	Phylogenetic relationships of the <i>Alyssum montanum</i> - <i>A. repens</i> complex (Brassicaceae)	LPP-0085-06	55	79533	principal investigator
2007	PHYLO-TAXON, Phylogeography, postglacial history and taxonomy of model groups of taxa in Europe	RPEU-0003-06	42	24895	principal investigator
	The participation of endomembranes in the maintenance of root hair polarity in response to abiotic stress	APVV-0432-06	36	118070	principal investigator
2008	Limitation of Eutrophication Process in Water Basin Using Composite Sorbent	APVV-0566-07	28	17071	co-investigator
	Taxonomy of selected groups of vascular plants of the Carpathians and adjacent	APVV-0368-07	40	134269	principal investigator
	New methods of evaluation and mapping biotic harmful agents in urban greenery	APVV 0421-07	28	8390	co-investigator
2009	EVO-PICRIS, Taxonomy and phylogeny of the European representatives of the genus <i>Picris</i>	LPP-0239-09	42	41526	principal investigator
2011	MICRO-EVO, Microevolutionary processes in Asteraceae	APVV-0320-10	39	74032	principal investigator
	Plant ionome modification by silicon for improvement of the crop nutrition quality	APVV -0140-10	42	8570	co-investigator

<sup>2</sup> Excluding projects for the popularisation of science

iii. Number of projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

VEGA	2007	2008	2009	2010	2011
number	18	21	23	22	20
funding in the year (EUR)	55666	75981	91680	119072	129300

- Summary of funding from external resources

External resources	2007	2008	2009	2010	2011	total	average
external resources (milions of EUR)	0,265	0,282	0,312	0,268	0,306	1,433	0,287
external resources transfered to cooperating research organisations (milions of EUR)	0,012	0,011	0,006	0,000	0,007	0,036	0,007
ratio between external resources and total salary budget	0,428	0,424	0,441	0,370	0,437	-	0,420
overall expenditures (milions of EUR)	1,357	1,396	3,368	1,564	1,424	9,109	1,822

iv. List of projects the EU Structural Funds

- Summary of external resources of the EU Structural Funds (ERDF/ESF)

Year	Project title	Project number	Duration in months	Funding for the Organisation (EUR)	Role of the Organisation
2009	Natura 2000 in lifelong education	NFP24150120003	22	3000	co-investigator
	KRA-BIO Center of excellens for protection and use of landscape and for biodiversity	NFP26240120010	31	115430	co-investigator

**v. Supplementary info and/or comments on research projects and funding resources**

none

**5. Organisation of PhD studies, other pedagogical activities**

- i. List of accredited programmes of doctoral studies (as stipulated in the previously effective legislation as well as in the recently amended Act on the Universities). Period of validity of accredited scientific disciplines, characterization of perspectives of PhD study on the Organisation**

- [1] 15-07-9 botanika (botany)
- [2] .15-05-9 fyziológia rastlín (plant physiology)
- [3] 4.2.6 botanika (botany)
- [4] 4.2.9 fyziológia rastlín (plant physiology)

- ii. Summary table on doctoral studies (number of internal/external PhD students; number of students who completed their study by a successful thesis defence; number of PhD students who quitted the programme)**

PhD study	31.12.2007			31.12.2008			31.12.2009			31.12.2010			31.12.2011		
number of potential PhD supervisors															
PhD students	number	defended thesis	students quitted												
internal	13	4	1	12	0	0	14	1	3	15	6	0	10	2	1
external	11	1	0	10	2	0	9	1	1	7	2	0	6	1	0
supervised at external institution by the research employees of the assessed organisation	4	2	0	2	0	0	2	0	0	2	0	0	1	0	0

**Supervised at external institutions:**

A. Guttová – assistant supervisor (2004–2007), postgraduate student Lenka Brodeková, Dublin Institute of Technology, Dublin, Ireland; Thesis: An assessment of epiphytic lichens in semi-natural woodlands of Knocksink Wood nature reserve and other woodlands in Co. Wicklow (defended 2007)

K. Marhold – supervisor (1999-2007), postgraduate student Mgr. Jana Leong-Škorničková, Charles University, Prague, Czech Republic, Thesis: Taxonomic studies in Indian Curcuma L. (defended 2007).

K. Marhold – supervisor (2005-2012), postgraduate student Mgr. Hana Daneck-Dvořáková, Charles University, Prague, Czech Republic, Thesis: Phylogeography of temperate plant species with the focus on Central Europe (submitted for defence April 2012).

F. Hindák – specialist supervisor (2007–2010), postgraduate student D. Hlúbiková, Faculty of Natural Sciences Comenius University Bratislava; thesis: Selection of suitable assessment metrics for ecological status of the rivers of Slovakia based on benthic diatoms [Výber vhodných hodnotiacich metrick ekologickeho stavu tokov Slovenska založených na bentických rozsievkach (*Bacillariophyceae*)]

**iii. Postdoctoral positions supported by**

**a) external funding (specify the source)**

Mgr. Marek Slovák, PhD., postdoktorandský projekt APVV ( Sept. 2009-Aug. 2012, LPP-0239-09), 50%

RNDr. Stanislav Španiel, PhD., CIP-ICT projekt OpenUp! (May 2011-March 2012), 100%

RNDr. Barbora Šingliarová, PhD., FP7 PESI (Sept. 2010-Dec. 2010), 50%

Ing. Jaromír Kučera, PhD., FP6 ENSCONET (Jan. 2009-Oct. 2009), 0.25%

Mgr. Marek Slovák, PhD., FP6 ENSCONET (Jan. 2009-Aug. 2009), 0.25%

**b) internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz**

Ing. Jaromír Kučera, PhD. (May 2009-), 50%

Mgr. Marek Slovák, PhD. (May 2009-), 50%

RNDr. Barbora Šingliarová, PhD. (Jan. 2011-Dec. 2014), 50%

Mgr. Ľubica Liptáková (Halušková), PhD. (May 2011-) 50%

**iv. Summary table on pedagogical activities**

Teaching	2007	2008	2009	2010	2011
lectures (hours/year) <sup>3</sup>	124	126	112	179	175
practicum courses (hours/year) <sup>3</sup>	194	184	242	315	365
supervised bachelor thesis (in total)	1	0	4	23	12
supervised diploma thesis (in total)	8	6	9	8	20
supervised rigorous thesis (in total)	28	22	23	32	17
members in PhD committees (in total)	8	8	9	10	6
members in DrSc. committees (in total)	0	1	3	2	0
members in university/faculty councils (in total)	1	1	1	1	1
members in habilitation/inauguration committees (in total)	2	3	2	1	2

3

**v. List of published university textbooks**

[1] **Marhold, K.** & Suda, J. 2008: Štatistické spracovanie mnohorozmerných dát v taxonómii (Fenetické metódy). – Katedra zoológie Prírodovedeckej fakulty Univerzity Komenského & Faunima, Bratislava. [Slovak translation of the book published in 2002 Charles University, Praha]

[2] **Hindák, F., Hindáková, A.,** Kyselová, Z., Šoltés, R., Gáper, J., Gáperová, S. Botany - lower plants. 1. vyd. Žilina : Institute of High Mountain Biology : University of Žilina, 2009. 201 p. ISBN 978-80-88923-21-3

**vi. Number of published academic course books**

none

**vii. List of joint research laboratories/facilities with the universities**

[1] **National Taxonomic Facility / Národné taxonomické laboratórium** – joint facility of the Department of Vascular Plant Taxonomy of the Institute of Botany SAS, Department of Botany and Department of Zoology, Comenius University in Bratislava, Slovak National Museum, and Institute of Biological and Ecological Sciences P. J. Šafárik University in Košice

**viii. Supplementary information and/or comments on doctoral studies and pedagogical activities**

<sup>3</sup> Do not include time spent with bachelor, diploma or PhD students during their supervising

none

## 6. Applied research (Applications of results)

### i. List of the most important results of applied research projects

- [1] **Biological forms of carbohydrate hyperaccumulation. Projects: VEGA 2/0200/10, BIO2007-63915.** Production of volatile compounds is typical for growing colonies of different microorganisms. It is known that volatile compounds may affect plant growth and development. However, little or nothing has been known about how microbial emissions may affect primary carbohydrate metabolism in plants. Our original results show that volatile compounds emitted from microorganisms induce reactions in plants leading to changes in central metabolism of carbohydrates and amino acids. We found strongly promoted starch accumulation in leaves of both mono- and dicotyledonous plants. Changes in metabolism in plants exposed to volatiles emitted by microorganisms were documented by transcriptomic analysis of many genes as well as by determination of enzymatic activity. It is new, unreported mechanism for the elicitation of plant carbohydrate metabolism by microbes. Based on data achieved, we proposed a model how the metabolism of plants could be determined by these signals to starch overaccumulation. We proved and documented reaction to microbe-emitted compounds in important agricultural species, like potato and maize. The discovery that microbial volatiles trigger starch accumulation enhancement in leaves provides new opportunities for practical and commercial application of these mechanisms in the industry where starch is used as raw material.
- [2] **Management models for grassland habitats, projects: SK 0115 (EHP, Norwegian financial mechanism), VEGA 2-0181-09.** Over the last few years, considerable attention has been paid to the use of grassland habitats and their conservation in Slovakia. This is the result of international commitments which Slovakia, is bound to follow in the field of nature conservation. However, it is also a consequence of the significant loss and degradation of rich-in-species grasslands in Slovakia. In collaboration with Daphne – Institute for applied ecology 20 management models for grassland communities were prepared. Field experiments, focused on examining the influence of mowing, grazing and mulching on the species and vegetation structure of plant communities in selected territories of Slovakia, were an inherent part of the project. Each model offers complete information on the habitat ecology, its distribution in Slovakia, and its development trends and threats. It recommends measures for appropriate management, and summarizes the ecological and management demands of specific species of fauna and flora. Information on Natura 2000 habitat codes and codes in the Catalogue of habitats in Slovakia is provided. Examples of calculating the habitat management and restoration costs are provided. The proposed procedures for management and restoration of a habitat's natural value provide information on the appropriate regime of mowing or extensive grazing, based on the latest knowledge from research completed both in Slovakia and elsewhere in Europe. References to the financial tool, which has a significant impact on the state of habitats in Slovakia - the Agro-environmental program, a part of the Rural development program, are provided too. The models serve as a superstructure to this program, and they are important for planning the type of care in each particular locality, mainly in territories with high nature value (NATURA 2000). All models for non-forest habitats and information brochure in Slovak and English language were provided to staff of state nature protection and other stakeholders
- [3] **Database of Flora of Slovakia – DataFloS Project APVV-0368-07.** A new database application entitled the Database of the Slovak flora (Dataflos) was developed at the Institute of Botany, Slovak Academy of Sciences (IB SAS). The database serves as data archives as well as a management tool for plant distribution data from herbarium specimens, published sources as well as from various manuscripts. Dataflos includes both distribution data on plants in Slovakia and data about herbarium specimens collected abroad but deposited in Slovak herbaria. Data on all groups of plants and fungi, including cyanobacteria and algae, lichens, micro- and macrofungi, and vascular

plants, are deposited in the database. Various botanical institutions and botanists who are willing to share their knowledge on Slovak flora may input or import data to the database, upon the registration and creating login passwords. At present, Dataflos contains mainly data on taxa from Caryophyllales which were input by researchers at IB SAS within the scope of the treatment of the taxa for a new issue of *Flóra Slovenska/Flora of Slovakia VI/3*. Subsequently, the database will be updated by various institutions with additional records on various plant and fungal taxa. Dataflos is linked to a global botanical information system GBIF (Global biodiversity information facility) operating within BioCASE (Biological Collection Access Services). The database is assumed to be linked also with other botanical databases that have been developed in Slovakia, e.g. database on plant nomenclature, phytosociology, karyology and bibliography. Dataflos is publicly available at [www.dataflos.sav.sk](http://www.dataflos.sav.sk). Now the database includes approximately 120,000 publicly accessible records. After a combination of some of these criteria is entered, a list of corresponding records would be retrieved and this can be either downloaded as a spreadsheet table (Excel) or records may be displayed on the three types of maps (vegetation belts, phytogeographical division or Central European mapping scheme).

[4] **Building of Carpathian Biodiversity Information system and design of the ecological network for the Western Carpathians. Project DBU 24829-33/0.** The vegetation experts of the Institute of Botany prepared a full list of non-forest and forest biotopes included in the system Natura 2000 in Slovakia. For this the data on their occurrence in orographical units in the Western Carpathians from the Central Database of Phytosociological Relevés were used. The national concept was discussed on international level with the teams from other Carpathian countries (Poland, Czech Republic, Hungary, Ukraine, Romania, Serbia) with the aim to consolidate the understanding of biotope definition and to clarify the distributional data. The resulting database enabled further analyses which were then published.

[5] **Bridging genomics and agrosystem management: Resources for adaptation and sustainable production of Lotus spp. in environmentally constrained South - American soils FP6 – 517617.** In the frame of multilateral cooperation with the institutions of EU and South America the team of the Institute of Botany S.A.S. focused on the study of selected environmental stressors (low soil pH, Al toxicity, aridity) and their influence on growth and production of biomass of selected species and cultivars of *Lotus corniculatus* and *L. japonicus*. Main goal of the project was to select suitable cultivars of *L. japonicus*, which could bring sufficient and quality biomass for cattle stock raising and development of cattle grazing under the conditions of environmental burden of soils in South America. International partners were responsible for cultivation and production of new cultivars, our role was linked with the characterization of structural and functional properties of these cultivars, optimization of uptake and utilisation of nutrients, and characterization of the role of particular enzymatic systems in an oxidative stress induced by Al and low pH. *Lotus* sp., compared with other crops (maize, barley), is capable to withstand relatively high concentrations of Al in the root system, on the other hand, it is more sensitive to low pH. Elongation growth process showed, that with decrease in pH in the root system from 6.5 to 4.0, the growth of the root slows down by 30 %. The presence of Al did not increase the extent of inhibition of the elongation growth of the root up to the concentration of 0.5 mM, which, in case of barley or maize practically stopped the growth of the root. With decreased pH and the presence of Al *Správa o cinnosti Botanického ústavu SAV - 13* - decreased also the uptake of nitrate form of nitrogen, while evidential inhibition of nitrate uptake was observed with the concentrations 10 times lower than in the case of observation of the root growth rate. The methods which were used in the experiments may well served for quick assessment of susceptibility of the new cultivars of *Lotus* to the Al and low pH.

[6] **The distribution and diversity of aquatic macrophyte vegetation in water-bodies of Slovakia in relation to environmental factors and anthropic disturbance** The project was focused on distribution and ecology of aquatic and marsh plants in Slovak running water. We completed knowledge about distribution of the selected rare, endangered or taxonomical

problematic macrophytes (e.g. *Ceratophyllum submersum*, *Potamogeton berchtoldii*, macroscopic algae – Charophyta). The hydrological connectivity and land use surroundings of watercourse were determined as the main/major environmental drivers affecting distribution and quantity patterns of macrophytes in the Slovak river (Danube). On the other hand, environmental factors including sediment type, shading of shrubs and trees on the banks, water depth, NO<sub>2</sub>–and water acidity become more relevant for macrophyte composition in Slovak streams. Vegetation study dealing with seasonal dynamics of macrophytes in two streams pointed out statistically significant effect of water depth and air temperature to quality and quantity of plants as well as different behaviour of three species group (hydrophytes, helophytes and amphiphytes). We prepared reference index for assessment of ecological status of running water in sense of European Water Frame directive.

## ii. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign organisations

- [1] LIFE/Restoration and management of sand dune vegetation in military training area Záhorie, State Nature Conservancy, Banská Bystrica, 2011
- [2] Regional land-use system of ecological stability of the district Liptovský Mikuláš, Slovak Environmental Agency (SAŽP) Banská Bystrica, 2011
- [3] Ecological and floristic assessment of the cadaster area of Stupava, district of Malacky, for EIA – "TESCO Stupava", ADONIS CONSULT, 2011
- [4] Ecological and floristic assessment of the cadaster area of Babín for EIA – „Veterný park Poľana“ and „Veterný park Babínska hoľa“, SWWE, a.s. ADONIS CONSULT, 2011
- [5] European Red List, European Red List of Vascular Plants. Luxembourg, 2011
- [6] Expert opinion on the identity of the narcotic and psychotropic substances, District Police Directory Trnava (2 cases), Regiona Police Directory Trnava (1 case), 2011
- [7] Expert scientific cooperation: Ramsar sites, Zdeno Vlach – KARPATIA, 2011
- [8] Expert scientific cooperation: Prohibited kingdom, Branislav Molnár – Fotománia Plus, 2011
- [9] Conservation of European Roller and Endangered Bird Species, Management of its Habitats in Central Danubian Lowlands, Slovenská ornitologická spoločnosť/BirdLife Slovensko, 2011
- [10] Mapping selected localities from the herbarium of frater Cyprián (František Ignác Jaschke) from Červený Kláštor, Slovenské národné museum, 2011
- [11] Preparation of expert zonation of TANAP, Ministry of Environment SR, 2011
- [12] Occurrence of the lichen protected by law *Lobaria pulmonaria* (L.) Hoffm. and other rare epiphytes of NR Cigánka – castle Muránsky hrad, State Nature Conservancy SR – Administration of NP Muránska planina, 2010
- [13] Lichens of primeval forests of Central Europe, FSC (Forest Stewardship Council) Slovakia, 2010
- [14] Expert assessment to the management of the area of Devínska Kobyla, BROZ, State Nature conservancy SR, Administration of PLA Malé Karpaty, 2010
- [15] Expert opinion on the identity of the narcotic and psychotropic substances, District Police Directory Trnava (6 cases), Regiona Police Directory Trnava (2 cases), 2010
- [16] Preparation of scientific proposal for amendment of NATURA 2000 in pannonian and alpine biogeographic regions, DAPHNE, 2010
- [17] Identification of lichens, Považské múzeum, Považská Bystrica; Institute of Botany AV ČR Průhonice; Department of botany Masarykova University Brno, 2007, 2010
- [18] Analysis of the condition of biotopes of European importance in the zone of extraction Liptovská Porúbka – Malužiná, Eurovia- Kameňolomy, s.r.o., Hlinská č. 40, 011 18 Žilina, 2010
- [19] Expert opinion to the zonation of Vysoké Tatry, Ministry of Environment SR, 2010
- [20] Proposal for Western Carpathian Ecological Network as a precondition for effective cross-border nature protection, Carpathian Ecoregion Initiative, 2008, 2009

- [21] Management models for grassland biotopes, DAPHNE – Institute of Applied Ecology, 2009
- [22] Identification of plant material for the staff of State Nature Conservation (TANAP, NP Muránska planina, PLA Ponitrie, PLA Biele Karpaty, NP Slovenský raj etc.), scientific and pedagogical institutions from Slovakia and abroad. 2008
- [23] Regular monitoring of cyanobacteria and algae and macrophytes in the gravel pit lake Štrkovec during vegetation period 2007, 2008 for Municipality of Bratislava-Ružinov.
- [24] Phytoplankton of backwaters and flowing waters – tests for the staff water laboratories in SR, Water Research Institute 2008
- [25] Expertise of condition and development of flora and vegetation of NR Fabova hoľa for Regional environmental office in Banská Bystrica and membership in the expert commission of Regional environmental Office for the assessment of the conflict between State forests SR and Administration of NP Muránska planina, on authorization of logging in PR Fabova hoľa. 2008
- [26] Update on the status of the bryophytes of European importance sites in Záhorie (Rudava, sand dune sites), State Nature Conservancy
- [27] Expert opinion on the growing over of the water reservoir Sĺňava on the river Váh for Slovak Fisherman Association, Žilina, July 2007.

**iii. List of licences sold abroad, incl. revenues**

none

**iv. List of licences sold in Slovakia, incl. revenues**

none

**v. List of contracts with industrial partners, incl. revenues<sup>4</sup>**

none

**vi. List of research projects with industrial partners, incl. revenues<sup>4</sup>**

none

**vii. Supplementary information and/or comments on applied activities**

	2007	2008	2009	2010	2011	total
studies for the decision sphere, government and NGOs, international and foreign organisations	6	4	10	9	11	40

**7. Popularisation of Science (outreach activities)**

**i. List of the most important popularisation activities**

Here we list a selection of activities which were covered by important national media, foreign media, as well as some local media – national TV (STV, TA3), Czech TV – Česká televize, private TV national

<sup>4</sup> If not included in documentation of projects in chapter 4 (Projects structure, research grants and other funding resources).

cover (TV Markíza, JOJ), radio – national cover (RVTS – Sro, Rádia VIVA, Rádio Expres), local TV (Televízia Považie), daily (Pravda, Plus jeden deň), weekly (Plus sedem dní, Roľnícke noviny), press conference organized by the Presidency of SAS. The name of the contribution is original in Slovak, followed by the name of the media and the date of broadcast, release, event. Other numerous activities, which are not listed here include lectures for students of elementary and secondary schools as well as university students, excursions for students and teachers in the field, articles in a laymen form published in specialist and popular journals (Quark, Ochrana prírody na Slovensku, Záhorie), PR reports in SAS media ([www.sav.sk](http://www.sav.sk), Správy SAV). Institute of Botany organizes regularly the event - The open doors day, when the students and their teachers (elementary and secondary schools) are invited to be acquainted with the work of researchers in the Institute. There is a handful of activities prepared for the students in the Departments, the most favourite are the visits to the laboratories (plant physiology, molecular biology, geographical information system).

- [1] **Marek Slovák:** Budúcnosť Kochovej záhrady TV Markíza 6.11.2011; Jedovaté rastliny ohrozujúce deti – Dámsky magazín STV8.11.2011
- [2] **Marek Slovák, Jaromír Kučera:** Budúcnosť Kochovej záhrady TV Bratislava 11.11.2011
- [3] **Jozef Šibík, Ivana Šibíková:** Zbaľ sa a poď do... Južnej Afriky, Vlastivedné múzeum v Považskej Bystrici Televízia Považie 15.6.2011;  
<http://www.tvpovazie.sk/index.php/vysielanie/archiv/spravodajstvo/764-zba-sa-a-po-do-junej-afriky-2806201128.6.2011>
- [4] **Miroslav Ovečka:** Rastlinná neurobiológia – nová vedná disciplína 21. storočia Bratislavská vedecká cukráreň.; Centrum vedecko-technických informácií SR, Bratislava, [www.cvtisr.sk](http://www.cvtisr.sk), [www.vedatechnika.sk](http://www.vedatechnika.sk) 8.1.2011; Ako vnímajú rastliny JOJ, TV noviny 11.9.2010
- [5] **Anna Guttová, Judita Zozomová:** Sprístupňovanie činnosti Botanického ústavu SAV verejnosti s dôrazom na žiakov a študentov STV – Správy a komentáre 8.11.2010; Aplikácia lichenologického výskumu do praxe – výskum epifytických lišajníkov v Bratislave, SRo – Program na týždeň: Kto je nový Leonardo? 11.11.2010
- [6] **Ivan Jarolímek:** Zonácia TANAPu - stanovisko Botanického ústavu SAV Česká televize - Události 24.4.2010; Zonácia TANAPu - stanovisko Botanického ústavu SAV STV Správy 23.4.2010
- [7] **František Baluška:** Neurobiológia rastlín, Tlačová konferencia Úrad predsedníctva SAV 14.12.2010
- [8] **Ján Pavlovkin:** Solárium: Stres rastlín z chladu I. Slovenský rozhlas (SRo) 1.2.2010; Solárium: Stres rastlín z chladu II. Slovenský rozhlas 2.2.2010; Solárium: Zdravie z menej známych ovocných druhov Slovenský rozhlas 6.8.2010
- [9] **Dušan Senko:** Geografický informačný systém odhaľuje zmeny vegetácie krajiny v čase SRo – Program na týždeň: Kto je nový Leonardo? 11.11.2010
- [10] **Jozef Šibík:** Medveď sľúbil prehodnotiť zonáciu Tatier, ochranári sú skeptickí Pravda 28.4.2010; Politici sa mali o názor vedcov zaujímať skôr Pravda 17.4.2010; Tatry v ohrození Plus sedem dní 7.5.2010; Vedci vyzývajú vládu, aby nepodpísala zonáciu TANAPu! Pluska.sk 31.3.2010; Zonácia Tatier sa odkladá Plus jeden deň 30.4.2010
- [11] **Milan Valachovič.** Rozhovor o botanike, relácia Solárium, Slovenský rozhlas, 15.3.2008
- [12] **František Hindák:** Sinice a riasy ako ich nepoznáme. Slovenský rozhlas 14. 12. 2007
- [13] **Ján Pavlovkin:** Topics covered: vplyv sucha na vegetáciu; fytoterapia; jedovaté rastliny; využitie zeleniny pri prevencii voči chorobám; vplyv ťažkých kovov na životné prostredie, stres u rastlín: 2007: Televízia TA3 (3); Slovenský rozhlas 1 (6); Slovenský rozhlas 3 (6) ; Rádio Viva (8); Rádio Expres (3)

## ii. Summary of outreach activities

Outreach activities	2007	2008	2009	2010	2011	total
articles in press media/internet popularising results of science, in particular those achieved by the Organization	112	121	10	12	9	264
appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	26	23	0	10	7	66
public popularisation lectures	4	9	10	16	19	58

iii. Supplementary information and/or comments on popularisation activities

none

8. Background and management. Staffing policy and implementation of recommendations from previous assessments

i. Summary table of personnel

Personnel	2007	2008	2009	2010	2011
all personnel	102	91	94	99	94
research employees from Tab. Research staff	58	58	63	67	64
FTE from Tab. Research staff	50,0	51,0	53,5	51,2	48,5
average age of research employees with university degree	41,7	42,8	46,5	45,9	44,4

ii. Professional qualification structure (as of 31.12. 2011)

FEMALE	AGE									
	Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof. <sup>5</sup>	0	0	0	0	0	0	0	0	0	1
II.a / Assoc. prof. <sup>6</sup>	0	0	2	3	1	0	2	3	3	5
other researchers PhD./CSc.	3	4	1	1	0	0	1	0	0	0
doc./Assoc. prof.										

<sup>5</sup>, <sup>6</sup>

<sup>5</sup> Responsibility to organize PhD study

### iii. Professional qualification structure (as of 31.12. 2011)

MALE	AGE								
	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof. <sup>5</sup>	0	0	0	0	0	1	1	0	1
II.a / Assoc. prof. <sup>6</sup>	0	1	3	3	2	0	2	2	1
other researchers PhD./CSc.	1	1	5	1	0	0	0	0	0
doc./Assoc. prof.									

### iv. Status and development of research infrastructure incl. experimental, computing and technical base (description of the present infrastructure, premises, and material and technical resources. Infrastructure, instrumentation and major technical equipment necessary for the achievement of the objectives specified in the research Concept)

**The Department of Geobotany.** During the assessed period we substantially build and upgraded GIS laboratory which moved the knowledge on the formation of vegetation communities depending on abiotic part of the landscape. By means of <sup>7</sup> of *i*) four powerful computers, *ii*) an immensely powerful computer mapping system Arc GIS™ v 10<sup>8</sup> (we use GRASS GIS GNU/GLP on Linux Debian/Ubuntu for geospatial data modelling, and/or management and analysis, image processing), *iii*) Continuous digital vector data based on Topographic map of Slovakia (Zakladná mapa) in 1:50 000 scale, *iv*) tuned Corine Land Cover in 1:50 000 scale, *v*) Europe Solar radiation<sup>9</sup> (from 01/1994 up to present, spatial resolution 250 m: Global, Diffuse and Direct normal horizontal irradiation/irradiance), *vi*) Europe Air temperature (time coverage: 01/1991 up to present, spatial resolution: 1 km, *vii*) Europe Average air temperature at 2 metres, *viii*) Europe Relative humidity, Wind speed at 10m and Wind direction, *ix*) Digital Terrain Model of Slovakia in resolution 10 m per pixel, and *x*) other supporting software we could verify the hypothesis validity of mathematical relation in similar scales. Credibility of our results was growing with the complexity of the background input data. Trajectory and the time line of this laboratory was aimed at finishing of these extrapolation equations, e.g. *i*) topoclimate equations (soil temperature, vertical precipitation) in detailed scales, *ii*) management models, *iii*) prediction of occurrence, *iv*) contamination models, etc. Other significant results are algorithms for spatial extrapolation of the potential natural vegetation in Slovakia, which is based on strict mathematical rules.

Thanks to the acquired hardware and software we were able to create an applications based on Geoinformation Services: *i*) Tool to assign geographical coordinates, *ii*) Interactive on-line map of phytogeographical classification of Slovakia, *iii*) The online tool for searching locations within the squares of vegetation mapping in Slovakia, and *iv*) automatically expert searching of coordinates of phytosociological relevés based on known variable.

This innovative approach in GIS laboratory can be applied on many environmental studies (e.g. ecological stability, capacity, sensitivity, vulnerability). It has a potential of answering important

<sup>6</sup> Responsibility to be a supervisor of PhD study

<sup>7</sup> Acquired into "the Centre of Excellency for biodiversity and land-use conservation" (ŠF OPVaV 26240120014, Research & Development Operational Programme funded by the ERDF).

<sup>8</sup> ArcGIS™ is a complete system for designing and managing solutions through the application of geographic knowledge.

<sup>9</sup> Limited non-exclusive and non-transferable rights to use the purchased data.

questions, e.g. process development trajectory or identification of the most endangered areas. We tried to emphasize the need of close connection between GIS and botanical methodology by outlining the selected aspects of simulating the landscape potential.

In general framework, the ecological and geographical studies are very important and necessary for conservation planning, and must be considered as well. Traditional geobotanical approaches need to adapt to the challenges for greater precision and spatial objectivity within a GIS environment. Modern geotechnologies bring a huge methodological impetus.

Pedology laboratory is equipped with basic equipment for the analysis of basic pedological characteristics (pH, soil texture, content of soils).

**The Department of Vascular Plant Taxonomy** is well equipped for the use of a wide spectrum of methodical approaches, including multivariate morphometrics, karyology and molecular systematics. Instrumental and software equipment required for the application of multivariate morphometrics consists of several high-quality stereomicroscopes (Olympus SZ 61) with digital cameras to output images to PC, and A3 scanner allowing observation, digitalization and subsequent evaluation of the investigated material. Software accessories comprise licenses of statistical programs and packages (SAS, SYN-TAX) needed for evaluation of biostatistical data. Regarding karyological research, the Department possesses a karyological laboratory equipped by a microscope Axioscope 2 (Zeiss) and two flow cytometers (Partec CyFlow® ML) running in parallel and equipped by a green laser with 488 nm excitation wave and an HBO mercury arc lamp for UV excitation. Flow cytometers allow to detect relative (DNA ploidy level) as well as absolute DNA amount in plant material. The laboratory of molecular systematics is equipped by all instruments (centrifuges, mixer mills, three PCR thermocyclers, termoblocks, NanoDrop spectrophotometer, UV transluminator and camera for digitalization and documentation, sufficient capacity of deep freezers, etc.) necessary for standard methods used in molecular systematics such as DNA extraction, PCR, PCR-RFLP, PCR product purification and AFLP or SSR analyses. The Department owns licenses for all relevant programs needed for molecular data evaluation (PAUP, MacClade, SYN-TAX, SAS, DAX - software for trace analysis - AFLP, SSR data). Sequencing and fragment analyses of DNA are performed at DNA sequencers owned by BITCET consortium, a member of which is also our Institute. Next generation sequencing was recently applied in cooperation with the University of Zürich, Switzerland and GATC Biotech AG, Germany. Evaluation of such data is performed in cooperation with the Institute of Botany AS CR, Czech Republic, but own personal capacities for bioinformatic data analysis are currently developed. Important part of the infrastructure is also a herbarium consisting of more than 120,000 specimens serving as a source of data on plant distribution, for documentation as well as for comparative purposes.

**The Department of Non-vascular plants** equipped three laboratoria for basic work with specimens focused at fungal physiology, biochemistry and microscopy (light and fluorescent). These are: 1) algological laboratory for preliminary microscopic identification of specimens and preparation of cultures of cyanobacteria and algae, 2) mycological analytical and isolation laboratory, where we perform chemical analysis of secondary compounds using thin layer chromatography, and where we prepare the samples for isolation of total DNA from lichenized and non-lichenized fungi. In near future we would like to equip the lab with two instruments so as the whole process of DNA extraction can be performed here, 3) cultivation and inoculation mycological laboratory, as well as storage of fungal strains.

**The Department of Plant Physiology** is grouped of experts in plant physiology, molecular biology, biochemistry, and microscopy. All of them have a long-term experience in the studies of stress physiology and morphogenesis of root cells. This experience in the field of stress physiology and functional anatomy along with good and modern technical equipments make possible to realize the ongoing research at high professional level. The laboratory of stress physiology is equipped with

modern instruments for separation and analysis of proteins (Beckman U-8 ultracentrifuge, FPLC, gel slab electrophoresis, UV-VIS spectrometer, fluorescence reader, etc.) and nucleic acids analysis (PCR). For the monitoring and characterisation of rapid changes taking place on root cell membranes electrophysiological methods are used which are able to follow the changes in the membrane potential of root cells or the activity of different membrane pumps in very short time laps (sec., minutes). The laboratory of functional anatomy is equipped with various types of microscopes (light, fluorescence, electron, confocal, image analysers). An integrated approach in this field is based on application of modern methods of confocal microscopy, videomicroscopy, evanescent wave microscopy and immunofluorescence and immuno-electron localization techniques. Some image analyses are performed in the BITCET consortium located in the Institute of Virology. One approach for improving the efficiency and better understanding the role of different genes coping with the stress situation in plants is application of modern molecular biology methods using transgenic plants. In regard to this new approach we started the cooperation with the Department of Molecular Biology in the Centre of the Region Haná for Biotechnological and Agricultural Research. Great experience and modern technical equipments are the main reason that both groups are leading teams in this field in Slovakia and collaborate with many institutions in Europe (Vienna, Bonn, Darmstadt, Madrid, Sevilla, and Bristol).

#### Laboratory of stress physiology

Characterisation of enzymes involved in antioxidative protection; enzymes involved in production of reactive oxygen species and determination of their products in different developmental zones of roots during oxidative stress, heavy metal stress and increased salinity using fluorescence, chemiluminescence and spectroscopy methods, PCR, FPLC, PAGE. Using activators and inhibitors in the regulation of expression and activity of reactive oxygen species generating and antioxidative enzymes we can characterize their role on the root morphology and development and on the root hair formation and growth.

**Laboratory of electrophysiology.** Using measurements of electrical and permeability properties of plasma membrane of root cells and specific staining for cell nucleus and DNA fragmentation we can characterize the viability of root cells and determine the impact of stress on the process of programmed cell death in root. Determination of membrane potential changes enables us to characterize the very early changes in the membrane structure and function of root cells exposed to stress conditions.

**Laboratory of functional anatomy.** Modern methods of confocal microscopy, videomicroscopy, evanescent wave microscopy and immunofluorescence and immuno-electron localization techniques enable us to characterize anatomical and morphological changes induced by stress factors in plant roots. Determination and localisation of calose, lignin and suberin in cell walls are used for characterisation of cell wall modification induced by stress factors. For the determination of endomembrane dynamics and endocytosis in root hairs fluorescence and confocal microscopy is used. Microscopy image analysis is used for the determination of root hairs apical growth. Standard microscopy methods are used for the determination and histochemical localisation of different reactive oxygen species and studied metals and GFP constructs in root hairs.

Some technical equipment as HPLC and atomic absorption spectroscopy could achieve better productivity and quality of our research.

#### **v. Describe how the results and suggestions of the previous assessment were taken into account**

In previous assessment the IB SAS was evaluated in "A" category. Most of reviewer's recommendations have been accepted and realized.

Scientific: The new volumes of Flóra Slovenska and Vegetácia Slovenska were published. Karyological database was updated and results were published in book. Also the database of phytocoenological relevés was statistically evaluated and results, together with new syntaxa checklist were published in special volume of the series Vegetácia Slovenska. Knowledge of non-vascular plants, fungi, lichenized fungi and algae was improved. Research area was significantly widened from Slovakia to European (including East) and Mediterranean countries, in relevant cases also to East Asia and North America, usually in close collaboration with local botanical experts and institutions. In plant physiology the stress physiology is in the spotlight and physiologists work on subcellular and molecular level.

Personal policy: In collaboration with Comenius University, the Institute realizes PhD study in the fields of Botany and Plant Physiology. The most successful PhD students have been employed in the Institute and have been continuously building their knowledge and expertise in their specialization. The staff is stabilized, with suitable personal specialization and good average age. The Institution supports mobilities of all PhD students and workers and accepts also postdoc workers from abroad and colleagues within inter-academic exchange. To support publication activity, the Institute evaluates scientific workers individually and results of evaluation applies to bonus payment.

Facilities: The new building of the IB SAS was built and within it new laboratories and laboratory equipment, including new herbarium rooms, were arranged. In this way, the working environment and conditions for high level scientific work were significantly improved. The Institute has gained several larger projects from both European and national level and has solved fewer projects with more money. Laboratory equipment and IT technology are updated continuously.

**vi. Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

none

**Other information relevant to the assessment**

The team of Karol Marhold from the Department of Vascular Plant Taxonomy was evaluated among other teams of the Slovak Academy of Sciences by the Slovak Academic Ranking and Rating Agency (ARRA) in 2011. From among 200 evaluated teams, 22 were selected as top ones and 17 well above the average in respect of the comparison with the teams of the same branch of science all over the world. The team from the Institute of Botany was classified in the latter category. Altogether, only three teams from the SAS institutes of the group of Agricultural and Veterinary Sciences were evaluated in these two categories.