

Oral presentations

“You will see the forest here...”

Forty years of secondary succession in the Experimental Ecological Garden of Białowieża Geobotanical Station

Wojciech Adamowski¹ & Anna Bomanowska²

¹Białowieża Geobotanical Station, Faculty of Biology, University of Warsaw, Sportowa 19, 17-230 Białowieża, Poland, e-mail: w.adamowski@uw.edu.pl

²Department of Geobotany and Plant Ecology, Faculty of Biology and Environmental Protection, University of Łódź, Banacha 12/16, 90-237 Łódź, Poland, e-mail: knopikaa@biol.uni.lodz.pl

Two principal methods are used to study secondary succession: chronosequence and long-term observation of permanent plots. An example of such long-term studies on secondary succession are experiments conducted since 1974 on permanent plots at the Experimental Ecological Garden of the Białowieża Geobotanical Station, University of Warsaw, initiated and coordinated for many years by Professor Janusz Bogdan Faliński.

Initially, species composition was dominated by short-lived plants associated with arable lands in the case of the abandoned field and grasses, particularly *Dactylis glomerata* in the case of the uncut meadow. On the abandoned field, between years 5 and 16 of the experiment, a significant role was played by perennials, including grasses, whereas clonal perennials (first *Cirsium oleraceum* and later *Urtica dioica*) dominated on the uncut meadow between years 5 and 27. The first individuals of arborescent species outgrew herbaceous plants in year 11 of observation in both successional series and the first trees reached the tree stand in year 13 of observation. Tree stand cover on the abandoned field reached 50% in year 21, whereas on the uncut meadow in year 29; recently tree stand cover reached 60-70%.

After forty years, in both series, succession reached brushwood stage with domination of pioneer trees (*Salix caprea*, *Betula pendula*, *Populus tremula* on the abandoned field and *P. tremula* on the uncut meadow) and increasing the share of permanent forest compo-

nents (*Acer platanoides*, *Carpinus betulus*, *Tilia cordata*) in the tree stand. The tallest trees were more than 20 m high, i. e. half of the height of mature forest trees in Białowieża Forest. Recently, individuals of *S. caprea* have shown signs of dieback. Permanent forest components, particularly *T. cordata*, *C. betulus* dominate in the shrub layer. Insignificant role of *Quercus robur* in both successional series is interesting; its future incorporation into the tree stand is still unsure. In recent years, the first forest herbaceous plants occurred under the tree canopy (for example *Convallaria majalis*, *Anemone nemorosa*, *Isopyrum thalictroides* on the abandoned field and *Stellaria holostea*, *Ranunculus cassubicus*, *I. thalictroides* on the uncut meadow), whereas the cover of herb layer decreased dramatically.

At the moment, juvenile individuals of woody taxa are the main component of the herb layer. Results obtained up to this moment confirmed that undisturbed secondary succession on abandoned farmland leads from a typical segetal or meadow community to the formation of a juvenile tree stand and allows for the assumption that the forest will return to the abandoned field and uncut meadow. However, the achievement of species combination typical for a natural oak-hornbeam forest is rather improbable, because of the small size of the study plots and encroachment of some alien woody taxa. We expect the development of degenerative forms of oak-hornbeam forest, connected with forest edges.

Gypsophila perfoliata L. (Caryophyllaceae) – new, potentially invasive species in Poland

Wacław Bartoszek¹ & Alina Stachurska-Swakoń²

Institute of Botany, Jagiellonian University, Kopernika 27, 31-501 Kraków, Poland, e-mail: ¹wacław.bartoszek@uj.edu.pl, ²alina.stachurska-swakon@uj.edu.pl

Gypsophila perfoliata L. (*G. trichotoma* Wenderoth) is a species occurring in western Siberia, the Caucasus, northern Iran, eastern Turkey, Bulgaria and Romania. It is the species spreading in Europe, mainly along railway lines and roadsides. It occurs in anthropogenic habitats, especially tracks, roadsides, industrial dumps, often involving highly saline areas creating its own community *Gypsophilo-Puccinellietum*.

In Poland, so far, it has few localities. It was first described in 1957s from the area of Ostrowiec Świętokrzyski. In 1960s, it was observed in the piles of Kraków Soda Factory, where later it became missing due to habitat destruction. Currently, the population of the species was found in another locality in Kraków: in the heaps of T. Sendzimira Steelworks. In 1992, the species was listed from dumps in the reserve “Krzemionki Opatowskie”. In 2013, it was found for the first

time in the area of the Polish Carpathians in Stróża near Myślenice. Locality of the species in Ostrowiec Świętokrzyski is still maintained. Similarly, the locality in the reserve “Krzemionki Opatowskie” has been recently confirmed. The population in Kraków as well as in Stróża is monitored.

So far, the occurrence of *Gypsophila perfoliata* in Poland is associated with anthropogenic habitats and no information was reported about entering of this species into semi-natural or natural communities. However, dynamic changes of numerous plant populations of foreign origin in Poland observed in recent years call for careful observation of this potentially expansive species.

Gypsophila perfoliata was considered in Poland, until recently, as an ephemerophyte. In the latest study on alien species in Poland, it has the status of epeko-phyte.

Genetic structure of the *Hordeum murinum* L. in Kraków in relation to its genetic variation in Central Europe

Wojciech Bieniek

Department of Vascular Plant Systematics and Phytogeography, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland, e-mail: w.bieniek@botany.pl

The *Hordeum murinum* L. is a synanthropic, zoochorous, cleistogamous grass of Mediterranean origin that commonly occurs in ruderal habitats throughout the area of Central Europe where it is an invasive plant. Previous studies on chloroplast DNA of the *H.*

murinum from Austria, the Czech Republic, Hungary, Germany, Poland, Romania, Slovakia and Ukraine revealed two haplotypes. The geographic structure of the haplotypes in Central Europe strongly correlated with the Main European Watershed: the area of Poland and all

of the remaining areas in the Baltic Sea and the North Sea drainage basins were colonized exclusively by only one of those haplotypes (HT I), whereas both haplotypes (HT I and HT II) were found in the Black Sea drainage basin. Thus, it was shown that the geographic structure of the synanthropic plant was formed by some natural factors, whereas human activities, such as long distance transportation of seeds, did not influence the migration of *H. murinum* in a noticeable way, as it could be expected.

Then the genetic variation of *H. murinum* in Kraków was analyzed to investigate if the wide-scale pattern

was accurate and to assess the human impact on long distance seed transportation. Seventy eight specimens representing twenty six populations of *H. murinum* were analyzed by means of PCR-RFLP markers. The results indicated the presence of HT II in Kraków, but also the overwhelming dominance of HT I (90% of specimens). Thus, it was shown that the long-distance transportation of seeds from the south affected the genetic structure of *H. murinum* in Kraków.

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Artemisia pollen seasons in a changing environment of a big city

Paweł Bogawski^{1*}, Łukasz Grewling¹, Agata Frątczak² & Bogdan Jackowiak^{1,2}

¹Laboratory of Aeropalynology, Faculty of Biology, Adam Mickiewicz University in Poznań, Umultowska 89, 61-614 Poznań, Poland, *e-mail: bogawski@amu.edu.pl

²Department of Plant Taxonomy, Faculty of Biology, Adam Mickiewicz University in Poznań, Umultowska 89, 61-614 Poznań, Poland

Artemisia pollen grains are known to be an important cause of allergy reactions in Central Europe with prevalence exceeding 15% among sensitized inhabitants. In Poznań, the most common *Artemisia* species are *A. vulgaris* and *A. campestris*. Lately, on the basis of phenological observations, we documented that *A. vulgaris* pollen dominated in the first part of the pollen season (from the middle of July to the middle of August), whereas *A. campestris* was a major pollen contributor in the second part of the pollen season (second fortnight of August). Both *Artemisia* species are ruderal plants growing frequently on human-transformed sites e.g. construction places, roadsides, and disturbed soils. In recent years, marked transformations in land-use together with distinct changes in climatic conditions (mainly increase in summer temperatures) were observed in Poznań. All these changes might affect the *Artemisia* pollen concentrations in the air.

The main aim of this work was (1) to examine possible trends in *Artemisia* sp. pollen concentration, (2) to compare pollen concentrations in two periods of the pollen season attributed to different *Artemisia* species, and (3) to indicate possible triggers affecting pollen concentrations of *A. vulgaris* and *A. campestris*.

Pollen concentration measurements were performed daily from 1996 to 2013 (city center, CC) and from 2005 to 2013 (city outskirts, CO) in Poznań by means of Hirst-type volumetric pollen trap. Possible trends of pollen season parameters and meteorological variables were examined by Mann-Kendall test and Sen's method. Pearson correlation coefficient was used to relate the pollen totals to precipitation and temperature. We also assessed land-use patterns using historical dataset of satellite and aerial images from Google Earth dated from 24 May 2001.

Artemisia pollen season at CC advanced (-1 d/yr, $p < 0.01$), lengthened (+1.7 d/yr, $p < 0.01$) and the seasonal pollen total decreased (-77 p/yr, $p < 0.05$). The pollen totals (recorded at CO) attributed to *A. vulgaris* were significantly higher than in *A. campestris* (1243 and 419 pollen m^{-3} , respectively, t test $p = 0.003$). *A. vulgaris* pollen totals at CO were positively correlated with the air temperature in April ($r = 0.80$, $p < 0.01$) and precipitation in June ($r = 0.69$, $p < 0.05$). We did not find any significant relationships between *A. campestris* pollen totals and precipitation or temperature.

The relatively stable pollen totals in *A. campestris* pollen season in comparison with *A. vulgaris* (coefficient of variation, CV=0.25 and CV=0.52, respectively)

may indicate that the pollen production in *A. campestris* was less susceptible to meteorological conditions than in *A. vulgaris*. The lack of significant correlations with the temperature and precipitation seems to confirm *A.*

campestris resistance to meteorological conditions. Otherwise, the variations in *A. campestris* pollen production can be masked by land-use changes which markedly affected Poznań CO in recent decades.

Environmental monitoring: a tool for assessment of degree of transformations and efficient conservation of synanthropic habitats

Anna Bomanowska¹ & Izabella Kirpluk²

¹University of Łódź, Faculty of Biology and Environmental Protection, Department of Geobotany and Plant Ecology, Banacha 12/16, 90-237 Łódź, Poland, e-mail: knopikaa@biol.uni.lodz.pl

²University of Warsaw Botanic Garden, Faculty of Biology, University of Warsaw, Al. Ujazdowskie 4, 00-478 Warszawa, Poland, e-mail: ikirpluk@biol.uw.edu.pl

The obligation to monitor the environment is imposed by the Nature Conservation Act. It also results from the European Union legislation and international conventions, mainly the Convention on Biological Diversity and Habitats Directive.

In Poland, under the State Environmental Monitoring Programme, monitoring has, so far, been carried out of natural habitats and plant and animal species listed in annexes to the Habitats Directive, with a particular consideration of Special Areas of Conservation in Natura 2000 sites. However, for the needs of biodiversity conservation in Poland, the scope of monitoring should be wider and include habitats and species not listed in the Annex of Habitats Directive, e.g. synanthropic communities which are today undergoing rapid and irreversible changes and becoming threatened with extinction.

An opportunity to implement this in practice emerged in 2013 when Kampinos National Park commissioned development of a methodology and performance of monitoring for two types of synanthropic habitats within the Park area, i.e. segetal communities from the *Stellarietea mediae* class, and ruderal communities from the *Artemisietea vulgaris* subclass.

Based on orthophotomaps, maps of actual vegetation, analyses of available data and field pilot research, 10 sites were chosen for each of the two types of habitats where, in 2013, monitoring plots were established

and observations carried out. Observations were carried out according to the recommendations specified in the State Environmental Monitoring Programme, with specific adjustment to the monitored habitats. We used, for example, modified indices for specific structures and functions, e.g. by introducing the parameter “archaeophytes”, which was also adopted as a cardinal index for synanthropic habitats, and a more detailed definition of “alien invasive species” parameter, because some of them were species characteristic or distinguishing for syntaxonomic units.

The lecture presents the objectives, scope and organizational aspects of monitoring, a description of the research procedure, including its assessment for use in synanthropic habitats and the key findings from the performed monitoring, including the evaluation of the conservation status of habitats covered by the monitoring, and evaluation of effects of influencing factors.

The results of the monitoring carried out on segetal and ruderal habitats can be used for the assessment of their conservation status in Kampinos National Park, including the need for efficient conservation, especially to indicate specific active conservation measures.

Importantly, this is the first proposal for the standardized monitoring of synanthropic habitats and, thus, it will be revised in future in line with new experiences and new findings.

A large-scale survey of genetic variation and genome evolution within the invasive *Reynoutria* complex

Katarzyna Bzdega¹, Agnieszka Janiak², Tomasz Książczyk³, Elwira Śliwińska⁴ & Barbara Tokarska-Guzik¹

¹Department of Plant Systematics, Faculty of Biology and Environmental Protection, University of Silesia, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: katarzyna.bzdega@us.edu.pl, barbara.tokarska-guzik@us.edu.pl

²Department of Genetics, Faculty of Biology and Environmental Protection, University of Silesia, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: agnieszka.janiak@us.edu.pl

³Department of Environmental Stress Biology, Institute of Plant Genetics of the Polish Academy of Sciences, Strzeszyńska 34, 60-479 Poznań, Poland, e-mail: tksi@igr.poznan.pl

⁴Department of Plant Genetics, Physiology and Biotechnology, University of Technology and Life Sciences, Al. Kaliskiego 7, 85-789 Bydgoszcz, Poland, e-mail: elwira@utp.edu.pl

The taxa from the genus *Reynoutria*: *R. japonica*, *R. sachalinensis*, originating from Asia, and their hybrid *R. ×bohemica* are some of the most troublesome alien invasive species in Europe and North America, particularly dangerous to riparian ecosystems. Simultaneously, these taxa constitute a unique model system for the creation of hybrids and the initiation of evolutionary processes in an invaded range. The aim of the study was: (i) to examine the level of genetic diversity using *Amplified Fragment Length Polymorphism* (AFLP) markers in selected populations of three *Reynoutria* taxa from Poland, Hungary, Ukraine and Slovakia in comparison with Japan, (ii) to identify marked chromosomes in all taxa using fluorescence *in situ* hybridization (FISH) with rDNA sequences, and (iii) to establish genome size and ploidy level in the knotweed species using flow cytometry (FCM).

The results showed presence of genetic diversity within all taxa, including genetic diversity between individuals of *R. japonica*, from selected Polish populations which were considered to be genetically uniform in entire Europe, because they were introduced as a single female clone. The variation in ploidy among individuals of *R. japonica* and within hybrids was confirmed.

Among *R. japonica*, individuals octoploids ($2n=88$; $2C=8.48pg$) were the ones which dominated, while hexaploids ($2n=66$; $2C=6.51pg$) dominated within *R. ×bohemica* plants. All individuals of *R. sachalinensis* were hexaploids ($2n=66$; $2C=6.01pg$). Chromosome identification and dynamics of chromosome re-arrangements was necessary to understand the evolution of a genome in the *Reynoutria* complex. Within the chromosome complement of *R. japonica*, *R. sachalinensis* and *R. ×bohemica*, physical mapping of 5S and 18S–5.8S–26S rDNA (35S rDNA) loci provided markers for 16 out of 88 chromosomes, 13 out of 66 chromosomes and 10 out of 66 chromosomes, respectively. Assignment of known chromosomal markers to corresponding parental genomes in their hybrid *R. ×bohemica* is in progress. To date, genetic variation, ploidy level and genome size, and the chromosome complement of the *Reynoutria* complex in Poland in comparison with European population and population from native range have been worked out.

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Plant species diversity associated with invasive *Reynoutria* taxa in riparian vegetation

Damian Chmura¹, Gabriela Woźniak², Barbara Tokarska-Guzik³, Teresa Nowak³, Agnieszka Błońska², Katarzyna Bzdęga³, Barbara Ziemer² & Małgorzata Szary²

¹University of Bielsko-Biala, Institute of Environmental Protection and Engineering, Willowa 2, 43-309 Bielsko-Biala, Poland, e-mail: dchmura@ath.bielsko.pl

²University of Silesia, Department of Geobotany and Nature Protection, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: gabriela.wozniak@us.edu.pl, agnieszka.blonska@us.edu.pl, bziemer@us.edu.pl, mszary@us.edu.pl

³University of Silesia, Department of Plant Systematics, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: barbara.tokarska-guzik@us.edu.pl, tnowak@us.edu.pl, kbzdega@us.edu.pl

Invasive plant species influence the resident species, communities and ecosystems in many ways. They may reduce species richness and abundance of native biota and decrease their local species diversity, although individual habitats vary considerably in their susceptibility to invasion. Riparian habitats are especially valuable ecological communities with high species richness and are identified as habitats with value for nature conservation. These particular habitats, together with other waterside habitats, are the most endangered and most easily invaded by alien invasive plants. In many riparian habitats, the *Reynoutria* taxa individuals are common invaders. The description and quantification of differences caused by closely related alien taxa such as *Reynoutria* on the diversity of riparian vegetation resident species is presented. For this purpose, analysis of the studied vegetation based on the participation of species with similar morphological and ecological characters (Plant Functional Groups (PFG)) was performed. The use of the concept of PFG-s in studies on invaded communities provides a pragmatic approach which will make

it possible to implement links between traits of species and community and/or ecosystem functional structure.

The aim of the present study was to determine whether there were differences in the species diversity, particular in terms of the structure of plant functional groups of accompanying species, between patches of riparian vegetation dominated by *R. japonica*, *R. sachalinensis* and *R. ×bohemica*, respectively. We hypothesized that presence of the three *Reynoutria* taxa studied caused differences in the composition of plant functional groups which the associated species represented.

The expectation was that the structure of plant functional groups of species accompanying the *R. ×bohemica* dominated riparian patches would be most different in terms of all the analysed features as the hybrids were known to possess the best invasive abilities. However, the results suggest that the functional composition of riparian patches dominated by *Reynoutria japonica* was the most distinctive when compared with the composition of patches dominated by *R. ×bohemica* and *R. sachalinensis*.

Vascular plant, bird and moss – where and why do they meet in anthropogenic landscape?

Joanna Czarnecka¹, Ignacy Kitowski², Anna Rysiak¹ & Robert Zubeł³

¹Department of Ecology, Institute of Biology and Biochemistry, Maria-Curie Skłodowska University, Akademicka 19, 20-033 Lublin, Poland, e-mail: a_czarnecki@wp.pl, anrysiak@tlen.pl

²State School of Higher Education in Chełm, Pocztowa 54, 20-100 Chełm, Poland, e-mail: ignacyk@autograf.pl

³Department of Botany and Mycology, Institute of Biology and Biochemistry, Maria-Curie Skłodowska University, Akademicka 19, 20-033 Lublin, Poland, e-mail: robert.zubeł@poczta.umcs.lublin.pl

The Blackbird (*Turdus merula*) is one of widespread breeder and very numerous birds in Poland. It was, primarily, a forest species which colonized cities in the 20th century and, presently, is one of the most abundant breeding bird species in urban parks, graveyards and other brushwood of urban landscape. It is broadly known that the Blackbird disperses fleshy-fruited plant species endozoochorously, but it also takes part in secondary dispersal of seeds with nest material as it incorporates some amount of soil into the nest. It disperses mosses which are frequently used as the nest lining as well.

The goal of our work was to study the role of the Blackbird in seed and moss dispersal in habitats with different land-use patterns. We studied seed bank (seedling emergence method was applied) and moss species present in 51 nests of the Blackbird which were collected in the following habitat types: (1) urban habitats (in medium-sized towns of Zamość and Chełm and a small town of Rejowiec Fabryczny); (a) city centres with moderately high-density housing, backyards and lawns mown with different frequency (N = 11); (b) ruderal habitats in urban landscapes with spontaneous vegetation on formerly disturbed industrial areas which can be divided into two groups: with prevailing abundance of herbaceous vegetation and with dominance of brushwood in close surroundings of nests. They were often adjacent to roads or railway tracks (N = 16); (2) agrocoenoses where nests were usually

placed in orchards (frequently abandoned) and brushwood surrounded by arable fields, meadows and fallow lands (N = 12); (3) forest habitats which were treated as primary habitats of the Blackbird (N = 12).

We recorded seeds of 98 taxa of vascular plants (*Stellaria media*, *Urtica dioica* and *Poa annua* were the most abundant and frequent) and we found 19 species of mosses with *Oxyrrhynchium hians* and *Brachythecium rutabulum* present with the highest frequency. Although seed dispersal by birds with nest material seems to be a stochastic process, the same cannot be said about the moss dispersal. The two most frequent moss species were pleurocarpous and formed mats called ‘wefts’, which were characterized by a loose intertwining of straggling shoots, which stuck up and arched over each other in different directions. Probably these loose mats were easy to collect for birds, and due to their structure were often used as a lining.

The role of the Blackbird in seed dispersal seems to be more important in anthropogenic habitats. The mean number of seedlings and plant species was lower in nests coming from forest habitats (seedlings – 146/1000 g of nest dry weight, species – 5) than in the case of three other habitat types (agrocoenoses – 253 and 7 respectively, urban ruderal habitats – 348 and 8, city centres – 335 and 11). Recorded differences were statistically significant for mean species number (Kruskal-Wallis test: $H = 9.302$, $P < 0.05$).

Dynamic trends of alien woody plant species in Poland

Władysław Danielewicz & Wojciech Szwed*

Department of Forestry Natural Foundation, Faculty of Forestry, University of Life Sciences, Wojska Polskiego 71D, 60-625 Poznań, Poland,
*e-mail: w-szwed@wp.pl

About 260 species of trees and shrubs occur naturally in Poland, and at least 10 times more non-native woody plants species are cultivated. A list of alien taxa with the ability for spontaneous propagation in botanical gardens and parks, in urban and rural areas and in the woods is compiled based on many years of field observation and on the data from literature. The attempt was made to classify these plants in terms of the degree of settling in different environmental conditions.

The following division of the species was used:

Group I: species producing self-seedings, does not arise generation plants able to reproduce the generative, or those for which there is no reliable information on the development of self-seeding

Group II: species with self-seedings transformed into a generation of plants capable of generative reproduction, sustained only for anthropogenic habitats (botanical gardens, parks, cities) and, therefore, outside the shrubs and forest communities;

Group III: species transformed into a self-seeding generation plants capable of generative reproduction, persistent habitats unchanged or slightly changed by man, in natural or semi-natural communities (forests, scrub).

Among nearly 400 species on that list, most of the trees and shrubs were non-native species without permanent population which ephemeral appearing of self-seedlings were found most frequently in the dendrological collections. About 35% of the species showed the ability to develop self-seeding in the generation capable of further generative reproduction. In the forest environment, approximately 20% of the analyzed taxa was permanently naturalized. They were predominantly species introduced into forests within of acclimatization experiments and for production objectives, biocenotic and phyto-melioration. A large part of them remains in few places, only in those places where they have been previously entered. A few species considered invasive in Poland were grown on a commercial (economic) scale in the lowland forests of many regions of the country.

Due to the long development cycles of woody plants, knowledge of the dynamic tendencies of alien trees and shrubs should be periodically updated. It is, in fact, a fairly large group of species recently introduced into cultivation which can show the ability for spontaneous propagation from seeds in future.

Alien species of American origin on the cranberry plantation in Belarus

Maxim Dzhus

Belarusian State University, Biological Faculty, Nezavisimisty Ave. 4, 220030, Minsk, Belarus, e-mail: dzhus_maxim@rambler.ru, dzhus_maxim@gmail.com

In 2010-2014 on cranberry plantations in Belarus (Gantsevichi, Pinsk, Berezovsky districts of Brest region, Lelchitsy district of Gomel region), a complex of naturalized alien species of North American origin was found. Primary introduction (seeds and vegetative parts of plants) with exported cranberry from Wisconsin (USA) took place thrice: in 1982, 1983 and 1985 during the organization of new plantations in Gantsevichi and Pinsk districts. Further spread on the territory of Belarus and Russia occurred with the planting stock mainly from Gantsevichi experimental base.

Among the mentioned 30 species, 17 were new in Belarus and 14 new and well-established aliens in Eastern Europe: *Eleocharis obtusa* (Willd.) Schult., *Carex crawfordii* Fernald, *Agrostis hyemalis* (Walter) Britton, Sterns et Poggenb., *Penthorum sedoides* L., *Triadenum fraseri* (Spach) Gleason, *Hypericum canadense* L., *H. ellipticum* Hook., *H. mutilum* L., *Truellum sagittatum* (L.) Soják, *Lysimachia terrestris* (L.)

Britton, Sterns et Poggenb., *Lycopus uniflorus* Michx., *Eutrochium maculatum* (L.) E. E. Lamont, *Campanula aparinoides* Pursh, *Cicuta bulbifera* L.

Some species: were found on the plantations with high abundance and were characterized by significant invasive potential: *Elodea nuttallii* (Planch.) H. St. John, *Scirpus cyperinus* (L.) Kunth, *Agrostis hyemalis* (Walter) Britton, Sterns et Poggenb., *Penthorum sedoides*, *Triadenum fraseri* (Spach) Gleason, *Hypericum canadense* L., *H. mutilum* L., *Ludwigia palustris* (L.) Ell., *Truellum sagittatum* (L.) Soják, *Bidens frondosus* L., *Euthamia graminifolia* (L.) Nutt., *Cicuta bulbifera* L.

Correct determination of several collected species requires further clarification: *Stellaria longipes* Goldie, *Viola pallens* (Banks ex Ging) Brainerd, *Myriophyllum farwellii* Morong, *Symphotrichum ontarione* (Wiegand) G. L. Nesom, *Juncus brevicaudatus* (Engelm.) Fernald.

Synanthropization of the thermophilous fringe communities (*Trifolio-Geranietea sanguinei*) in Ukrainian Polissia

Dmytro Iakushenko

Department of Biological Sciences, University of Zielona Góra, Z. Szafrana 1, 65-516 Zielona Góra, Poland, e-mail: d.iakushenko@wnb.uz.zgora.pl

Thermophilous fringes are semi-natural plant communities, a sort of “filters”, that typically form a border with stable forest communities (on one side) and with other semi-natural or anthropogenic plant communities (on the

other side). Therefore, we can expect significant involvement of synanthropic species in their structure. The thermophilous forest fringes (*Trifolio-Geranietea sanguinei* T. Müller 1962) are critically important for the maintenance

of the biodiversity level in agricultural landscapes.

The dataset consists of 183 phytosociological relevés containing 321 vascular plant species. In Ukrainian Polissia, the communities of the class are represented by 3 alliances: meso-xerophilous and xerophilous fringes on the margins of thermophilous oak and oak-pine forests (*Geranion sanguinei* Tx. in T. Müller 1962, 76 relevés), meso-subxerophytic shady fringes on the margins of mesic forests and scrubs (*Trifolion medii* T. Müller 1962, 56 relevés), and fringes on acidic sandy soils (*Melampyrion pratensis* Passarge 1979, 51 relevés).

The extent of transformation of the plant communities was estimated by the calculation per relevé of the synanthropization index (the proportion of apophytes and anthropophytes relative to the total species number) and of the adventization index (the proportion of anthropophytes relative to the total species number).

The total number of synanthropic species in the dataset was 79 (24.6%). Among apophytes (67 species, 20.9%), the most frequent were *Achillea millefolium* L. (66%), *Dactylis glomerata* L. (37%), *Carex hirta* L. (27%), *Taraxacum officinale* F. H. Wigg. (25%), *Elytrigia repens* (L.) Nevski (22%), and *Geum urbanum*

L. (17%). Within anthropophytes (12 species, 3.7%), the most frequent were kenophytes: *Impatiens parviflora* DC. (12%) and *Erigeron annuus* (L.) Desf. (10%). Surprisingly, the share of the species which seemed to be a fringe-associated species in the region (*Saponaria officinalis* L. and *Lupinus polyphyllus* Lindl.) did not exceed 1% for each species. Probably, the plots with a considerable cover of this species were excluded from the survey already at the stage of field research.

In total, the synanthropization index for individual relevés varied in a wide range (from 0-4.0 to 44.1-65.0). For the alliances, the synanthropization index changed from 26.9 (*Geranion sanguinei*) to 19.8 (*Trifolion medii*) and 18.9 (*Melampyrion pratensis*). The adventization index was relatively low: it varied from 4.0 (*Geranion sanguinei*) to 2.1 (*Trifolion medii*) and 2.5 (*Melampyrion pratensis*).

The thermophilous forest fringes in Ukrainian Polissia, in general, are moderately synanthropized. The tendency of transformation due to increasing nitrification and progression of neophytization is observed more and more often.

Field crops in the modern period in Central Poland. Grain and weed diaspores from the grange in Pomorzany

Joanna Koszałka* & Joanna Strzelczyk

Institute of Archaeology and Ethnology, Polish Academy of Sciences, Rubież 46, 61-612 Poznań, *e-mail: yokosz@o2.pl

During the archaeological excavations carried out in the former grange in Pomorzany, in one of the buildings dating back to the 17th-18th century, certain amount of charred grain was discovered. Discovering a source material like this allowed for archaeobotanical research, which is the subject of this paper.

According to historical sources, during the operation of the farm in Pomorzany manor in the 17th-18th century, cereals were the main crop plants grown in peasant farms and manors on the Polish territory. Prevalence of cereal crops was typical for agriculture of that time and for a crop-fallow three-field system. The three-field system provided balance between winter and spring crop sowing, however due to rather harsh climate and unfavourable soil conditions only

one type of crop could be favoured. The major crop at that time was rye, then oats, barley and wheat. Millet and foxtail were relatively less important. The present research and Pomorzany farm archeobotanical findings confirm most of the above information. The analysed material included 24,760 diaspores representing 71 taxa. The characteristic feature of this finding was the predominance of cultivated cereal crop species, and the abundance of accompanying segetal weed species. About 95% of the gathered crop material was *Secale cereale*. Another important crop was *Hordeum vulgare* and there were also some remains of *Avena sativa*, *Triticum aestivum* and *Setaria italica*. In addition, the remains of *Fagopyrum esculentum*, *Cannabis sativa* and *Linum usitatissimum* were found as well. Weeds

contaminating grain were, among others, the following species: *Agrostemma githago*, *Raphanus raphanistrum*, *Apera spica-venti*, *Bromus secalinus*, *Centaurea cyanus*, *Spergula arvensis*, *Thlaspi arvense*, *Viola arvensis/tricolor*, *Fallopia convolvulus*, *Polygonum persicaria*, *Mentha arvensis*, *Anthemis arvensis*, *Papaver rhoeas*, *Rumex acetosella*, *Scleranthus annuus*, *Aphanes arvensis*, *Setaria pumila*, *Setaria viridis/verticillata*. These species occur mostly in both spring and winter crops, being usually annuals, surviving the winter in form of seeds and developing in the next growing season along with crops. Extremely large participation of wild plant diaspores in the material allows to conduct economic

and environmental reconstructions. On the basis of ecological requirements of individual plant species, there is a high probability of restoration of habitat conditions for crops, as well as agronomic practices used in the past. Reconstruction methods applied, used primarily in case of macro remains from granaries, are fully applicable to the analysed plant residues. Weed species composition in the analysed material shows that they are mostly typical for the main winter crop. There have also been found some amount of species typical for other habitats, and they probably come from the near-by rye field. The presence of perennial diaspores indicates that the field was probably set-aside.

Interesting findings of the vascular plants in the railway junctions of southeastern Slovakia

Jana Májeková¹, Marica Zaliberová¹ & Vladimír Jehlík²

¹Institute of Botany, Slovak Academy of Sciences, Dúbravská cesta 9, 845 23 Bratislava, Slovak Republic, e-mail: jana.majekova@savba.sk, maria.zaliberova@savba.sk

²V Lesičku 1, 150 00 Praha 5 – Smíchov, Czech Republic

Railways provide suitable conditions for spreading and potential establishment of plant species, both native and alien. Detailed research on the flora and vegetation in selected railway junctions of southeastern Slovakia was performed by V. Jehlík in the second half of the 20th century. We repeated the research in years 2012-2013 (in April, July, August). We studied presence and distribution of native and alien vascular plants in railway stations and transshipment yards in Čierna nad Tisou, Dobrá, Veľké Kapušany, Maťovce, and Košice. We recorded species that is new for the Slovak flora – *Euphorbia davidii*; it is native to North America and it was introduced to Slovakia through the Eastern migration route, probably from Ukraine. We found the second locality of the alien species *Grindelia squarrosa* and *Gypsophila perfoliata* in Slovakia. We also

recorded presence of several interesting alien species, e.g. *Centaurea diffusa*, *Geranium sibiricum*, *Choripora tenella*, *Lactuca tatarica*, *Lepidium perfoliatum*. Some threatened segetal archaeophytes, namely *Adonis aestivalis* (with the category of threat LR:nt), *Cyanus segetum* (LR:nt), *Erysimum repandum* (VU), *Nigella arvensis* (VU), and *Veronica triphyllos* (VU), were also quite frequent in these localities as their seeds are transported with cereal grains. Archaeophyte species *Tribulus terrestris* (EN) and neophytes *Geranium purpureum* and *Senecio vernalis* are recently spreading along railways not only in eastern Slovakia but also in warm areas of entire Slovakia. Surprisingly, we found the native species *Ceratocephala orthoceras* which was considered to be extinct in Slovakia.

Species distribution models as tools for the *Heracleum mantegazzianum* s.l. management in Poland

Piotr Mędrzycki* & Izabela Sachajdakiewicz

University of Ecology and Management in Warsaw, Olszewska 12, 00-792 Warsaw, Poland, *e-mail: piotr.medrzycki@pser.pl

Species Distribution Models (SDM) are the most recent and widely used family of methods applied for mapping current and predicting future distribution of species. They attempt to explain and predict species presence/absence or abundance using various algorithms: regression-based, generalised linear, additive and mixed models, discrimination analyses, classification trees, support vector machines, artificial neuron nets, regression trees, random forests, boosted trees or maximum entropy algorithms. There are also ensemble models, averaging the results of many single models.

Advantages of SDMs are: easy parametrization through an initial learning phase and clear assessment of predictor importance. The biggest disadvantage is that they are statistical models, i.e. contrary to structural equations models or individualistic models, they do not simulate biological processes. SDMs are basically single scale models, i.e. they rely on spatial resolution of predictors or on sampling strategy of modelled species. SDMs are also static, i.e. they analyse and predict a momentary relation between predictor and response.

A serious limitation of the use of SDMs for biological invasion modelling is the *equilibrium assumption*, i.e. the requirement that the modelled space is optimally occupied by a given species. However, this is not the case in early phases of biological invasions which are the easiest to manage. There have already been attempts to apply SDMs in such cases by incorporating probability of colonisation into the model.

Here, we present the application of SDMs for analysing and forecasting the range of *Heracleum mantegazzianum* s.l. (HM) in Poland. There have been many attempts to quantify the actual and future range of HM. The logistic regression was used in Britain and Denmark. The cellular automata were used for modelling the local spread in Germany. The bioclimatic envelope was used to model the potential range in Europe.

Looking for the most simple and efficient model, capable of predicting the HM distribution on the country level, we used the ensemble models implemented in the R package Biomod 2. As the response data, we used the 2013 country-wide data set gathered during the National Census of Giant Hogweed, as the source for probability of colonisation – the 2011 data for Poland, and as predictors – a freely available set of over 100 environmental predictors prepared by T. Hengl. The computed models, projections and forecasts were used to answer various management questions: where is HM supposed to occur now and where could it be found in a few years' time? where can new populations of HM appear? what is the HM potential range in Poland?

Finally, we discuss the possible use of the models in management at different spatial levels: from country to a land lot, and how to deal with the processes ongoing in different spatial and temporal scales without losing the greatest advantage of all the models: simplicity.

Cereal stubble communities in East Slovakia

Sergej Mochnacký

Botanical Garden of P. J. Šafárik University in Košice, Mánesova 23, 043 52 Košice, Slovakia, e-mail: sergej.mochnacky@upjs.sk

The paper presents the results from a study of cereal stubble communities in East Slovakia in the years 2003-2005. These results represent the first information on cereal stubble communities in East Slovakia after more than 55 years of absence of stubble fields suitable for investigation into agrophytocoenoses in East Slovakia. There were determined 7 associations belonging to 6 unions of the class: *Stellarietea mediae* R. Tx., Lohmeyer et Preising in R. Tx. ex von Rochow 1951 and subclass: *Violenea arvensis* Hüppe et Hofmeister ex Jarolímek *et al.* 1997:

Ordo: *Centaureetalia cyani* R. Tx., Lohmeyer et Preising in R. Tx. ex von Rochow 1951, Union: *Caulalidion lappulae* (R. Tx. 1950) von Rochow 1951 (1) *Kickxietum spuriae* Krusem. et Vlieg. 1939, Union: *Sherardion Kropáč* et Hejný in Kropáč 1978 (2) *Aethuso-*

Galeopsietum G. Müller 1964, Union: *Veronico-Euphorbion* Sissingh ex Passarge 1964 (3) *Veronicetum trilobae-triphyllidi* Slavnić 1951; Union: *Scleranthion annui* (Kruseman et Vlieger 1939) Sissingh in Westhoff *et al.* 1946 (4). *Trifolio arvensis-Scleranthetum annui* Morariu 1943;

Ordo: *Atriplici-Chenopodietalia albi* R. Tx. (1937) Nordhagen 1940, Union: *Spergulo-Oxalidion* Görs in Oberd. *et al.* 1967 (5) *Panico-Chenopodietum polyspermi* R. Tx. 1937; union: *Panico-Setarion* Sissingh in Westhoff *et al.* 1946 (6). *Stachyo annui-Setarietum pumilae* Felföldy 1942 corr. Mucina 1993;

Ordo: *Eragrostietalia* J. Tx. ex Poli 1966, Union: *Eragrostion* R. Tx. ex Oberd. 1954 (7) *Hibisco-Eragrostietum* Soó et Timár 1957.

Every cloud has a silver lining – a good face of synanthropization (?)

Arkadiusz Nowak¹, Marcin Nobis², Paweł Kojs³, Magdalena Maślak³ & Małgorzata Gębala⁴

¹Department of Biosystematics, Laboratory of Geobotany & Plant Conservation, Opole University, Oleska 48, 45-052 Opole, Poland, e-mail: anowak@uni.opole.pl

²Department of Plant Taxonomy, Phytogeography and Herbarium, Institute of Botany, Jagiellonian University, Kopernika 27, 31-501 Kraków, Poland, e-mail: m.nobis@uj.edu.pl

³Silesian Botanical Garden, Mikołów, 43-190 Mikołów, Poland, e-mail: pkojs@op.pl, magdalena.maslak@gmail.com

⁴Regional Directorate of Environmental Protection in Opole, Obrońców Stalingradu 66, 45-512 Opole, e-mail: m.gebala1@gmail.com

According to the commonly accepted definition, synanthropisation of plant cover means past and present changes of vegetation caused by human activity. As it was proposed by Faliński, the process of man-made

changes in plant cover could be divided into several periods: pre-, proto-, poli-, meta-, eu-, and pansynanthropisation. In recent years, however, the raising awareness and concern regarding plant conservation brought about

a significant increase in many successful conservation actions undertaken by humans. These positive changes in vegetation and flora are also due to human activity, so, they perfectly fulfil the definition of synanthropisation (*synanthropos* – related to man). In Poland, as well as in whole Europe, almost countless actions and measures considering population supplementation, population augmentation, restocking, enhancement, subspecific substitution, ecological substitution, assisted migration, managed relocation, conservation translocation, floristic restoration, restoration of novel (invented) ecosystems, habitat rehabilitation and many others were implemented. For many years, apart from the classic in

situ conservation, also *ex situ* and *inter-situ* techniques were introduced. So, is it fair to assess human beings and their present activity in relation to plant cover solely in negative context? Analysing the conservation efforts in several regions of Poland, we argue that the synanthropisation has only one, bad side for the vegetation. We propose to add also the post-synanthropisation period to the Faliński's order which should be characterised as an era of conscious and reasonable conservation actions based on sound knowledge of botany, ecology and gardening aiming at reversing the degeneration of spontaneous and native plant cover. At least, it should stop the extinction of plant diversity.

The peculiarities of transformer group in the Ukrainian Polissya

Vira Protopopova & Myroslav Shevera*

M. G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Tereshchenkivska 2, 01601 Kiev, Ukraine, *e-mail: shevera@mail.ru

The aim of the present work was to survey transformer species of the Ukrainian Polissya (Forest zone of Ukraine). This study is a sequel to the research on this subject on regional level.

Substantial differences between Left- and Right-Bank parts of the studied Region were observed. The alien fraction species of the Left-Bank regions of Polissya had higher species diversity and wider distribution. Influence of the Forest-Steppe zone and Central European (Central-Russian) uplands was noted. In floro-genetic spectra, the species of East Mediterranean and Iran-Turanian origin prevailed. The species of Middle European origin as well as the species associated with mountainous areas of Southern Europe, Western Mediterranean, the Balcans and Caucasus and some mesophytes of North American origin were characteristic for the Right Bank regions of Polissya. The distribution of the alien species in Polissya was promoted by land-reclamation which caused substantial changes in the species composition and ecosystem structure.

As a result of the studies on the invasive potential of the alien fraction species, eight transformers common for both regions of Polissya were selected, e.g. *Amelanchier ovalis* Medik., *Echinocystis lobata* (Michx.) Torr. & A. Gray, *Heracleum mantegazzianum* Sommier & Levier, *H. sosnowskyi* Manden., *Impatiens glandulifera* Royle, *I. parviflora* DC., *Reynoutria japonica* Houtt., *Robinia pseudoacacia* L. All species were ergasiophytes; three species were introduced in the Region at the end of the 19th century and five – in the second half of the 20th century. However, their active distribution and incorporation into natural coenoses started at the end of 20th century was characterized by a short period of naturalization. The occurrence of the transformer species in anthropogenic, semi-natural and natural ecotopes and plant communities of the Polissya and its impact on the native flora were analysed. Some species formed plant communities of different ranks. The river bank habitats showed the highest invasion level in the Region.

The distribution map of the transformer species in the region was prepared.

Alien plant species distribution in the surroundings of selected mountain huts in the Beskidy Mts.

Adam Snopek

Department of Geocology, Faculty of Geography and Regional Studies, University of Warsaw, Krakowskie Przedmiescie 30, 00-927 Warsaw, Poland, e-mail: adamсноpek@gmail.com

The study concerns the occurrence of alien species in plant communities in the surroundings of eight mountain huts situated among the montane forests in the Polish part of the Beskidy Mts. Preliminary observations resulted in focusing on the common nettle *Urtica dioica* atypical for surveyed plant communities and the giant hogweed *Heracleum mantegazzianum*, non-native

to Poland. Inventory based on radial transects from the particular huts, using the bonitation method, allowed creation of species occurrence maps.

The distribution of those species on the study sites, clearly related to the use of tourism infrastructure, was not recognized as a significant threat to forest biodiversity in the surveyed area.

Archaeophytes in Lower Silesia (SW Poland) after hundred years of research

Ewa Szcześniak & Remigiusz Pielech

Department of Botany, University of Wrocław, Kanonia 6/8, 50-328 Wrocław, Poland, e-mail: ewa.szcześniak@uni.wroc.pl, remekpielech@o2.pl

Species introduced before the 15th century (archaeophytes) make the oldest group of alien plant species in the flora of Central Europe. Their long-term coexistence with cultivated plants resulted in evolution of new taxa and made them a valuable part of local biodiversity and landscape. Almost all of them are terophytes and weak competitors colonizing only disturbed areas. For a long time, this group of plants was not evaluated in categories of threat because of foreign origin and methodological problems concerning classification. In Poland, this group consists of 165 taxa and, for the first time, was evaluated according to IUCN categories of classification in 2009.

Our research of archaeophytes was conducted in Lower Silesia (SW Poland) in years 2010 to 2014. The main aim was to recognize current status and dynamical tendencies of regional flora of archaeophytes.

We proposed a standardized method of determination of the level of threat to archaeophytes in regional scale. Decrease of regional range, current area of occupancy and number of sites are the most valuable criteria. In this group of plants, global range and projected decrease in numbers of sites seem to be useless due to its correlation with unpredictable impact of human pressure. The conducted analyzes indicated a group of 70 endangered archaeophytes (50% of all noted in the region). The most endangered were segetal weeds. Majority of species associated with ruderal or both ruderal and segetal habitats was not threatened.

We also analyzed general distribution of archaeophytes in the region to estimate areas of the highest number of archaeophyte species, areas of the highest factor of their extinction and areas with the best survived flora of these weeds. The richest flora of archaeophytes

was associated with black soils and calcareous clay in lowland, and non-acid soils (rendzinas, pararendzinas, some forms of brown soils) in lower parts of the the Sudetes. Nowadays, the best preserved flora of archaeophytes could be observed in areas of extensive cultivation: the Sudetes foothills and in areas of the poorest soils in the lowland. The number of stands of ar-

chaeophytes classified as endangered decreased in the middle of the 20th century, slightly increased in the time of economic crisis in '80s-'90s and started to decrease once again in the 21st century; the total number of their sites decreased from ca. 3 050 in the period 1860-1903 to ca. 685 in the period 2001-2014.

Morphological and cytological diversity of goldenrods (*Solidago* L.) from south-western Poland

Magdalena Szymura¹, Tomasz H. Szymura² & Agnieszka Kreitschitz³

¹Department of Agroecosystems and Green Areas Management, Wrocław University of Environmental and Life Sciences, pl. Grunwaldzki 24A, 53-363 Wrocław, Poland, e-mail: magdalena.szymura@up.wroc.pl

²Mountain and Polar Ecosystems Laboratory Department of Ecology, Biogeochemistry and Environmental Protection, Wrocław University, pl. Maksa Borna 9, 50-328 Wrocław, Poland, e-mail: tszymura@biol.uni.wroc.pl

³Department of Plant Morphology and Development, University of Wrocław, Kanonia 6/8, 50-328 Wrocław, Poland

Invasive plants are defined as widespread non-native species that produce reproductive offsprings, often in huge numbers, and which have the potential to spread over a large area. Several studies have focused on the reasons why invasive plants are more efficient in colonization of new areas than other plants. However, the mechanism of invasion still remains unclear. Since the colonisation is controlled by two factors: competitiveness and dispersion ability, such life traits as plant height and inflorescence size are frequently mentioned as ensuring alien species effective invasion.

Exceptionally successful worldwide plant invaders are species from the *Solidago* genus. In central Europe, five representatives of the *Solidago* genus are found. Only one species (*S. virgaurea* L. agg.) is native, while the other four are of American origin: *S. gigantea* Aiton, *S. canadensis* L., *S. altissima* L. (*S. canadensis* var. *scabra* (Muhl.) Torr. and Gray) and *S. graminifolia* (L.) Elliot. Three of the introduced taxa (*S. gigantea*, *S. canadensis* and *S. altissima*) are invasive and morphologically similar to each other. The range of *S. graminifolia* is, so far, limited to few locations in Europe. The taxonomical status of *Solidago* species occurring in Europe is still discussed. Particularly, the taxonomical status of *S. canadensis* and *S. altissima* is unclear.

The aim of the presented study was comparison of the morphology (concerning life traits) and cytology of *Solidago* species occurring in Central Europe.

These traits were examined against the background of environmental variables. The *Solidago* taxa were surveyed on the basis of sampling plots arranged in 10 x 10 km regular grids, covering ca. 30,000 ha in Silesia (SW Poland). Among 324 inspected plots, *Solidago* species were present on 241. For detailed study, 84 sampling plots were randomly selected to ensure similar number of samples for each taxa. The measurements of the height of ramets, length and width of inflorescences, as well as the number and size of leaves were taken for 10 ramets per plot. Seeds from the studied populations were also collected and, subsequently, they were germinated and observations of chromosome number were made. The diploid number ($2n=18$) for *Solidago altissima*, *S. canadensis*, *S. graminifolia* and *S. virgaurea* and tetraploid ($2n=36$) for *S. gigantea* were determined. Leaves from 40 populations were collected to assess DNA content (5 plants per population, 200 samples, in total). Measurements were taken using the flow cytometric analysis. Significant differences were found in case of *Solidago altissima* and *S. canadensis* populations. Due to the possibility that the observed differences were the effect of hybridization or diversity within the species, additionally, detailed measurements of flowers (length and width of capitulum, and the length of disc and ray florets) as well as leaf shape were taken for these two taxa.

Does the landscape structure allow prediction of plant invasion?

Tomasz Szymura¹ & Magdalena Szymura²

¹Department of Ecology, Biogeochemistry and Environmental Protection, University of Wrocław, pl. Maksa Borna 9, 50-328 Wrocław, Poland, e-mail: tszymura@biol.uni.wroc.pl

²Department of Agroecosystems and Green Areas Management, Wrocław University of Environmental and Life Sciences, pl. Grunwaldzki 24A, 53-363 Wrocław, Poland, e-mail: magdalena.szymura@up.wroc.pl

Spatial pattern of occurrence of invasive plant species is not random. There are both areas highly infected as well as areas harboring only limited number of neophytes. Among causes of this diversity, there are differences in land use, landscape structure, climate and socio-economic factors. Knowledge about the influence of these factors on plant invasion is in high demand, since it may be helpful in elaborating models enabling better understanding of invasions. In Central Europe, one of the most successful invaders comprises species belonging to *Solidago* genus, originating from North America. In this study, we present the results of our analysis concerning the influence of landscape metrics (land use classes, patch number and size) on the distribution of invasive *Solidago* species. We put forward

a hypothesis that probability of occurrence of alien *Solidago* species can be modeled using landscape structure as a predictor. The data come from our original field surveys performed on the basis of regularly placed sampling plots in Silesia, Poland (*Solidago* distribution) and CORINE land cover 2006 map (landscape structure). We studied the landscape influence in three nested spatial scales: large (ca. 75 km²), medium (ca. 12 km²) and small (ca. 0.7 km²). Since we assumed that different factors can operate at different scales, and the interactions can be hierarchically spatially nested and nonlinear, we used classification and regression tree methods (CART) as a highly flexible tool suitable to examine such data.

The decline of anthropozoogenous community of *Potentillo albae-Quercetum*. Case study of “Dąbrowy Obrzyckie” Natura 2000 site

Maria Wojterska¹ & Katarzyna Wiszniewska²

¹Adam Mickiewicz University in Poznań, Faculty of Biology, Department of Plant Ecology and Environmental Protection, Umultowska 89, 61-614 Poznań, e-mail: mwzerios@amu.edu.pl

²Adam Mickiewicz University in Poznań, Faculty of Biology, Umultowska 89, 61-614 Poznań

The tendency of decline of patches of thermophilous oak forest phytocoenoses is generally known already for over 20 years. The synthesis of Jakubowska-Gabara has

confirmed the phenomenon in the area of whole country. In that time in the region of Obrzycko (Wielkopolska) were stated patches, which were not bearing any signs

of degeneration, as compared to other objects in the region, where the deterioration of the state documented in earlier studies has led either to significant degeneration or to the total disappearance of the community.

The good state of patches, thoroughly documented, inspired creation of a series of permanent plots to study the dynamics of community. The area was designed as nature reserve in 1998 and in 2005 as Natura 2000 site for protection of 9110 priority habitat.

Documentation gathered on permanent plots indicates that this area also underwent negative transforma-

tions resulting in: expansion of kenophytes (*Impatiens parviflora*, *Padus serotina*), development of undergrowth of spruce and beech exerting negative influence on the habitat, spread of nitrophytes (*Urtica dioica*), decline of diagnostic species, especially of *Campanula persicifolia*.

In the protection scheme of the nature reserve and of the Natura 2000 site have been proposed the experimental reintroduction of grazing and removal of alien tree species as remedy for ongoing degeneration.

The relationship between successional vascular plant assemblages and associated microbial communities on coal mine spoil heaps

Gabriela Woźniak¹, Anna Markowicz¹, Sławomir Borymski¹, Zofia Piotrowska-Seget¹, Damian Chmura² & Lynn Besenyey³

¹Faculty of Biology and Environmental Protection, University of Silesia, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: woźniak@us.edu.pl, anna.markowicz@us.edu.pl, slawomir.borymski@us.edu.pl, zofia.piotrowska-seget@us.edu.pl

²Institute of Environmental Protection and Engineering, University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biala, Poland, e-mail: dachmura@gmail.com

³Faculty of Science and Engineering, University of Wolverhampton, Wulfruna 1, Wolverhampton WV1 1LY, e-mail: L.Besenyey@wlv.ac.uk

The aim of the study was to investigate relationships between vascular plant species and associated soil microbial properties at various stages of vegetation development on unclaimed hard coal mine spoil heaps in Upper Silesia (south Poland). The spontaneous vegetation, soil chemistry as well as the activity and structure of microbial communities were recorded on this specific habitat. The colliery heaps were divided into four age classes and plant species composition and cover abundance were recorded on the established plots (2x2m). The soil microbial activity under vegetation patches was assessed using fluoresce in diacetate

hydrolytic activity (FDHA) and the soil microbial biomass and community composition were determined by phospholipid fatty acid (PLFA) biomarkers. Total microbial biomass in soils from the older vegetation plots was significantly higher than those in soils from the younger plots. In all studied samples, microbial communities consisted, primarily, of bacteria with the dominance of Gram negative bacteria over Gram positive and aerobic microorganisms were more dominant than anaerobic ones. Statistical analysis revealed a correlation between the type of vegetation and microbial community structure.

Certain regularities in the distribution of kenophytes in the Polish Carpathians and their foreland

Maria Zając & Adam Zając

Institute of Botany, Jagiellonian University, Kopernika 27, 31-501 Kraków, Poland, e-mail: maria.zajac@uj.edu.pl, adam.zajac@uj.edu.pl

The Polish Carpathians and their northern foreland are a rewarding object for kenophyte distribution research. Cartogram maps with 2 x 2 km grid were used for research purposes. A general regularity could be observed there that these plants were being eliminated with increasing terrain altitude. Only few of them entered the lower positions of lower montane zone. This regularity also covered the species which reach significant altitudes in the mountains of their native lands. A number of species penetrated into the Carpathians through rivers and streams. Several factors were responsible for that. River valleys generate many open habitats which are easily colonized by kenophytes, because

of the lack of competition. In the Carpathians, towns used to be established in mountain valleys which was also the factor of kenophyte propagation. It is obvious as valleys are situated underneath their surroundings. Presentation of the ranges in the Polish Carpathians, including their foreland, enabled the group of species to be traced which did not enter the Carpathians; moreover, it made it possible to discover possible migration routes into the area covered by the research. Certainly, it was possible only for those species which had not filled the whole available area yet. It was also an important issue to indicate the most dangerous invasive species.

Mycorrhizal status of *Molinia caerulea* on heavy metal contaminated and non-contaminated sites in Upper Silesia

Barbara Ziemer¹, Łukasz Małkowski², Agnieszka Błońska¹, Wojciech Bąba³,
Agnieszka Kompała-Bąba¹, Teresa Nowak², Edyta Sierka¹, Małgorzata Szary¹
& Ewelina Roszkowska¹

¹Department of Geobotany and Nature Protection, Faculty of Biology and Environmental Protection, University of Silesia, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: bziemer@us.edu.pl, agnieszka.blonska@us.edu.pl, akompala@us.edu.pl, edyta.sierka@us.edu.pl, mszary@us.edu.pl, roszkowska.ewelina@gmail.com

²Department of Plant Systematics, Faculty of Biology and Environmental Protection, University of Silesia, Jagiellońska 28, 40-032 Katowice, Poland, e-mail: malkowski.lukasz@gmail.com, teresa.nowak@us.edu.pl

³Institute of Botany, Jagiellonian University, Lubicz 46, 31-512 Kraków, Poland, e-mail: wojciech.baba@uj.edu.pl

Wastes connected with zinc and lead industry are extremely harsh substratums for plant growth. They contain high levels of heavy metals, lack organic matter and are characterized by low porosity resulting

in unfavourable air-water conditions. One plant that successfully colonizes these sites is *Molinia caerulea*, a diagnostic species of moist meadows (the *Molinion* alliance) and wet coniferous forests (the *Molinio-*

Pinetum). Successful survival and growth of plants on heavy metal contaminated sites is greatly dependent not only on the abiotic properties of the soil but also on the activity of microbial populations. Symbiotic fungi are often suggested to improve plant establishment under harsh conditions as mycorrhizal symbiosis reduces negative effects of stresses caused by unfavourable edaphic conditions.

The aim of the study was to determine and compare the mycorrhizal status of *Molinia caerulea* in chosen areas connected with zinc and lead industry and in moist grasslands. The results revealed differences in the level of mycorrhizal colonization depending on the type of the habitat which was lower on heavy metal contaminated sites.