

Posters

Expansion of adventive plant species in Velykodobron`skiy Reserve (Transcarpathia, Ukraine)

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Velykodobron`skiy Reserve, of state value as a part of Regional Landscape Park "Prytysyansky", is located in the floodplain of the lower reaches of the Latoritsa River in the Transcarpathian Lowland. In this site, the vegetation is formed by floodplain forests and meadows, providing habitat for a number of rare plant species (*Fritillaria meleagris*, *Leucojum vernum*, *L. aestivum* etc.). Such rare environment types as the riparian natural willow-poplar and alluvial oak-elm-ash forests and alluvial meadows of river valley are protected here. In 2013, sites of Chomonyn forest tract situated in close proximity to the village of Velykiy Dobron were studied. The aim of the studies was to establish the participation of invasive and potentially invasive alien plant species in communities of different habitat types in the Reserve.

In the studied area, 9 habitat types were identified: oak-hornbeam forests, oak-elm-ash alluvial forests, willow-poplar floodplain forests, willow thickets, planted forests, alluvial meadows, banks of canals, dams and deforested areas. In these habitats, 14 species of alien plants were identified that pose a threat to the vegetation of these biotopes: *Acer negundo*, *Ambrosia artemisiifolia*, *Asclepias syriaca*, *Conyza canadensis*, *Echinocystis lobata*, *Erigeron annuus*, *Fallopia japonica*, *Helianthus tuberosus*, *Heracleum sosnovskyi*, *Parthenocissus quinquefolia*, *Robinia pseudo-acacia*, *Solidago canadensis*, *Solidago gigantea*, *Xanthium italicum*.

In the investigated territory, the most aggressive species were: *Helianthus tuberosus* (projective cover about 70%), *Fallopia japonica* (up to 60%) and *Heracleum sosnovskyi* (up to 50%), species that were distributed in willow-poplar floodplain forests, *Conyza canadensis* (up to 60%) and *Erigeron annuus* (up to 60%) in deforested areas, and *Helianthus tuberosus* (up to 50%) along the banks of canals. No invasive species were found in the oak-hornbeam forests. Almost in all the habitat types, with the exception of only one, the presence of *Acer negundo*, *Conyza canadensis* and *Erigeron annuus* was noted.

Acer negundo invasion to the most valuable habitats such as flood meadows leads to a significant transformation of this vegetation; the species is noted in all the floors of plant communities. Afforestation of the meadows leads to shading and changes in the floristic composition of the grass layer. Most alien species were observed along the canals, 11 species of different cover were growing there, and this was the only habitat where *Asclepias syriaca* thickets were found.

Thus, we can conclude that invasions of alien plant species occurred not only in anthropogenically transformed areas of the reserve, but also far away from the settlements of the reserve tract; however, in certain proximity to the canals within the tract.

The emergence of new localities of *Orobanche bartlingii* Griseb. in the Silesian-Cracow Upland as a result of the spreading of *Libanotis pyrenaica* (L.) Bourgh. due to changes in land use

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During the last few decades, many cultivated fields and grazed grasslands have disappeared in the Silesian-Cracow Upland. Therefore, abandoned lands occupy now a large area there. As a result of these changes, some plant species have significantly increased the area of occurrence. *Libanotis pyrenaica* is one of them. In many places it begins to behave like an expansive species.

In the Cracow-Częstochowa Upland *Libanotis pyrenaica* occurred mainly in open rock grasslands. After the cessation of grazing, it spread on slopes of hills and in many places created huge phytocoenoses. It penetrated also fallow lands at the foot of the hills and often formed extensive phytocoenoses there. In the Silesian Upland, *L. pyrenaica* occurred only in mesoregions where Triassic limestones were a substrate. The area of patches with mass share of this plant was usually huge, the largest could be found in the eastern part of the Tarnowskie Góry Ridge, south-east of Katowice Steelworks. They developed here on fallow lands, ungrazed grasslands, railway embankments as well as on roadsides. Recently, *L. pyrenaica* spread also in the central part of the Tarnowskie Góry Ridge, where it especially occupied abandoned fields and sometimes entered xerothermic grasslands.

Orobanche bartlingii parasitized *Libanotis pyrenaica*. The first report of its occurrence in Poland (Ojców National Park) was published in 2001. Then, the next information about the occurrence of this plant in other parts of the Cracow-Częstochowa Upland, the Silesian Upland as well as the Kielce Upland appeared in literature. In recent years, in the area of the Silesian and Cracow-Czestochowa Upland, further stands of *O. bartlingii* were found. This led to the conclusion that currently this parasitic plant was spreading in the Polish Highlands due to frequent and abundant occurrence of *Libanotis*. As an anemochory species, it can spread over long distances.

The relevés made in phytocoenoses with the participation of *Libanotis pyrenaica* and *Orobanche bartlingii* (xerothermic grasslands, abandoned fields and roadsides) allowed us to perform their floristic characteristics. The analysis of Ellenberg indicator values showed that patches differed in terms of the share of species with different soil moisture, fertility and pH requirements. The ordination of relevés on the DCA diagram showed that the floristic composition of these phytocoenoses was also determined by differences in local species pool.

The synanthropic flora of Człuchów against anthropogenic indexes

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Examinations concerning the synanthropic flora of the built-up areas (cities, towns, smaller settlements) are characterized by the long-lasting tradition. They have been the object of interest of naturalists for many years and the process of synanthropization has been the subject of many examinations of botanists.

The aim of the study was to identify the entire flora of Człuchów vascular plants and to show its characteristics. Observations and field research of Człuchów vascular flora were conducted during the vegetation period in years 2008-2011 using the itinerary method. Floristic data, their different analyses and classifications were the materials of this article. All taxons except those cultivated were analyzed. Also indexes of anthropogenic changes of the flora were calculated.

550 species of vascular plants and 53 cultivars were identified in the area of Człuchów. They represented 2 divisions, 4 classes, 98 families and 342 genera. Seed plants were a dominant group – 545 taxons (99.1%). On the basis of analysis of the examined flora regarding Raunkiaer life forms, dominant participation of hemicryptophytes representing 44.8% of the whole flora (170 species) was shown. Also terophytes were a numerous group (81 species – 21.3%). Forms of sprouts lasting are connected with the spectrum of life

forms. Perennials were the most numerous group among them (42.2% of the whole flora). Analysis concerning sociological-ecological spectrum showed domination of phytosociological affinity species (360 species, 94.9%). The other 19 taxons (5.1%) were without phytosociological rank. Groups belonging to classes representing anthropogenic geographical-historical groups of the examined flora showed domination of the autochthonic species – 288 taxons were found (75.9% of the whole flora). Apophytes represented 44.8% among them; however, nonsynanthropic spontaneophytes represented 31.1%. Species of allochthonous origin (anthropophytes) were found relatively seldom (91 species – 24.1% of the whole flora). In connection with predominant number of synanthropic spontaneophytes in the flora of Człuchów, the level of apophytization of the spontaneophytes reached 59.0%. It affected high indexes of the total synanthropization (68.8%) and of the permanent synanthropization (67.4%) and it also showed anthropogenic changes at the level of flora and its adaptations shown as progressive synanthropization. Considerable habitat and phytocoenotic diversity and also low degree of anthropopressure of some areas of Człuchów affected its floristic richness and biodiversity.

Kenophytes in the flora of vascular plants at the edges of the complexes of fish ponds in the northern part of the Oświęcim Basin

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The purpose of the speech is the presentation of a part of the results of floristic field research conducted on the basis of the cartogram method ATPOL. Research was carried out in the northern part of the Oświęcim Basin in 2013 and 2014. Among others, complexes of fish ponds which are an essential element of the Oświęcim Basin landscape were studied. During the census of the flora of the test area, an increase in the share of foreign origin plant species was observed at the outskirts of complexes of fish ponds in relation to the data from the 19th and 20th centuries. The occurrence

of 144 species of synanthropic plants was reported of which 58 species were apophytes, 47 species were classified as kenophytes and 39 species as archaeophytes. The most abundant species populations were kenophytes: *Echinocystis lobata*, *Impatiens parviflora*, *Solidago canadensis*, *S. gigantea* and *Reynoutria japonica*. They were brought to our attention due to the fact that they were a group of invasive plant species in our country. In the study area, the occurrence of numerous such species posed a threat to native plant species.

Consorts connection of woody plants and xylomycobionts on the border of the Right Bank Polissya and the Right Bank Forest-Steppe of Ukraine (Kiev region)

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Consorts connection of woody plants and xylotrophic fungi in forests on the border of the Right Bank Polissya and the Right Bank Forest-Steppe of Ukraine (Kiev Region) was analyzed. We investigated structures of tree vegetation and xylomycobionts (mycorrhizal, parasitic and wood-destroying fungi) at various levels.

These included: a) vitality, age, sanitary structures of *Betula pendula* Roth, *Pinus sylvestris* L., *Quercus robur* L.; b) species, systematic, trophic structures of 46 species of fungi which refer to 33 genus, 22 families, 8 orders of Ascomycota divisions (class Leotiomycetes) and Basidiomycota (class Agaricomycetes).

Alien invasive vascular plants species in the city of Stargard Szczeciński (NW Poland)

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The city of Stargard Szczeciński is situated in the north-western part of Poland, at the Ina River in West Pomeranian Voivodship and has about 70 thousands residents. Studies on the vascular flora of the city have been carried out since 2011 using the cartogram method, accordingly to ATPOL assumptions (with basic unit of 1x1 km square).

To date, approximately 800 species of vascular plants have been recorded. Analyzed flora is characterized by a large share of foreign origin taxa. So far 30 invasive

species have been found, such as: *Reynoutria japonica* Houtt., *R. sachalinensis* (F. Schmidt) Nakai, *Echinocytis lobata* (F. Michx.) Torr. and A. Gray, *Sisymbrium altissimum* L., *Sisymbrium loeselii* L., *Impatiens parviflora* DC., *Impatiens grandulifera* Royle, *Bides frondosa* L., *Juglans regia* L., *Robinia pseudoacacia* L., *Padus serotina* (Ehrh.) Borkh., *Quercus rubra* L., *Rosa rugosa* THUNB., *Conyza candensis* (L.) Cornquist, *Heliantus tuberosus* L., *Solidago canadensis* L., *Solidago gigantea* Aiton, *Veronica filiformis* SM.

Invasive herbs along a railway track Hajnówka-Topiło in the western part of Białowieża Forest

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The Central European vegetation landscape is a result of a mix of impacts due to plant colonization after the last glacier period and anthropogenic cultural and industrial imprint. The majority of species had to migrate into the “new land” after the retraction of glacier and formed new plant communities.

At least 2 thousand years before the Neolithic Revolution, Central Europe brought sustainable changes and synanthropization of young plant communities. The next big anthropogenic impact occurred in the “Industrial Age” and lasted, intensified by globalization, to this date.

The Primeval Forests of Białowieża, located on the pass to Eastern Europe are the last woody landscape with still preserved intact and natural character. The fraction of anthropogenic elements and the rate of naturalization according to foreign plant species are here very low comparing with other woody landscapes in Europe. This area is a unique investigation field of foreign plant invasion into the intact plant associations.

This study deals with invasive herb species along 11 km apron of narrow-track rail penetrating natural woody communities in the western part of Białowieża Forest. The whole distance was divided into 416 tran-

sects expanded with a four-meter wide stripe on both sides of the track to cover the embankment and the ecotone. The occurrence of foreign herb species was recorded for every transect corresponding to variable plant communities.

The floristic mapping detected a series of foreign herbs which seem to distribute, depending on hosting plant associations varying along the apron, on soil types

and light conditions. We discovered 18 foreign taxa and four of them: *Carex brizoides* (Zittergras-Segge), *Impatiens parviflora* (Small Balsam), *Parthenocissus inserta* (Thicket Creeper) and *Rudbeckia laciniata* (Cone Flower) invaded into the natural plant communities. This observation confirms records made by other authors.

Ecological and geographical preferences of liverwort *Aneura pinguis* inferred from isozyme data

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Aneura pinguis (Jungermanniidae, Marchantiophyta) is a species of liverwort which frequent occurs in Europe. In Poland it is common from the lowlands to the highlands, and grows in various habitats: on calcareous rocks, basic humus, peat bogs, wet sands at lakeshores, and fallen decorticated logs. However, the species is sensitive to eutrophication of its habitat. Isozyme studies have revealed that *A. pinguis* is a complex species. Up to now, five cryptic species tentatively called A, B, C, D and E have been distinguished within the *A. pinguis* complex. Three of them occur abundantly in Poland (A, B, C). The aims of this study were to analyze the allozyme variability of *A. pinguis* species A, B and C in order to estimate their genetic diversity and describe their geographic distribution and ecological preferences in Poland.

The total of 1652 of the *A. pinguis* complex individuals from different regions of Poland were studied. Based on allozyme data, we determined 1169 specimens of A, 340 – of B and 140 – of C. They were surveyed for variation in 12 putative gene loci. The highest genetic variation within populations (H_s) was determined in species A, and the lowest in species B. Species A had the highest number of alleles per locus (A), the poly-

morphic loci (P) and number of genotypes (G). The mean genetic distance (D) between the cryptic species was 1.3393. The highest genetic variation within populations (H_s) was in species A, and the lowest in species B. In species A and C, genetic diversity within populations was higher than between populations, whereas in species B, genetic diversity between populations was higher than within populations.

Genetic studies showed that the species A was most common; it occurred mostly in the Western Carpathians. Species B was most frequent in the Eastern Carpathians. Species C was the rarest; it appeared both in lowlands and in mountains, but mainly in lowlands. Individual species of the *A. pinguis* complex also differed with respect to habitat preferences. Species A, occurring in mountains, grew mainly on calcareous rocks, rock detritus or soil, and sometimes on humus. Species B preferred clay soil in the Bieszczady Mts., but on humus or rotten wood in lowlands. Species C appeared on various substrata, depending on locality: in mountains on clay soil, while in lowlands on humus. This work was financially supported by grant no. 2011/01/B/NZ8/00364 from the National Science Centre, Poland.

New locality of the grass-leaved goldenrod *Solidago graminifolia* (Asteraceae) in the Carpathians

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The grass-leaved goldenrod *Solidago graminifolia* (L.) Elliott. is one of the goldenrod species which, in the 19th century, were introduced from North America to Europe as ornamental plants. There are three introduced *Solidago* species in Poland: *S. gigantea*, *S. canadensis*, *S. graminifolia*, while the only native species is *S. virgaurea*. The grass-leaved goldenrod came at a similar time as the two introduced species mentioned above, but it does not have such a strong tendency to spread and has the lowest rate of colonization of the *Solidago* species (Weber, 2001). In the area of Poland, it occurs

in Silesia, occupying ruderal habitats, mainly former industrial wasteland.

In 2012, a new locality of the grass-leaved goldenrod was found in the village of Paleńnica (Gmina Zakliczyn, Małopolska Province) in the central part of the Rożnów Foothills in the Carpathians. The population consisted of about 20 flowering shoots, growing in a roadside ditch at the edge of a forest. This location shifts the boundary of the species in Poland in the east. Monitoring of the population conducted in subsequent years (2013-2014) indicates its good condition.

Alien species in the flora of the “Bagna” peat land near Chlebowo (Wielkopolska region)

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The largest complex of peat lands in Wielkopolska, “Bagna” near Chlebowo is situated about 40 km north of Poznań, in the eastern part of the Notecka Primeval Forest. It constitutes a depression surrounded from the North, West and South by dune embankments and by transitional marshland and meadows from the East and, partially, from the South. A few houses are situated in the north-eastern boundary of the discussed complex.

The “Bagna” peat land near Chlebowo underwent a strong human influence from the beginnings of the 19th

century. The area was drained by a system of ditches and canals. The lowering of the water level allowed peat exploitation but it also caused destruction of the peat land. Digging out of peat was carried out with differing intensity for a number of years, initially by hand and, later on, with the assistance of various types of diggers and strippers.

Up to the beginning of the 21st century, the total of about 400 vascular plant species were determined on the discussed area, of which 59 belonged to anthropophytes

(approx. 15%). Dominating majority among alien species were plants which occurred only sporadically characterized by negligible resources. They were found to occur, primarily, on arable lands and ruderal sites located at edges of the complex. They could also be found in the central part of the complex, sporadically on and along roads, as well as on small, local garbage dumps established as a result of recreational and touristic utilization of this region. Roads crossing the center of the marshland in a number of places appeared to be particularly attractive for anthropophyte expansion. In places, these roads were made of mineral, foreign materials brought in together with wastes and rubbish from areas adjacent to the peat land.

Majority of 30 archeophytes and half of kenophytes observed here were characterized by a zero degree of expansiveness. Only a few kenophytes exhibited greater than others tendencies for expansion in systems specific for marshland. These included, among others: *Bidens melanocarpus*, *Epilobium adenocaulon*, *Juncus macer*, *Padus serotina*, *Picea excelsa* and *Robinia pseudacacia*.

Aronia ×prunifolia is a serious ecological problem in the area of the Chlebowo complex. Its occurrence is associated, mainly, with small dust roads leading to the main roads through which peat is driven away as well as with birch scrubs. At the beginning of the 21st century, first sites were observed on peat as well as in pine coniferous forest.

New species of anthropophytes in the flora of Wielkopolska

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Among 700 thousand of floristic data collected during the long-standing floristic studies in the area of NE Wielkopolska, these that concern species not recorded in Wielkopolska so far and only sporadically noted in Poland, such as: *Glyceria striata*, *Lathyrus aphaca*, *Melilotus wolgica* are of special importance.

Glyceria striata (Lam.) Hitchc., a species originating from North America, was observed in Poland for the first time in the Częstochowa Upland (1989). Subsequent reports came from the Białowieża Forest (2002) as well as Jędrzejów Plateau and Maków Beskids (2012). A locality situated in the Długi Bród Forest District (Gniezno District) was the fifth known locality of this species in Poland.

Melilotus wolgica Poir. in Lam. originates from the steppes of south-east Europe and western Asia. In Poland, the species was recorded in 10 localities,

in the following order: Szczecin (1937), Cikowice on the Raba, Medyka (1967), Opole (1971), Zawadzkie, Racibórz (1976), Strzelce Opolskie, Kędzierzyn Koźle (1981) and Warszawa – between Kawęczyn and Rembertów (1987). In 2010, large populations of this species were noted in the area of the former brown coal mine in Gosławice (Konin District).

The third species, *Lathyrus aphaca* L., originates from south Europe. It is thought to be connected with calcareous and segetal habitats (*Caucalidion* alliance). It was noted in the sidings of Podstolice railway station (Września District). This is the first recording of this species in Wielkopolska. So far, it was reported mainly from southern Poland: Lower Silesia (1900; 1931; 1932); Opole Region (1981; 1987); Gliwice (1988); Kraków Kobierzyn (2011), as well as Szczecin, Kamień Pomorski (1937) and Gdańsk (1898).

Ergasiophytes in old cemeteries in the Wielkopolska region (Poland)

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Research on vascular flora of abandoned cemeteries was initiated by me in Poland in 2001, in three Protestant and one Jewish cemeteries in Wielkopolska. Many of the vascular plants recorded there could be classified as ergasiophytes. As defined by Naegeli & Thellung (1905), ergasiophytes (Er) are alien plant species cultivated and introduced intentionally, which are permanently naturalized in parks, gardens, and cemeteries but do not spread to other sites. More detailed field research was conducted in 2005-2014 in about 2450 old cemeteries (Protestant, Jewish, Roman Catholic, Orthodox, and multi-denominational) in the Wielkopolska region. Only cemeteries that are no longer used, or are now very rarely used for burial, were taken into account. On the basis of my research, a complete list of the permanently naturalized ergasiophytes in Wielkopolska and Poland has been compiled, including

414 species. Among the 1438 vascular plant species recorded in old cemeteries in the Wielkopolska region, 29% are ergasiophytes. They are the largest group of anthropophytes, which accounts for 53% of their total number. This indicates that about half of introduced plant species, even when neglected, are able to survive and reproduce for many years. Three groups of ergasiophytes can be distinguished: Er1 = primary ergasiophytes (cultivated plants introduced before 1945); Er2 = secondary ergasiophytes (introduced to cultivation relatively recently, in 1945-2000); and Er3 = latest ergasiophytes (introduced into cultivation after the year 2000). As many as 98 of the ergasiophytes found in cemeteries are new to the flora of Poland.

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Occurrence of alien species on grasslands in the Sudeten Mts.

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The expansion of non-native species is one of the most important ecological problems relating to the conservation of biodiversity. Relations between the occurrence of alien species and the species composition of meadows are poorly recognised aspects of these valuable plant communities. The expansion of non-native species in meadows has a clear correlation with changes of land use.

The primary objective of the study was to understand: (1) the frequency of non-native species occurrence in meadow communities in the Sudeten mountains, (2) the gradient variation of meadows and native species habitat preferences. Phytosociological data were collected using Braun-Banquet method. Selection of plots was performed on the basis of a numerical terrain model made in GIS software using vector

layers, including information on where grassland areas occurred in the Sudeten Mountains. In order to obtain sample plots, grid squares of 10 km side length were applied. From each square, five point locations in meadow areas were randomly selected. Around each point, we built a buffer in the shape of a circle with a radius of 250 m. Within these buffers, two nested plots were established from where phytosociological data could be collected. Additionally, habitat descriptions were gathered as well as information referring to

the occurrence of the presence of trees, roads and other landscape elements.

According to the preliminary results of the present study, we can assume that *Solidago canadensis*, *Solidago gigantea* and *Lupinus polyphyllus* were the most widely distributed alien species in meadow communities of the Sudeten Mts. Second conclusion is that there were differences in the type of meadows preferred by neophyte and the presence of alien species was affected by land use type and meadow surroundings.

Expansion of American maples (*Acer saccharinum*) in Central Europe

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The North American silver maple (*Acer saccharinum*) and boxelder (*A. negundo*) have been cultivated in Europe for a long time. They appeared, for the first time, at the turn of the 17th and 18th century in the gardens of Great Britain, but only towards the end of the 19th and, especially, in the 20th century they were often planted in parks, along streets and alleys. They both originate from American riparian communities and are well adapted to growing in variable conditions typical for this habitat. They have similar ecology: they are short-lived, fast-growing, heavily-germinated tree species; they begin seed production at a very early stage and produce seed crops every year. But at this moment,

only the boxelder can be treated as an aggressive, invasive alien plant.

This research points to the difference which, perhaps, does not allow intense expansion of the silver maple on new territories, namely, the plant's immunity to desiccation of seeds and short period of germination. Additionally, the date of fruiting falls on high growing season making germination of seeds and survival of saplings very difficult. Nevertheless, *A. saccharinum* should be considered as an expansive alien species which appears in semi-natural and natural forest communities. Probably, silver maple has only just started its invasion in Europe which, perhaps, will not be as extensive as that of *A. negundo*.

Morphological and site diversification of *Anthoxanthum aristatum* Boiss. populations occurring at European borders

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Anthoxanthum aristatum (Poaceae) is an annual plant which can be found in the Atlantic Ocean part of Western Europe as well as in sites separated from its continuous range along the Mediterranean Sea and in Central Europe. In Poland, it is treated as an invasive species spreading from the west.

Comprehensive comparative investigations were carried out of *A. aristatum* populations collected in differing sites at edges of its range in Europe. The experimental material was gathered in Spain (the province of Galicia) from a natural site (mountain sward) and anthropogenic sites (along roads and grapevine cultivations) as well as from central-eastern Poland (arable field).

The performed comparative morphological analysis carried out with the assistance of multivariate statistics revealed statistically significant differences between the examined populations and a distinct difference of Spanish populations. In addition, significant differ-

ences were also found between populations derived from the western edge of the range in Spain. The population from a ruderal site (roadside) was characterised by a clear dissimilitude both in relation to the population from the grapevine cultivation and from the mountain sward.

Results of soil analysis showed that Polish populations grow on oligotrophic sites. On the other hand, *A. aristatum* sites situated within its natural range are more fertile and, at the same time, more varied with respect to soil parameters. Values of available potassium (K) from sites in Spain were higher in comparison with the respective values derived from sites situated in Poland. Available nitrogen (N) and carbon (C) from trampled sward were characterised by much higher values than the remaining ones. On the other hand, N and C values determined on a segetal site (grapevine cultivation) only slightly exceeded values obtained from field sites in Poland.

Synantropization of *Phragmito-Magno-Caricetea* class in Ukraine

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Phragmito-Magno-Caricetea class in Ukraine consists of 56 associations belonging to seven alliances and four orders. In total, the communities amount to 657 species. Among them, 156 species from 37 families and 111 genera are synanthropic. The general synanthropization index of *Phragmito-Magno-Caricetea* coenoses is 23.7%. Asteraceae, Lamiaceae, Fabaceae, Polygonaceae, Poaceae, Apiaceae, Chenopodiaceae, Caryophyllaceae and Scrophulariaceae united 75.6% species form a spectrum of leading families of synanthropic coenoflora fraction. *Persicaria*, *Rumex* and *Bidens* are the principal synanthropic genera. Apophytes prevail by origin and comprise 106 species (67.9% from total quantity) which belong to 75 genera and 27 families. The general apophytization index of *Phragmito-Magno-Caricetea* communities is 16.1%. By adaptation degree to anthropogenous factors among apophytes the eupophytes prevail (45.2%) which affirms extraordinary anthropogenous disturbance of the class coenoses. Part of hemiapophytes and casual apophytes is the same and is 32% every-one. The adventitious fraction consists of 50 species belonging to 43 genera and 22 families. The general adventitization index of *Phragmito-Magno-Caricetea* communities is 7.6%. By adventition time, kenophytes prevail (62% of fraction composition). Archaeophytes constitute 38% of the total quantity of non-aborigines. The ratio between these groups is 1:1.6. Such distribution confirms active replenishment of floristic com-

munity composition by adventitious species at present time. By the naturalization degree, epecophytes mainly prevail (72%). The proportion of agriophytes is 28%, of ergasiophytes – 10%, of ephemerophytes – 6% and of hemiepecophytes – 4%. Among the adventitious species of *Phragmito-Magno-Caricetea* coenoflora, species of American origin prevail (30%). Species originating from Asian floristic centres constitute 28%, from the Mediterranean – 28%, from Europe – 10%. To identify the anthropogenous transformation degree of *Phragmito-Magno-Caricetea* communities indicators of archeophytization, kenophytization, modernization and flora instability were used. The general index of archeophytization amounted to 12.2%, of kenophytization – to 19.8%. The index of flora modernization was 62% indicating a considerable change of specific composition in favour of eukenopytes and species-transformers. The instability flora index of *Phragmito-Magno-Caricetea* coenoses was 1.2%. The most invasive ability was charactered to 25 species. Among them, *Ambrosia artemisiifolia*, *Amorpha fruticosa*, *Bidens frondosa*, *Conyza canadensis*, *Salix fragilis*, *Xanthium albinum* were species-transformers. They had the highest invasive potential. They were naturalized at the phytocoe-notic level, actively renewed populations and had mass expansion in the natural ecotops under human impact. Rare species, whose population development was affected, were especially vulnerable to the influence of transformers and also to unique swamp phytocoenoses.

Invasive species on the territory of the Romensko-Poltavsky Geobotanical District (Ukraine)

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The process of regional flora adventization is intensifying year by year which is most apparent in the increasing number of invasive species and activation of their spread and impact on the environment. On the basis of literature sources, herbarium (KW, CWU, PW, PWU) and the author's original research undertaken during the period of 2010–2014, the following was found: 342 species of alien fraction flora of vascular plants among which 7 species (2 %) were invasive (*Acer negundo* L., *Amaranthus retroflexus* L., *Ambrosia artemisiifolia* L., *Conyza canadensis* (L.) Cronq., *Iva xantifolia* (Nutt.) Fresen, *Portulaca oleracea* L., *Setaria glauca* (L.) P. Beauv., *Solidago canadensis* L.) and 2 species (0.6 %) were potentially invasive (*Asclepias syriaca* L., *Parthenocissus quinquefolia* (L.) Planch.). Among the invasive species of the region, the following species dominated: by the time of immigration – kenophyte (8 species); by origin – North American species (8); by the degree of naturalization – epoecophyte (7); by the overall spreading – cosmopolites (6); by the type of the areal space structure – integrate (7); by the systematic location – the representatives of the Asteraceae family (4); by biological types (according to Ch. Raunkiaer) – therophytes (7); by life forms (according

to I. H. Serebryakov) – herbaceous plants (8); by the duration of the life cycle – monocarpic plants (6); by the disposition to the soil trophicity – mezotropes (7); by the disposition to the lighting regime – heliophytes (7); by the disposition to the thermal mode – mezothermophytes (6); by disposition to the moisture regime – xeromesophytes (5 species); by eco-coenotic affiliation (according to O. L. Belgard) – ruderal (9); by the affiliation to the types of habitats – mixed (9): transport pathways, ruderal and segetal, anthropogenic and natural. For example, *Conyza canadensis* more common in agrophytocoenoses and in other different types of anthropogenic ecotopes and on differently changed semi-natural and natural ones, where it replaced the natural species; incorporation in meadow, meadow-steppe, forest margins and river bank habitats. *Solidago canadensis* and *Iva xantifolia* were characterized by a similar situation of distribution in the region. The distribution maps of invasive species on the territory of the region were compiled. The results of our research suggest further activity of the investigated species in the region and expansion of their eco-topological amplitude.

Management of invasive plant species in the valley of the Ślepiotka river in Katowice

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Invasive alien plants, besides river regulations, are one of the main reasons for transforming the riparian flora and vegetation. In many cases, the replacement of native species caused by alien plants may result not only in ecological losses but also economic ones. The group of invasive plants spreading along rivers in Poland include, among others: *Acer negundo* (Boxelder maple), *Echinocystis lobata* (Wild cucumber), two species from the genus *Impatiens*: *I. glandulifera* (Himalayan balsam) and *I. parviflora* (Small balsam), *Padus serotina* (Black cherry), *Reynoutria japonica* (Japanese knotweed) and *Solidago gigantea* (Giant goldenrod). Currently, in many countries, actions are undertaken which are dedicated to restoration of river valleys and halting the spread of invasive plant species. The project Revitalisation of Urban River Spaces (REURIS), implemented in 2009-2012 in the Ślepiotka river valley in Katowice, can be an example of such activity. Within the framework of the project, eradication of several alien plant species occurring in this area was conducted.

The main objectives of this study included: (i) assessment of the effects of invasive plant eradication within the REURIS project and assessment of the treatments continued by Katowice Urban Greenery and students of the Faculty of Biology and Environmental Protection of the University of Silesia, (ii) development of general guidelines for the control of invasive *Impatiens parviflora*.

The outcome of control methods used during the REURIS project was permanent reduction of the size of the populations of: *Impatiens glandulifera*, *I. parviflora*, *Padus serotina*, *Reynoutria japonica* and *Solidago canadensis*. Currently, upon completion of the REURIS project, elimination of the invasive plant species is continued and supervised by Katowice Urban Greenery, according to the guidelines drawn up as part of the project. Additionally, in these actions, staff and students from the Faculty of Biology and Environmental Protection of the University of Silesia take part, who participate in the manual elimination of two species: *Impatiens parviflora* and *Reynoutria japonica*.

The treatments applied during the project led, in the end, to the reduction in growth and vigour of *Reynoutria japonica* shoots and decline in the pool of *Impatiens parviflora* diaspores in the soil seed bank. On the other hand, majority of current attempts to control invasive species contributed exclusively to reducing the size of their populations. The choice of the appropriate method of elimination should be adapted to the biology and ecology of the species and the type of habitat. Therefore, it is recommended that treatments related to control of analysed species should be conducted systematically over several growing seasons until the complete elimination of *Impatiens parviflora* diaspores from the soil seed bank and rhizomes of *Reynoutria japonica*. The results made it possible to elaborate general guidelines for dealing with invasive plant species.

Transformations of meadow and pasture phytocoenoses of *Arrhenatheretalia* order in the Brynica valley (NE Poland) in the period of last 40 years

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Range and character of transformations of meadow and pasture vegetation of *Arrhenatheretalia* order was evaluated on the basis of a comparison of phytosociological data from 1974-1978 with the data of the last two years. For about 30 formerly examined phytocoenoses, present plant communities and causes of the occurred changes were determined. In case of some phytosociological relevés, a repeat in the same localities and afterwards a comparative analysis of floristic composition was possible thanks to their detailed localization. The area of the research is the Brynica valley situated to the east of Brodnica (macroregion of Chełmno-Dobrzyń Lakeland).

The majority of formerly and currently observed phytocoenoses revealed distinct changes of vegetation type. Phytocoenoses of *Arrhenatheretum elatioris* association were either preserved with partial changes or transformed into plant communities, mainly of *Artemisietea vulgaris* and *Agropyreteae intermedio-repentis*

classes. It was mainly due to secondary succession as a result of abandonment and habitat eutrophication. *Lolio-Cynosuretum* phytocoenoses, in turn, due to lack of grazing, transformed into fresh meadows of *Arrhenatheretum elatioris* or into plant communities of *Artemisietea vulgaris* class. In some cases, in place of pastures, fish ponds or parking lots were established. Generally, an increase of area of *Arrhenatheretum elatioris* phytocoenoses and decrease in the area of *Lolio-Cynosuretum* phytocoenoses was revealed.

A comparison of a few former and present phytosociological relevés for *Arrhenatheretum elatioris* association revealed changes in structure and species composition. A distinct decrease of species number in a relevé, a decrease of moss layer coverage, a decrease of *Arrhenatheretalia* order and of the share of *Molinio-Arrhenathereteae* class species and a share increase of *Artemisietea vulgaris* species and *Agropyreteae intermedio-repentis* classes were determined.

Synanthropization of the Baltic-type raised bog “Roby” (NW Poland)

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Undisturbed peatland ecosystems are relatively resilient to the invasion and spreading of synanthropic flora species due to specific habitat conditions. How-

ever, there are only few such peatland ecosystems. Large majority of them are peat-bogs which underwent transformations, to a varying extent, as a result of diffe-

rent human-induced pressure and, therefore, are often exposed to the infiltration of species alien with respect to habitat. These peat-bogs include the Baltic-type raised bog “Roby” which has been under reserve protection since 2007. This protection aims at the preservation of populations of valuable vascular plants and cryptogams, including *Erica tetralix*, *Myrica gale* and rare species of peat-mosses, and re-naturalisation of their habitats. The reserve, with an area of 84.40 ha, is situated in an agricultural landscape, to the south of the village of Roby, in West Pomeranian Voivodeship. It is located in a shallow depression surrounded by arable fields and meadows with some meadows cutting into the area of peat-bog. In the past, this object was cut up with a system of drainage ditches; moreover, peat extraction was carried out here by the manual method (small-area peat post-excavation pits). Due to drainage, the peat-bog lost its skirt zone which usually plays an important buffer function and protects its most valuable part, i.e. the peat-bog cupola, from

fertilisation. Nutrient-rich waters running off arable fields and pastures flow freely into the area of peat-bog, providing, thereby, conditions for the invasion of synanthropic species. Floristic surveys carried out in the reserve in 2007-2009 and 2014 showed the spread, among others, of *Urtica dioica*, a typically nitrophilous species and *Impatiens parviflora*; furthermore, invasion of *Phragmites australis* and *Typha latifolia* was also observed. Unusually for the peat-bogs of this type, *Salix auritae* and *Salix cinerea* spread and take dominance here – this is evidence of strong fertilisation of the peat-bog. It is particularly visible in the eastern part of the reserve, where the decomposition process of peat-bog upper horizon is clearly marked.

Raised bog species have only been preserved in small fragments of the peat-bog in its north-western part, i.e. where hydrographic conditions are still chiefly determined by rainwater and the peat deposit is fairly well preserved.

Expansion of alien species in meadows in the Ojców National Park (southern Poland) during last 50 years

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Decline of semi-natural communities connected with the collapse of traditional agriculture is a problem in protected areas of Central Europe. The Ojców National Park (ONP) was established in 1956 to protect deep Jurassic valleys with diverse vegetation and traditional cultural landscape. In this time, valley bottoms were dominated by species-rich hay-meadows (*Arrhenatheretum elatioris*). The main questions of the study were the following: (i) How the abundance of alien species in meadows changed during 50 years? (ii) How distribution of alien species changed in last 5 decades? (iii) Were there modifications in local species pool? The vegetation in 204 square plots (100 m² each) was recorded using Braun-Blanquet method in 2011-2014. Additionally, vegetation data of 17 semi-permanent plots, from 1958-1960, 1986-1987 and 2011-2012 were analyzed. A phytosociological map of valley bottoms was made again in 2013 after

50 years. Data comparison showed that cessation of traditional management led to far-reaching modifications in species richness (decrease of alpha-diversity), composition and structure of meadow communities. Those changes were manifested by a decline of typical meadow species and expansion of nitrophilous and/or alien species (in majority *Solidago canadensis* and *S. serotina*). In spite of different rates and patterns of those changes, homogenization of vegetation was the main effect. Analyses of maps and floristic data showed relatively quick spreading of *Solidago* spp. and increasing of their stands and occupied area in the ONP between 1978 (3 stands only) and 2013 (ca. 5.5 ha). Those taxa occupied mesic and dry habitats, mainly abandoned meadows and arable fields on the top surface. They were present also in fallow lands in valley bottoms near park boundary as well as in tall-herb communities along riversides. In recent decades, continuous spreading

of *Solidago* spp. occurred despite active protection. It seems that the use of radical methods of meadow community restoration is indispensable to stop plant invasions in the ONP. The study provides evidence that

the local species pool was modified. Thus, it is probable that former species composition will not be recovered without reintroduction of some extinct meadow species.

Poison ivy (*Toxicodendron radicans* (L.) Kuntze – Anacardiaceae) – an invasive species, dangerous for the health of workers of botanical gardens and arboreta in Poland

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Poison ivy was originally distributed in the wild in the eastern and south-eastern part of North America, reaching up to Central America in the south. It is widespread in shady riparian forests, in wet and marshy habitats, as well as in areas exposed to sunlight, e.g.: in thickets, forest clearings, on roadsides and railway embankments.

Plants of this species grow rapidly in the occupied areas, forming extensive, dense, homogeneous patches on the ground or climbing trees and penetrating their canopies up to the height of 20 m. Seeds are dispersed by endozoochory.

Poison ivy was introduced in the 19th century to the UK because of its decorative qualities. This species is cultivated in many botanic gardens in Europe, including Poland. In the Botanical Garden in Poznań, its specimens were planted for the first time in 1925. Poison ivy proves to be invasive in temperate climates. This species spread rapidly and got naturalized in many countries of Europe and North Africa. As a an anthropophyte, it is also listed in the floras of China, Japan, Taiwan, India, and even Australia.

In 1993, a population of poison ivy was discovered in the village of Siedlisko near Nowa Sól (Lubuskie Voivodeship). The presence of this plant was confirmed again in 2013. This shows a tendency to naturalization of this species in Poland. In the Botanical Garden

of Adam Mickiewicz University in Poznań (AMU BG), a spontaneous spread of *T. radicans* was observed with seedling growth under the cover of lush patches of Virginia creeper (*Parthenocissus quinquefolia* (L.) Planch.). Poison ivy has strong vesicant properties. Urushiol, a light yellow, viscous oleoresin, excreted in resin canals and leaking from wounded plant parts, especially stems and roots is particularly dangerous. In case of people sensitive to this substance, touching leaves and inflorescences may cause allergic reactions in form of burns difficult to treat. Serious health complications can also be triggered by contact with pollen, and even by inhalation of smoke from burning plants. Dead wood retains the toxic properties for many years. Direct contact with this plant causes a complicated, delayed allergic reaction of the human body, developing during a few or even several days. It is manifested by intensive and extensive blistering rash, accompanied by incessant, severe itching and oozing of lymph fluid. In the AMU BG *T. radicans* was eradicated in 2013, after the case of a serious allergic reaction of one of the employees. Due to invasiveness of poison ivy and health risks it poses, we postulate to include this species in the list of species prohibited from cultivation in Poland. In addition, it should be destroyed in the established place of spontaneous occurrence in nature, in order to prevent accidents and the possibility of its further spread.

The analysis of synanthropic flora of Rzeszów Foothills

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Floristic studies were carried out in years 2007-2013 in the Rzeszów Foothills (SE Poland). The cartogram method in the ATPOL system (2 km grid squares) was applied. The research showed that Rzeszów Foothills region was profoundly modified by anthropopressure. The synanthropic taxa represented about 40% of the total number of vascular plant species occurring in the study area and alien plants were an important part of the local plant diversity.

The aim of this study was to analyze the synanthropic flora. Analyses presenting the numerical data

(number of species in each historical-geographical group, families most frequently represented by the apophytes and anthropophytes, index of synanthropization) showed the share of the particular life forms, described the habitat preferences, etc. Moreover, the distribution of the most interesting and invasive of the synanthropic species was presented. In addition, the plants vulnerable to extinction were identified (mainly archaeophytes) and the cause of their disappearance was specified.

Reproduction success and pollen limitation in natural and anthropogenic populations of orchid *Malaxis monophyllos* (L.) Sw.

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Human-induced environmental changes often disrupt interactions between plants and their pollinators which seem to be crucial for plant evolution. The new conditions often make plant species suffer from pollen limitation caused by different factors, such as decrease in numbers of reproductive individuals or by low pollinator availability. Fewer flower visits as well as smaller pollen loads lead to pollen limitation and reductions in fruits and seeds output.

We studied the reproduction success of *Malaxis monophyllos* in contrasting conditions of (i) natural wet calcareous peatlands and (ii) anthropogenic habitats such as pine forest, railway bank and post-mining area (6 populations in total). Our previous studies revealed distinct properties of anthropogenic populations in comparison with natural ones (larger densities and abundance). Thus, the aim of the present study was to examine whether the differences in fruiting

between natural and anthropogenic *M. monophyllos* populations were conditioned by pollen availability. For this purpose, we recorded in all populations the pollinia removal, densities and height of reproductive individuals and fruit set. Moreover, *M. monophyllos* is presumably self-incompatible species whose sexual reproduction depends on cross pollination by insects from probably Mycetophilidae family which are likewise strongly connected with wet and peaty environments.

Thus, we could suspect that those rather dry, anthropogenic habitats were not suitable for this group of insects. Our results showed that the average pollinia removal differed considerably between populations (from 35.2% – 81.8%), but we did not notice significant

differences between types of habitats (anthropogenic vs. natural). In contrast, average fruit production was almost two times higher in the peatlands than in anthropogenic, disturbed habitats (average 12.5% and 6.5%, respectively). Simultaneously, we found no correlation between rates of pollinia removal and level of fruit production. These results imply that the pollinators' availability need not be a limiting factor for reproductive success in *M. monophyllos* populations. They also suggest that pollinia lost can play an important role in shaping levels of fruiting, especially in anthropogenic populations. However, anthropogenic *M. monophyllos* populations need further investigations as separate and unique units.

Refuge of unique vascular flora in agricultural landscape of central Wielkopolska: geographical, ecological and historical determinants

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In areas surrounding the Lednickie Lake (central Wielkopolska), despite centuries of anthropopressure, enclaves of many disappearing vascular plants can still be found. Human settlements exerted the strongest pressure on the natural environment leading to either deforestation or land melioration of large parts of these areas.

The aim of this study was to determine interrelationships between the distribution of unique species of vascular plants and the history of land utilization as expressed by persistence of forest and meadow ecosystems. Site distribution of regionally rare and protected vascular plant species occurring in areas adjacent to the Lednickie Lake in relation to landscape changes from the middle of the 19th century were analysed. On the basis of the analysis of cartographic materials from years 1879, 1893, 1935, 1962 and 2000, with the assistance of the vector graphic program, duration of forest and meadow areas in the landscape was determined.

In all, the existence of 23 refuges was determined in the examined area. Small shelters (13) were distributed mainly in the region of the southern edge of the Lednica Lake trough. Eight objects were distinguished among medium shelters. Two objects were found in the group of large refuges: a complex of marshes and meadows and a forest. Both of these objects are situated in the culmination area of the end moraine. It was in these enclaves that meadow and forest areas persisted for over 150 years and such precious plant species as *Cephalanthera damasonium*, *Cypripedium calceolus*, *Phyllitis scolopendrium*, *Pinguicula vulgaris* subsp. *vulgaris*, or *Saxifraga hirculus* were found to grow. The accumulation of shelters south of the Lednickie Lake can be considered as a “regional hot spot” which distinguishes itself, among others, by a group of species characterized by a high endangerment status which keep growing here thanks to a long period of persistence of ecosystems.

Alien plant species in the flora of heavy-metal sites (the Silesia-Cracow Upland)

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Poland's largest resources of zinc and lead ores are located in the southern part of the country (the Silesia-Cracow Upland). The many-years' mining and smelting activity have caused the degradation of landscape and destruction of natural vegetation. The soil is poor in nutrients and contains considerable amounts of heavy metals (mainly zinc, lead and cadmium). These areas are colonized by plants which are highly tolerant to environmental stress. Unique plant communities are formed, and species with interesting biological features grow there.

Floristic studies were carried out in 2004 and 2014 in the five areas of irregular shape. These areas represent different ore deposits regions, in which Zn and Pb ore has been mined and processed for many ages, such as: Bolesław, Jaworzno, Chrzanów and 2 places in Tarnowskie Góry.

Based on the analysis of vascular diversity in the investigated sites, it has been determined that the native species dominate there (90%).

In 2004, the species of alien plants constituted only a small percentage of the flora of heavy-metal sites. They used to appear mostly at the outskirts of the studied places, at the paths, very rarely on slagheaps' surfaces. The group of tree species comprised: *Acer negundo*, *Padus serotina*, *Quercus rubra*, *Robinia pseudoacacia*. Herbaceous plants included, among others: *Solidago canadensis*, *Aster novi-belgii*, *Bunias orientalis*, *Impatiens parviflora* and *Reynoutria japonica*.

In 2014, some new species appeared in the studied areas, which have never been seen there: *Juglans regia*, *Aesculus hippocastanum*, *Fraxinus pennsylvanica*, *Echinocystis lobata* and *Parthenocissus inserta*. In addition, the area occupied by the alien plant species (earlier registered) has increased.

As a result of this research, it is suggested that monitoring of heavy-metal sites should be undertaken, especially, in the areas where calamine grasslands – protected within the Natura 2000 network – occur.

The occurrence of alien species in settlement areas of Kampinos National Park with a particular consideration of invasive alien species

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Studies aimed at the identification of the range and the method of spread of alien species in Kampinos National Park (KNP) and its closest vicinity have been carried out since 2012. Special emphasis was put on the surveying of sites of invasive taxa (IAS), and diagnosing potential threats posed to the natural and semi-natural vegetation of the national park by IAS present in rural areas. A floristic survey was carried out on the majority of settlement areas in the Kampinos Forest (104 various-sized villages, either populated, or partly or completely depopulated, of which 30 were within the borders of the national park). We found 52 plant species, including 40 invasive taxa which may potentially pose a threat to the ecosystems of KNP. On individual sites (villages), we identified from 1 to 34 species. Considering the distribution of IAS alone, we identified from 1 to 28 species. Most IAS (over 20) were recorded generally in partly depopulated villages located in the Park (e.g. Górki, Cisowe, Buda, Janówek, Józefów, Nowa Dąbrowa, Rybitew, and Sieraków). A cluster analysis (single linkage method based on Euclidean distance) was carried out for all investigated localities with regard to all alien species, and only IAS did not show a clear division

into separate groups. The most divergent villages were: Łazy Lesne, Lipków, Lasocin, Karolinów and Adamówek, whereas the highest similarity was shown for Grochale Nowe, Klaudyn, Stanisławów, and also for Stare Polesie, Zielonki, Wrzosówka, Dębina, Nowy Secymin, Dobrzyn, and Wólka Czosnowska. The most frequent species were trees and shrubs: *Rhus typhina*, *Robinia pseudoacacia*, *Syringa vulgaris*, *Acer negundo* and *Rosa rugosa*, and also herbs: *Solidago gigantea*, *S. canadensis*, *Amaranthus retroflexus*, *Anthoxanthum aristatum*, *Echinochoa crus-galli*, *Galinsoga parviflora*, *Oxalis fontana*, *Rudbeckia laciniata*, *Setaria pumila*, and *S. viridis*. Arable weeds formed a large group of the most widespread plants, persistent only on those types of segetal habitats and posing no serious threat to the natural ecosystems of KNP. Species encroaching from the settlement areas to semi-natural and natural communities included: *Bidens frondosa*, *Echinocystis lobata*, *Impatiens glandulifera*, *I. parviflora*, *Juncus tenuis*, *Lupinus polyphyllus*, *Reynoutria japonica*, and *Solidago gigantea*. Most of them were species from the highest (IV and III) classes of invasiveness in Poland.

Floristic diversity of grassland communities on dikes along the Vistula River

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Dikes are artificial slopes built along riverbeds to prevent flooding. They are an inherent part of the anthropogenic landscape. Various plant communities occurring on dikes develop both due to human activity and natural succession.

In June and July 2013 we carried out research on the diversity of grassland communities on dikes constructed along the Vistula River. The study was conducted in 24 transects of 200 m each, located in the area of Cracow (southern Poland). In every examined transect, 6 relevés (3 on the slope adjacent to the river and 3 at the opposite side of the dike) were performed. The relevé plot size used by us was 12 m². In our study, we used the following scale describing species cover: + – slight cover, up to 3 specimens; 1 – cover up to 15%; 2 – cover 15-50%; 3 – cover 50-100%. In total, we performed

144 relevés. To compare floristic diversity of vegetation patches on the two sides of the dikes, we conducted statistical analysis using MVSP 3.2 and Statistica 10.

During the study, we recorded 221 species of vascular plants (187 on the slopes adjacent to the river and 173 at the opposite side of dikes). Of the taxa recorded on both sides of the dikes, ca. 20% were alien to Polish flora. One of the recorded species – *Ononis arvensis* L. was under partial protection and the second one – *Allium scorodoprasum* L. was placed on the “Red list of plants and fungi in Poland”. The results of the analysis showed that patches located on different slopes of dikes differed in species richness and Shannon’s diversity index, which were higher for surfaces on the slope adjacent to the riverbed (the differences were statistically significant).

Synanthropophyton of the Sea of Azov coastal zone

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Phytodiversity of the Sea of Azov coastal zone (SACZ) is marked by significant dynamic changes. The factors that lead to changes in SACZ flora and cause its synanthropization are anthropogenic. The predominance of anthropogenic changes causes processes

of flora modernization and adventization. It was established that commensal fraction of SACZ flora comprised 848 species from 375 genera and 74 families and 3 departments (44% of spontaneous SACZ flora). The alien fraction of the flora was formed by 376

species from 59 families, representing 19.5% of spontaneous flora. In these terms, SACZ flora exceeded similar indicators of neighboring areas (10.7% – in the Northwest Caucasus flora, 15.2% – in plain Crimea) and was inferior only to the flora of the South-East Ukraine – 20.9%, Northern Prychornomor'ya – 23.6%. Archaeophytes in SACZ flora formed 121 species from 33 families (6.3%) and kenophytes – 255 species from 49 families (13.2%). Distribution of synanthropophyton types by blocks of ecotones, which we allocated for SACZ, proved that they exhibited the greatest diversity in the anthropogenic block of ecotone (21%) which was influenced by landslides, while the natural flora species acquired the largest diversity in the plakor block (39.2 %). In fluctuation block, there were 121 species of synanthropophytes (6.3%), while in native fraction – the index comprised 175 species (9.1%). In amphibian and aquatic blocks, the diversity of synanthropophyton was low (1.0% and 0.3%) because synanthropization of brackish and coastal ecosystems was slow. Ecological and coenotic analysis of synanthropophyton of SACZ showed that the major ecocoenomorphes of apophyte faction were – stepantes (37.9%), litorantes (10.4%) and pratantes (8.5%). Other coenomorphes in apo-

phyte faction played a subordinate role, although they were rather variable: mahrantes (5.9%), palyudantes (5.7%), halofantes (4.2%), aquantes (0.2%). The widest variety among apophytes (27.1%) was characteristic of fallow (12.2%), shear (4.2%) and residential (4.2%) ecotopes. Zonal coenomorphes in anthropophyton were of little diversity (most of them were in stepophyton (8.2%) and litoralophyton (5.3%)). The part of commensal coenotope was 77.3%. It was dominated by fallow (20.5%), residential (13.8%), industrial (13.0%) coenoelements etc. A specific regional feature of SACZ flora, which sets it apart from synanthropic flora of Ukraine, was the domination of apophytization over adventization (ratio 1.25:1) and a relatively high index of modernization (67.8). Most of adventitious species spread to SACZ from the Mediterranean region (188 species), different regions of Asia (95) and North America (37). By way of introduction, xenophytes (78.7%) dominated. The part of ergasiophytes was 21.3%. Synanthropization of SACZ flora causes the development of coastal ecosystems management that will lead to conservation of native flora and separate areas with natural communities, deceleration of coast destruction processes, precaution of phytoinvasion etc.

Communities with *Artemisia annua* L. occurring on anthropogenic habitats

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Artemisia annua L. is a kenophyte coming from south-eastern Europe and western Asia. It was brought into Europe in 1871, along with grain, cotton or wool, or it was deliberately cultivated. This species was recorded mainly in southern Poland (Lublin Province, Upper Silesia, Lower Silesia).

The aim of the study was to show diversity of communities with *Artemisia annua* L. in the Silesian Uplands and other regions in Europe; to show its habitat preferences and to make a functional analysis of communities with participation of *Artemisia annua*.

Artemisia annua penetrates plant communities that develop on anthropogenic habitats, undergoing disturbances occurring with different intensity and time such as: railway areas, roadsides, wastelands, lawns, rubble and construction sites.

The analysis of floristic composition of 94 patches with participation of *Artemisia annua* showed that this species mainly co-occurred with short-lived species confined to trampled sites (*Chamomilla suaveolens*, *Poa annua*, *Polygonum aviculare*), muddy banks and mid-field depressions (*Gnaphalium uliginosum*,

Bidens frondosa, *Plantago intermedia*, *Rorippa palustris*), some cereal and root-crop weeds (*Echinochloa crus-galli*, *Matricaria maritima* subsp. *inodora*, *Polygonum persicaria*, *Polygonum lapathifolium* subsp. *pallidum*, *Setaria viridis*), and ruderal species (*Lactuca serriola*, *Conyza canadensis*, *Sisymbrium officinale*). In sites where disturbances occurred less frequently, long-lived ruderal species, frequently confined to more

fertile habitats were found (*Lamium album*, *Ballota nigra*, *Chelidonium majus*, *Arctium lappa*).

In classification system of ruderal vegetation of Silesian Uplands, patches with *Artemisia annua* were included into *Chenopodium album*-*Atriplex nitens* stands. Diversity of vegetation with participation of *Artemisia annua* was mainly influenced by moisture conditions and soil reaction.

Woody invasive plants in the urbanized landscape: a case study of Bydgoszcz

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Cities create unique natural and physiognomic arrangements. Buildings, spontaneous vegetation and designed greenery determine their landscapes. Among complexes of urban green spaces, an exchange of plants takes place. Appearance of invasive plants in urban ecological systems is very important. Cities set the stage for their proliferation within their boundaries. Many alien species are of big decorative value and their presence is approved by many residents.

The analysis of 10 woody species spreading in Bydgoszcz was carried out (*Acer negundo*, *Aesculus*

hippocastanum, *Amelanchier spicata*, *Juglans regia*, *Padus serotina*, *Prunus cerasifera*, *Quercus rubra*, *Rhus typhina*, *Robinia pseudoacacia*, *Syringa vulgaris*). Their appearance was determined within areas of different use forms. Preferred habitats were determined for particular taxons (fallow lands, abandoned gardens, courtyards, postindustrial areas, decorative shrubs paths, community forests). The investigation was carried out on the basis of more than 2600 phytosociological records from Bydgoszcz urban areas.

The effect of habitat conditions on abundance of populations and selected traits of individuals *Impatiens glandulifera*

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The investigations were carried out in years 2013-2014 in several sites located across the Vistula River

valley from Pychowice to Tyniec (Southern Poland). These included: fallow land, a roadside, river banks,

a riparian forest edge, a willow thicket and riparian forest inside. In the aforementioned sites, light availability gradually diminished, while plant canopy height and soil moisture increased. In all populations, the number of individuals of *Impatiens glandulifera* was surveyed. The height of stems, width of stems at soil level, number of whorls with side branches, number of side branches and total number of flowers were noted in 30 individuals, while the selected flower traits (i.e. total length of flower, length and width of lower sepal, as well as length of spur) were measured in 100 randomly chosen flowers.

The population abundance, height and width of stems, number of whorls and side branches increased gradually from fallow land, through roadside and river banks to riparian forest edge. Such phenomenon

might be linked with rising height of adjacent plants and advanced intra- and interspecific competition for resources. Much lower rates of the above-mentioned parameters in the willow thicket and in forest inside might be caused by lack of insolation due to full overshadowing by trees.

Individuals growing in fallow land, roadside and river banks produced substantial number of flowers achieving small total length and considerable dimensions of lower sepal and spur. Such phenomenon might augment the chances for successful pollinator visits in very competitive environment. On the other hand, the low production of flowers reaching greater length and small dimensions of lower sepal and spur might be sufficient to allow the maintenance of populations in willow thicket and forest inside.

Man's impact on plant cover of four villages in SE Poland

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The observation of the rapid rate of plant cover transformation caused by urbanization and agricultural technology was the inspiration for undertaking the study in rural areas. The study was carried out in the Sandomierz Basin in four typical villages with varying degrees of the anthropogenic impact. The changes observed included: Koszyce Małe (a suburban village near Tarnów) – evident transformation of fields and meadows into building land; Kolbuszowa Dolna – intensive changes in land use, abandonment of fields and meadows, and river regulation; Roźwienica (near Jarosław) – emergence of new habitats for plant colonization after reclamation of land previously occupied by a brick factory and a landfill; Krzeczowice (near Przeworsk) – intensive crop cultivation and unchanged land use. In 2009-2010, floristic investigations with the patrol method were carried out in these areas, which involved records of plant species growing on roadsides, ditches, meadows, fields, wastelands, railway tracks, and in fragments of natural communities. Phytosociological relevés were taken with the Braun-Blanquet method in vegetation patches characteristic of the area. The historical-geographical classification and indices of

the anthropogenic changes of the flora were employed in the analysis.

Substantially higher abundance of synanthropic species than that of spontaneophytes was noted in the analysed floras. In the synanthropic species group, the proportion of apophytes was 3-fold higher than that of anthropophytes (with the exception of Kolbuszowa D.). Archaeophytes were more abundant than kenophytes (with the exception of the flora in Koszyce). The flora of Krzeczowice, an area affected by long-term anthropopressure, was by approx. 30% less abundant than that in the other villages; it was also characterized by the highest synanthropization index (89.3%), total apophytization index (65.2%), and index of apophytism of spontaneophytes (91.3%). In turn, the flora found in Kolbuszowa Dolna was rich due to the presence of a wide variety of habitats (fragments of natural communities, new habitats on abandoned fields and meadows, numerous roadsides); it was characterized by the lowest total apophytization index (36.7%) accompanied by the highest total anthropopization index (25.9%) related to the most abundant flora of roadsides.

The dynamics of *Orobanche bartlingii* in the Ostrów Małe Rudy locality situated within the Nature 2000 area Równina Szubińsko-Łabiszyńska PLH040029

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Orobanche bartlingii Griseb. is a Eurasian plant associated with the dry calciphilous grasslands. Although, the extent of its occurrence is wide (from France to China), it is everywhere a rare plant, known from a few localities only. It belongs to the most specialized parasites of the family *Orobanchaceae*. Its only host is *Libanotis pyrenaica* (L.) Bourg. This specialization and some morphological characteristics and the climatic preferences differ it from *O. alsatica*. *O. bartlingii* was first found in Poland in 1992 and was only observed at one locality in the Ojców National Park until recently. As a critically endangered species, it was entered in the Polish Red Book of Plants (category VU) in 2001. Since 2004, it is under strict protection.

The locality in the village Małe Rudy was discovered in 2000, but the species has been erroneously labeled as *O. alsatica*. This species occurs at the midmeadow hill

between Noteć and Noteć Canal and occupies approximately 3000 m². The habitat is covered with herbaceous vegetation of thermophilic grassland. *Seseli libanotis* is one of dominant plants. The nearest meadows were determined as *Galio veri-Molinietum*. Only a few specimens of *O. bartlingii* were found in 2000, when the hill was covered by sparse *Populus tremula* coppices. Eight shoots were found in 2010, when the European beaver (*Castor fiber* L.), cut down all the aspens. In the subsequent years, the number of plants was increasing. In the 2014, the number of plants comes to 85.

Unveiling thermophilic grassland from the eaves of the trees improved the growth conditions of *O. bartlingii* and its host *L. pyrenaica*. Thus, chances to preserve this species in the Nature 2000 area, Równina Szubińsko-Łabiszyńska PLH040029, increased significantly.

Inventory of alien plants along the trails of the Słowiński National Park

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Słowiński National Park (SNP) is one of the two coastal national parks in Poland. It has been recognised as a World Biosphere Reserve with regard to its

uniqueness (on the European scale) of the area of migrating dunes. It was created in order to protect lakes, bogs, marshes, meadows, forests and, especially, dune

spit. The flora of the SNP includes 920 taxa of vascular plants with about 50 species listed for protection. They include, among others: *Eryngium maritimum*, *Osmunda regalis*, *Drosera rotundifolia*. Tourist trails in the SNP are migration paths for many taxa. The objective of the study was to compare the occurrence of alien and invasive species along the trails of varying degrees of use. What was recorded was alien plant species and their number. The trails were divided into three categories according to the frequency of their tourist use. The first category included roads leading directly to the beach and those where car parks were located. The second category covered roads leading to the most famous tourist attractions of the SNP, while the third category

included trails that were used by tourists on bicycles or longer hiking routes. During the study, invasive and alien species were catalogued. The recorded invasive species comprised: *Conyza canadensis*, *Impatiens parviflora*, *Juncus tenuis*, *Oxalis stricta*, *Prunus serotina*, *Quercus rubra* as well as *Robinia pseudoacacia*. These plants, with varying frequency, occurred near different route categories. The performed study showed that tourism exerted the greatest impact on the roadsides floristic composition along the first category of routes as they were frequented by the largest number of tourists, while hiking along the third category affected the flora of the park to a lesser extent.

The role of land use in synanthropization of some valuable plant communities

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In a human-transformed landscape, the occurrence of particular plant communities as well as their synanthropization are determined by the presence of various forms of land use differing in the applied management techniques and technical measures. Based on 388 relevés collected in years 2006-2014 in SE Poland, synanthropization of several selected natural and seminatural plant communities developing in conditions of four different forms of land use were examined. These were: amphibious ephemeral communities from farmlands (mid-field depressions) and from fishponds, dry grasslands of extensive farmlands, sandy grasslands and heaths from military training grounds and fir forest used for standard production purposes. Vegetation patches of both

ephemeral wetlands communities and dry grasslands found in agricultural areas were characterized by the highest values of anthropophytization index (9.6% and 9.4%, respectively). The lowest values of the index were observed in the case of communities developed in military training grounds (0.6%) and forest areas (1.8%). Neophytes occurred most frequently in dry grasslands of agricultural areas (0.8 per relevé) and in fishpond amphibious annual communities (0.6 per relevé); the same was observed for invasive plants. The highest frequency of rare and endangered species was noted in amphibious ephemeral communities found both in farmlands and fishponds.

Homeless apophytes of the western part of Myślubórz Lakeland

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The status of homeless apophyte is given to a species of plant native to Poland, occurring outside of its natural habitats in a given area. Plants that have this status assigned in the western area of Myślubórz Lakeland were probably dominant species of the flora native to this area, but which lost their natural habitats due to the anthropogenic vegetation changes or were not found in them.

The first group of species are those whose locations in the Myślubórz Lakeland are within their overall home range, but do not have the natural habitats here. These include, among others, species of lithophytic communities: *Asplenium ruta-muraria* and *Asplenium trichomanes* that occur here only on walls and their natural habitat may have formerly existed on glacial erratics. A large part of this group are species of the

class *Isoëto-Nanojuncetea*, such as, *Elatine alsinastrum*, *Gnaphalium uliginosum*, *Gypsophila muralis*, *Limosella aquatica*, *Plantago intermedia*, or *Spergularia rubra*. For the last of them, an indygenat is difficult to determine in Poland, others are possible to locate in natural habitats, though, now, they mainly occur as weeds in cultivated fields or at the bottoms of drying ponds.

The second group includes species that occur in the Myślubórz Lakeland outside their home range in Poland. Here, we can find tree species introduced in forests and reproducing generatively: *Picea abies* and *Larix decidua* and formerly planted as ornamental plants, among others: *Galanthus nivalis*, *Ornithogallum umbellatum* or *Sambucus racemosa*. For some of them, their indygenat is difficult to determine in Poland. They include: *Berberoa incana*, *Aristolochia clematitidis*.

Molecular markers as a tool for studying plant invasions as exemplified by *Acer negundo* and *Padus serotina* case studies – plan of research project

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Invasive plant species are one of the major threats to biodiversity. It is due to the fact that they possess biological attributes (e.g. ability of effective reproduction, ability for massive spread on large areas) which

lead to displacement of native flora and disturbance of the functioning of ecosystems. Among more than 70 plant species classified as invasive in Poland, herbaceous plants, shrubs and trees can be distinguished.

Even though the number of invasive woody species is not significant, it is considered that they exert high pressure on native flora and can significantly disturb nutrient dependencies in ecosystems. Such examples in Poland are *Acer negundo* (Boxelder) and *Padus serotina* (Black cherry). Both trees have been deliberately brought to Poland from North America: Boxelder as an ornamental tree and Black cherry as a biocenotic addition and as windbreaks in forests.

The fact that *Acer negundo* and *Padus serotina* are long-lived species makes them perfect objects of observation of the invasion process. Important factors in determining the migration routes and pattern of distribution of invasive species are their genetic variation and biology. The main aim of the presented paper is discussing appropriate methodological assumptions which allow recognition of the course of invasion process for these species.

Genetic analyses with the use of AFLP (*Amplified Fragment Length Polymorphism*) will be conducted for this purpose. In the context of the invasion process, modeling by analyzing genetic diversity requires a number of aspects related to the selection of the ap-

propriate population for studying to be taken into account. One of them is age structure of the population. To verify how the genetic variety is trending within various age classes in selected populations of *A. negundo* and *P. serotina*, some samples of plants of various age (seedlings sampling, young trees [up to 50 cm] and mature trees [flowering]) will be collected and subjected to AFLP analysis. It should also be taken under consideration whether the studied populations are located in the vicinity of introduction place or on the edge of the local ranges in our country. Moreover, in our opinion, the planned research should also encompass populations from the native range and from the introduced range in other European countries.

Understanding of the invasion process of *Acer negundo* and *Padus serotina* is essential in the context of their appropriate management. The proposed model of research using the latest molecular techniques (such as AFLP) seems reasonable in determining the level of genetic diversity both in and between individuals and populations of *A. negundo* and *P. serotina*, including various components (differentiation in terms of age and origins of the population).

Ailanthus altissima (Mill.) Swingle in the National Nature Park “Podilski Tovtry” (Ukraine)

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Considerable invasion of *Ailanthus altissima* to plant vegetation of steppe grasslands and calcareous cliffs creates problems for their safety. These habitats are unique and dynamic ecosystems with complex disturbances that promote penetration of invasive plant species.

Ailanthus altissima is native to China and was first introduced in Europe in the middle of 18th century. As an ornamental plant, *A. altissima* was introduced in Kamyanets-Podilsky about one hundred years ago. During 1970-1984, 13 exotic trees of the species were reserved on regional level. Biological features of *A. altissima* contribute to its rapid capture of territory, as a plant propagated vegetatively and by seed, which is transferred by animals, people and transport.

Several habitats of the species are in a canyon of the Smotrych River within the town of Kamenets Podolsky. *A. altissima* colonizes limestone walls, where the vegetation is insignificant and transformed. Under the species canopy, *Artemisia absinthium* L., *A. marschalliana* Spreng., *Acinos arvensis* (Lam.), *Arctium lappa* L., *Ballota ruderalis* Sw., *Berteroa incana* (L.) DC., *Conium maculatum* L., *Chelidonium majus* L., *Phalacrologoma annuum* (L.) Dumort., and *Picris hieracioides* L. are found to grow.

Three populations of *A. altissima* were found in natural steppe habitats and two – on the slopes of Smotrich River. The largest area of the species growing was found on limestone-rocky shelves and screes near

the village of Zubrivka. On this site, next classes of plant communities are presented: *Sedo-Scleranthetea* Br. -Bl., 1935 (*Alyso-Sedetalia Moravec*, 1967, *Aurinio saxatilis-Allietum podolici* Onyschenko, 2001) and *Festuco-Brometea* Br.-Bl. et R. Tx. 1943 (*Cirsio-Brachypodium pinnati* Hadac et Klika 1944 em Krausch 1961 *Artemisio marschalliani-Elytrigion intermediae* Korotchenko, Didukh, 1997; *Festucenion valesiaca* Kolbek in Moravec et al. 1983 *Acini arvensis-Elytrigietum intermediae* (Kukovitsa et al. 1994) Kukovitsa in V. Solomaha, 1995; *Botriochloetum ischaemii* (Krist. 1937) I. Pop 1977). Here *A. altissima* changes the conditions for the existence of regionally rare species such as *Iris hungarica* Waldst. et Kit., *Allium podoli-*

cum (Aschers. et Graebn). *Blocki* ex Racib. and *Stipa capilata* L. (Red Data Book of Ukraine, 2009).

Near the village of Ustya, *A. altissima* occupies the association of *Salvia nemorosae-Festucetum valesiaca* Korotchenko et Didukh, 1997 (Cl. *Festuco-Brometea*) and its thickets have a negative impact on the population of *Salvia cremenecensis* Bess. (European Red List, 1991).

The third plot was discovered near Kitaigorod village. Here *A. altissima* extended to steppe slopes with *Botriochloetum ischaemii* (Krist. 1937) I. Pop 1977) where *Astragalus monspessulanus* L. and *Chamaecytisus albus* were also growing (Red Data Book of Ukraine, 2009).

The program of management and mechanical control of *A. altissima* was developed in NNP.

Synanthropization of dendroflora near the main roads in Białystok

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Dendroflora near roads undergoes continuous changes caused by modernisation of road network and development of urban infrastructure. In view of the above, an important problem is the proper choice of species composition and origin of trees and bushes planted along roads to ensure their best effectiveness as a biological barrier protecting against air pollution and noise.

The aim of the study was analysis of the species composition of dendroflora near the main roads in the city of Białystok taking into consideration their geographic and historical origin. The inventory was performed in the vegetation season of 2011 along four main roads in Białystok joining the national and voivodeship status routes. The species composition of dendroflora, the number of trees, their dendrometric features and geographic and historical origin were established. The dendroflora growing along the roads was also subjected to valorisation.

The inventory revealed presence of 837 individuals representing 36 species and 20 families. The most

abundant trees were those from the family Aceraceae (63.4%), while the most abundant bushes were those representing Rosaceae (86.3%). The contribution of native species (65.5%) was found to be about twice greater than that of alien ones (34.5%). The dominant among the native tree species was *Acer platanoides* L., while the dominant bush species was *Crataegus monogyna* Jacq. The foreign tree species were most abundantly represented by *Acer negundo* L., while bushes – by *Ligustrum vulgare* L. The trees and bushes spontaneously settled made a majority (59.9%) over those from plantations (40.1%). From among the native species of local origin, the dominant were synanthropic spontaneous species (51%), including *Acer platanoides* and *Tilia cordata* Mill. Anthropophytes were more abundantly represented by diaphytes (22.2%) than by kenophytes (12.3%). The most abundant from among diaphytes was *Ligustrum vulgare*, while among kenophytes – *Acer negundo*.

Current occurrence of *Scandix pecten-veneris* L. (Apiaceae) in the Małopolska Upland

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Scandix pecten-veneris L. is a rare archaeophyte in Poland and in others parts of Europe as well. The species was placed in the Polish “red book” as critically endangered (CR category), and also in the “red list” of all regions in Poland where it occurred. In the area of Gdańsk and Western Pomerania, Greater Poland (Wielkopolska) and Lower Silesia, it was found to be extinct (RE category). In Lublin region and Małopolska Upland, the species was included into the category of endangered (EN).

Scandix pecten-veneris is a plant of Mediterranean-Irano-Turanian origin. The partial northern and eastern limits of its secondary range are placed in Poland. The species was recorded mainly in southern parts of Poland - in the area of Uplands: Małopolska, Lublin and Śląsk-Kraków. However, the largest number of the Polish localities of the species comes from Małopolska Upland. Specimens are concentrated in the Nida Basin, limestone part of Świętokrzyskie Mountains and Przedbórz-Małoszycz Range.

Scandix pecten-veneris occurs on alkaline soils (mainly rendzinas) formed on limestone or rarely gyp-

sum and is one of the characteristic species for *Caucalido-Scandicetum* association.

Scandix pecten-veneris decreased as a result of modern agricultural methods (mainly herbicide treatments and seed screening). Vast majority of the localities of the species from Poland have not been confirmed recently and the populations observed after 1980s were small, usually consisting of several individuals.

All confirmed data on the occurrence of *Scandix pecten-veneris* in Małopolska Upland were collected. Each station was located in 2.5 km x 2.5 km ATPOL grid squares. Data on the new positions of species in the Świętokrzyskie Mountains were presented. Based on the available data, the distribution map of species in the region was prepared, making a distinction between historical and currently occurring localities. Information on abundance, habitat preferences and the threat at the localities was given. A proposal for the protection of these rare segetal archaeophyte will be listed.

Anthropogenic transformation of vascular flora of small town and adjacent areas

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Ćmielów is a small town located in a valley of the Kamienna river (Central Poland) surrounded by hills covered with forests. The beginnings of settlement

in the area of contemporary Ćmielów dates back to the Neolithic period, as evidenced by the development of agriculture and pottery. Currently, the valley of the

Kamienna River is, to a large extent, managed by man and the vegetation was taken into consideration.

The diversity of flora was characterized by both the presence of native synanthropic species and the anthropophytes established permanently. The archaeo-

phytes constituted a large group, which proved the introduction into these areas of alien species, so-called species “traveling” together with man and other species. Alien species introduced or imported by contemporary man for utility purposes were also found.

Occurrence of *Echinocystis lobata* in the Grabarski Canal valley (West Poland) and its phytosociological range

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Echinocystis lobata (F. Michx.) Torrey et A. Gray is a plant species currently classified as the most invasive in Europe (<http://www.europe-aliens.org>). The taxon was introduced to Europe from North America in the late 19th and early 20th century as an ornamental plant.

Echinocystis lobata, most strongly associated with water, is a component of vegetation of the *Artemisietea* class, under river wicker, rush communities and, recently, *Bidentetea* class which develops on exposed edges of water.

The studies on the occurrence of *Echinocystis lobata* were conducted in the Grabarski Canal valley, which is a tributary of the North Odra Canal (West Poland region). Location positions and phytosociological status were made based on relevés. Those records were carried out in 2012 and 2013 by Braun-Blanquet's method in modification of Barkman et al.. The Phi coefficient was calculated in Juice, which reflects the relation between species and vegetation units. In the study determination was shown for *Echinocystis lobata*.

Earlier field inspections from 2010, performed on the part of the watercourse, indicated presence of several

positions of wild cucumber. However, after years, the numbers increased with new additional positions. Currently, *Echinocystis lobata* was recorded in 36 plots. The highest constancy of the examined plant species was observed in *Phragmitetum australis* (Gams 1927) Schmale 1939, *Phalaridetum arundinaceae* (Koch 1926 n.n.) Libb. 1931, *Fraxino-Alnetum* W.Mat. 1952. Moreover, *Echinocystis lobata* was rarely noticed in *Salicetum pentandro-cinereae* (Almq. 1929) Pass. 1961, *Sambucetum nigrae* Oberd. 1973, *Urtico-Calystegietum sepium* Görs et TH.Müll. 1969, *Glycerietum maximae* Hueck 1931, *Ranunculo-Alopecuretum geniculati* R.Tx. 1937, *Poa pratensis-Festuca rubra* communities Fijałk. 1926.

Echinocystis lobata expanded its occurrence in the valley of the Grabarski Canal since 2010. All its positions were located near several small towns from which it probably escaped into the valley. *Echinocystis lobata* reached the highest fidelity to *Calystegia sepium*, *Phalaris arundinacea*, *Urtica dioica* as well as to *Sambucus nigra* and *Phragmites australis*.

Ambrosia artemisiifolia L. in the territory of National Natural Park “Oleshkivsky Sands”

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We studied the alien flora fraction of the National Natural Park “Oleshkivsky Sands” from 2008. As a result of our investigation, a preliminary list of alien species including 102 species of vascular plants from 84 genera belonging to 30 families was elaborated.

Ambrosia artemisiifolia L. was included in the Internal group of Quarantine List of Ukraine. It is one of invasive species which is actively distributing in the territory of the Park and incorporating in semi-natural habitats, e.g. meadow-steppe. Observations were carried out over 3 years. Standard methods of population ecology were used.

The highest population of *A. artemisiifolia* was found to grow on the plot “Burkut” and occupied the area of 94 m². It grew in lowland areas which were located along a country road. It did not appear in more xerothermic plots of the park. The area of spreading of *A. artemisiifolia* did not change on this plot for years of research. When precipitation increased during the growing period, *A. artemisiifolia* produced abundant above-ground mass. It is manifested most germination of seed.

It is proposed to apply the method of phytocoenotic destruction of *A. artemisiifolia* on the territory of the Park.

Large-scale *in vitro* propagation of *Pleurozium schreberi* (Willd. ex Brid.) Mitt. (Hylocomniaceae) for air pollution monitoring

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Growing concern about the level of air pollution has lead to an increased demand for biological materials which are used for air pollution monitoring. The aim of this study was to develop a method for vegetative multiplication of *Pleurozium schreberi* which is routinely used for air pollution monitoring.

The experiment consisted of three phases: (1) four different media constituents: Gamborg’s (B5), ½ B5, Murashige and Skoog basal, and Rudolph’s solution, *all* solidified with Bacto-Agar, with and without sucrose and with three growth regulators: indole 3-acetic acid (IAA), 6-benzyloaminopurine (BAP), and

gibberellic acid (GA_3) were tested. Three types of *Pleurozium* explants, i.e. shoot apices, branches, and longitudinal fragments of shoots were used; (2) based on the best result of the first phase of the experiment, the influence of genotype, vitamins, and specific concentration of phytohormones were investigated on the most suitable medium. In total, in the first two phases of experiment 2730 *Pleurozium* fragments were established and analyzed. (3) In the third phase, cell cultiva-

tion in a bioreactor was planned based on uninfected *Pleurozium* cells obtained from *in vitro* cultures.

Best results using *in vitro* organ culture method were obtained with the Rudolph's solution enriched with sugar and phytohormones. A method for producing a large-scale amount of *Pleurozium schreberi* using the organ culture method was established. This method allowed protection of natural stands of this moss. *In vitro* production costs were estimated.

Microevolution of intraspecific variation in flower color in *Corydalis cava* (L.) Schweigg. & Körte. (Fumariaceae): the role of frequency- and density- dependent selection

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Background: Floral polymorphism (corolla color) within species seems to be evolved for the purpose of attracting pollinators. If rare morph is preferred, this should promote floral dimorphism (negative-frequency dependent selection). However, only a few empirical studies have evaluated how morph frequencies and densities, and fitness parameters relate to one another in altered forest ecosystems through space and time.

Hypotheses: (1) Floral type in *Corydalis cava* (purple or white) preferred by pollinators is dependent on its frequency in a population (negative-frequency dependent selection, NFDS). (2) Absolute number of a particular morph per unit area is a factor responsible for pollinator choice (density-dependent selection, DDS); (3) Fitness of phenotypically intermediate hybrids is significantly lower in comparison with the "pure" morphs (Grant's model).

Specific questions: How reproductive success of morphs examined over space and time varies in relation to the morph's frequency and density? Are hybrids between pure color morphs commonly produced? Do they differ from the "pure" morphs in the level of reproductive success?

Methods: The study was carried out in 2013-2014 in two ecosystems in the Wielkopolska Region (Poland). In each ecosystem, three experimental plots (replications) (3 x 25 m²) were established. To determine if NFDS

and DDS were operating, white and purple morphs of *Corydalis cava* (3425 individuals), were analyzed. We focused on morph rates and morph densities. Morph fitness was measured as the number and weight of seeds. These data were studied in space – per site/replication, and time (two years) using a factorial MANOVA and linear regression analysis. Moreover, phenotypically intermediate hybrids (11) between "pure" morphs were evaluated in terms of their fitness by Student's t-test.

Results: (1) Both analyzed populations increased noticeably in number of individuals over two years, but specific morph ratio was maintained within a given population; (2) significant effects of the site, replication and the interaction (site x replication) on reproductive effort of morphs were demonstrated; (3) reproductive success of morphs did not depend on their frequency and density; (4) the existence of fertile (but rare) phenotypically intermediate hybrids between "pure" morphs was noted. Their reproductive success was significantly lower in comparison with the "pure" morphs.

Conclusions: Morph frequencies in *Corydalis cava* varied spatially but not temporally; this may indicate local adaptation. There was no evidence that floral type in *Corydalis cava* depended on its frequency and density in a population. It is necessary to explain, whether population rise is a symptom of population periodic fluctuations, or better conditions in a given year.

The influence of different habitat conditions in the Ojców National Park (Southern Poland) on selected physiological processes of *Impatiens parviflora* DC

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Small Balsam (*Impatiens parviflora* DC.) originates from the mountains of Central Asia. In Poland, the first specimens were noted in the mid-nineteenth century in the vicinity of Gdańsk. Currently, the species is common throughout the country, with the exception of the north-east, where it occurs in isolation. In the Ojców National Park this species was first recorded in years 1960-1965, at two sites. At present, it occurs commonly in forest and synanthropic communities of the Park. Expansiveness of this species is associated with the ability to produce large number of seeds which are transported e.g. by flood waters, mammalian hair or clothing of people visiting the Park. The aim of the study was to investigate the activity of selected physiological processes of *I. parviflora* in different habitat conditions of the Ojców National Park.

Three different habitat plots (areas) were selected for the study: (1) riparian riverside *Alno-Ulmion*, (2) lime-hornbeam forest fertile sub-association *Tilio-Carpinetum stachyetosum* at the foot of the slope, (3) lime-hornbeam forest typical sub-association *Tilio-Carpinetum typicum* on a slope. Experimental specimens of *I. parviflora* were collected (10 from each area) and measurements of light intensity and soil pH were carried out on the study plots. Additionally, the plots were characterized by phytosociological pictures. Differences between the designated plots in the intensity of light and soil pH values were determined on the basis

of analyzes. The highest intensity of light was observed on the area (2) and the lowest on the area (3). Soil pH fluctuated from 6 (area 3) to 8.5 (area 1). Statistically relevant differences were observed in the length of the aerial parts of *I. parviflora* specimens collected in the particular study areas. The longest shoots were observed among specimens growing in riparian riverside, and the shortest in lime-hornbeam forest typical sub-association. The water content in underground organs was highest among the specimens found in area (1) and lowest in area (3). In the case of the above-ground organs, the highest values of water content were recorded among plants growing in plot (3) and lowest in plot (2).

Measurements of flow of electrolytes by cell membranes of the investigated aerial and underground organs of *I. parviflora* showed significant differences, particularly apparent in leaves. The largest percentage outflow of electrolytes was observed among the specimens from the plot (2) and the smallest from the plot (1). Designation of chlorophyll content showed the lowest values in plants occurring on the plot (2) with the most intense light. Moreover, imaging of chlorophyll *a* fluorescence of leaves showed significant differences in the functioning of photosystem PSII of plants growing in lime-hornbeam forest fertile sub-association (2) compared to specimens from the two remaining plots.

Distribution and habitat preferences of selected newer kenophytes in Poland

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The natural barriers of expansion of kenophytes are overcome by globalization and human influence, therefore their number in the flora of Poland is constantly increasing. At the moment, in Poland, about 15% of the whole flora are vascular plants. Especially interesting is the occurrence of some newest arrivals, which were found in the area of Poland during recent years. Specific of their habitats, make possibilities to migration their diaspores, establishing in new places and in consequence spreading, and sometimes expan-

sion or rarely invasion. In Poland, these problems are related with e.g.: *Macroscadium alatum*, *Euphorbia taurinensis*, *Scirpus georgianus*, *Cardamine chelidonia*, *Viola suavis* and several other species established in semi-natural or natural plant communities. Detailed studies require their distribution, migration, dynamic of population, level of establishing and share in plant communities. The results of such studies could be in future very important from the point of view of phytogeography and nature conservation.

Alien plants in riparian habitats of artificial ox-bow lakes within urbanized areas of Opole during 13 years of succession

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The frequent occurrence and effective spread of alien plants along river corridors is a well-known phenomenon in Central Europe. Since the beginning of the 20th century, several invasive species were recorded in Silesia. The most frequent included: *Acer negundo*, *Impatiens glandulifera*, *Echinocystis lobata*, *Solidago gigantea*, *Aster lanceolatus* and *Acorus cala-*

mus. The abundant presence of alien plants in river valleys poses a considerable threat to native flora and vegetation of river side habitats. That is why, the aim of the present study was to determine the occurrence and abundance of alien invasive plant species in three artificially created ox-bow lakes of different size within the Odra River valley in urbanized areas in the city

of Opole (Poland). A detailed monitoring in 13 plots for each lake was started in 2001. Plots were located in different types of vegetation developing in the created habitats: rush zone, open water and in wet, inundated surroundings with *Bidentetea tripartiti* vegetation. After 13 years of observation, we recorded 18 kenophytes and 20 archaeophytes within the monitored plots. Kenophytes: *Acer negundo*, *Amaranthus albus*, *A. retroflexus*, *Aster lanceolatus*, *Bidens frondosa*, *Bunias orientalis*, *Chamomilla suaveolens*, *Conyza canadensis*, *Echinocystis lobata*, *Elodea canadensis*, *Erigeron annuus*, *Galinsoga parviflora*, *Robinia pseudoacacia*, *Senecio vernalis*, *Sisymbrium loeselii*, *Solidago canadensis*, *S. graminifolia*, *Veronica persica*. Archaeophytes: *Anagallis arvensis*, *Apera spica-venti*, *Atriplex nitens*, *Capsella bursa-pastoris*, *Carduus acanthoides*, *Cichorium intybus*, *Digitaria sanguinalis*, *Echinochloa crus-*

galli, *Erysimum cheiranthoides*, *Euphorbia helioscopia*, *Fallopia convolvulus*, *Lactuca serriola*, *Matricaria maritima* subsp. *inodora*, *Melandrium album*, *Papaver rhoeas*, *Scleranthus annuus*, *Setaria pumila*, *Sonchus arvensis*, *Vicia hirsuta*, *V. tetrasperma*, *V. villosa* and *Viola arvensis*. However, none of the above-mentioned species dominated a plot or the whole lake. Within a short period after bare-ground stage, aliens achieved the highest abundance. In 2002-2003, kenophytes showed the average cover per plot of approx. 2.2% and archaeophytes – of approx. 1%. Starting in 2004, the total cover of alien plants decreased permanently, achieving the negligible values in 2013 (ca. 0.02% per plot). This was mainly due to strong competitiveness of native plants, especially *Phragmites australis*, *Potamogeton natans* and *Glyceria maxima* which exhibited the highest cover rates.

Centaurea nigra L. in Poland – the occurrence and status

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Centaurea nigra is a perennial herb with rough shoots, growing up to 20-70 cm in height. Typically, its anthodia are formed individually, at the ends of shoots. Involucres of capitula have a nearly spherical shape. Appendages of involucral bracts are of round shape, black or blackish-brown, and regularly pectinate-fimbriate. The florets are all tubular, which is its fairly distinguishing feature. Typically, achenes have short pappus, about 1 mm.

Taxonomic studies emphasize its internal variability and its ability to hybridize with related species. The native range of this species covers mainly Western Europe. However, it is also recorded beyond this range. In many other parts of Europe and even North America it is an element of adventive floras. Beyond its native range, it is recognized as an established species and even considered to be invasive.

In Poland, according to the “*Flowering Plants and Pteridophytes of Poland*”, it is classified as a non-established alien plant species (an ephemero-phyte). In our country, its localities were recorded as early as in the second half of the nineteenth century, especially

in Pomerania and Silesia. It was probably brought to Pomerania by sea as a ballast plant, which was evidenced by herbarium materials deposited in the Herbarium of the Institute of Biology and Environmental Protection of the University of Nicolaus Copernicus in Toruń. At the same time, it colonized mainly ruderal habitats, where it was recorded. There is no contemporary data on the occurrence of this species in Poland. One of the reasons for this might be a decline of localities; however, it may also stem from misidentifications of the species. During the field studies in Pomerania in 2012, a massive occurrence of species of the *Centaurea* genus was recorded. Following comparative analysis, it was finally determined as *Centaurea nigra*. This locality, situated near the village of Karwieńskie Błota, south of Karwia, is relatively far from the localities recorded in Gdańsk in the nineteenth century. *Centaurea nigra* occurs there in the area of partially used hay meadows, at peripheries of dirt roads and on the slopes of draining canals. It is a dominant element in the meadow communities in which it grows. Most typically, it is accompanied by the following species:

Lysimachia vulgaris, *Molinia caerulea*, *Holcus lanatus*, *Vicia cracca*, *Lythrum salicaria*, *Angelica sylvestris*, *Heracleum sphondylium* and *Potentilla erecta*. However, this locality is endangered due to changes in the tendencies of spatial planning, from agricultural to residential area. Lowering groundwater level and abandon-

ing the meadows result in evident negative changes in the composition of these communities. Therefore, an urgent need for detailed studies of the recorded population exists as well as for further field exploration aimed at confirming other localities reported in Pomerania.

Relict species of Ophioglossaceae in Wielkopolska: resources, causes of withdrawal and protection

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Psilotopsida is an old group of plants which is made up of two families: Psilotaceae and Ophioglossaceae. In Poland, only representatives of the latter group (8 species) can be observed to occur. All of them are threatened with extinction and are under species protection. Only four species: *Ophioglossum vulgatum*, *Botrychium lunaria*, *B. matricariifolium* and *B. multifidum* can be found in the contemporary flora of Wielkopolska (the fifth one – *B. simplex* is considered as extinct). The aim of our studies was to show current Ophioglossaceae resources in Wielkopolska, causes of their disappearance and possibilities of protection. The authors based their studies on literature data as well as on their own observations (description of 3 selected species on permanent plots: *Ophioglossum vulgatum*, *Botrychium lunaria* and *B. matricariifolium*).

The most frequent Ophioglossaceae species in Wielkopolska is *Ophioglossum vulgatum* (about 150 localities). The number of specimens in populations ranges from a dozen to several thousand. It settles, primarily, moist meadows, less frequently riparian forests. *Botrychium lunaria* is a less frequent species with only 53 sites observed in Wielkopolska so far,

of which only 12 sites were reported after 1951. The number of specimens in populations does not exceed several dozen and undergoes considerable fluctuations every year. Its site spectrum comprises riparian forests, xerothermic swards and moist meadows. From among the reported 35 *Botrychium matricariifolium* sites, only 9 were reported recently. Populations of this species are characterised by large fluctuations of specimens ranging from 1 to several hundred. In Wielkopolska, it grows mainly in forests. *Botrychium multifidum* is the rarest species in Wielkopolska with only one site here situated in the area of Kępno on which from 1 to 4 specimens are found (it was not observed on the remaining 10 sites for years).

Majority of *Ophioglossum vulgatum* and *Botrychium lunaria* populations can be found in meadow ecosystems, so for them the worst threat is intensive utilisation, e.g. early cutting prior to sporulation, application of artificial fertilisers, herbicides as well as natural succession. For these species, cutting at the end of August when they finish their vegetation season would be most appropriate. Maintenance of the appropriate water regime is also very important

Participation of *Phalacrolooma annuum* (L.) Dumort. in different biotope types of Pokutsko-Medobory Geobotanical district (Ukraine)

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On the territory of Pokutsko-Medobory Geobotanical district, expansion of *Phalacrolooma annuum* (L.) Dumort., the North American species is observed. The species is a transformer and characterized by high vitality, speed of propagation and degree of naturalization, wide ecological amplitude and stress tolerance. The species *Ph. annuum* grows in secondary anthropogenically transformed ecotopes and incorporates into semi-natural and natural ecotopes in the region. The aggressiveness in colonization and transformation of new habitats using the resources of the new environment, inaccessible for native species are characteristic for the species.

The analysis of participation of *Ph. annuum* in natural and anthropogenic biotopes of the Pokutsko-Medobory geobotanical district was carried out. The species was often observed in the man-made habitats of type I: agrobiotopes with intensive cultivation, habitats that formed in deforested areas, herbaceous ruderal habitats, artificial habitats of trees and shrubs and ornamental artificial grass groupings. In addition, it was found in the grass-herbaceous meso- and xerotic habitats of type E with the prevalence of hemikryptophytes, which are formed in moderate or low moisture meadows, steppes, wastelands (*Molinio-Arrhenatheretea*, *Nardetalia*) and meadow-steppe habitats (*Festuco-Brometea*), and also in the habitats of type F, formed by chamaephytes and nanophanerophytes.

In wetland grassy habitats of type D the species occurred in coastal water groups, formed under sufficient irrigation conditions on muddy and sandy sediments (*Phragmito-Magnocaricetea*) with sharply varying moisture and on wetland groups – in continuous hydration on peatlands and mires.

We often observed plants of *Ph. annuum* in open forest clearings and forest edges in the habitats of phanerophytes type G: deciduous forests and shrubs (*Quercu-Fagetea*, *Quercetea robori-petraea*), shrubby habitats (*Rhamno-Prunetea*). They occurred less commonly in habitats of type H, the development of which is caused by geomorphological and accumulative processes: habitats on acidic silicate rocks exposures, habitats of alkali carbonate outcrops (*Alyso-Sedetalia*), habitats on accumulated sand sediments composed by xeromorphic succulent terophytes on saline soils, solonchaks, solonchaks.

It was established that plants of *Ph. annuum*, which are connected to the anthropogenic habitats, had the greatest variability of morphological features (plant height, pubescence of vegetative organs, quantity, color and diameter of flowers in the inflorescence, shape and size of leaves) and increasing of their quantitative parameters.

The cover of *Atriplex tatarica* on road margins in Warsaw: the importance of habitat conditions and interspecific relationships

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Atriplex tatarica L. is a C4 plant with the bundle sheet cells in leaves. It is also a facultative halophyte with secreting glandular trichomes on the leaf epidermis. The occurrence frequency of this Irano-Turanian species has increased in Warsaw over the last few decades.

The *A. tatarica* distribution along roads is strongly patchy. Moreover, with an increasing distance from the road and decreasing salinity, the cover of *A. tatarica* decreases, whereas of other plants increases. Regardless of a distance and actual salinity, the cover of other plants is always lower in the presence of *A. tatarica*, which suggests the competitive interactions between *A. tatarica* and other plants.

The aim of this study was to determine relative importance of habitat conditions, such as microtopography and mechanical disturbance (brushing by road cleaning vehicles), and of interspecific relationships with species of different photosynthetic pathways (C3/C4) and with halophytic/glycophytic (H/G) adaptations, for the *A. tatarica* cover inside and outside dense *A. tatarica* patches.

There were settled 300 of 0.5x0.5m sampling plots (SP) in 20 groups along 4- and 6-lane roads in the 6 districts of Warsaw. Each group consisted of 3 transects of 3 SPs inside dense *A. tatarica* patches, and 2 control transects in the closest patches with the low *A. tatarica* cover. There were assessed: for each plot – % cover of *A. tatarica* and other species, % bare area (BA), % area disturbed by brushing (BR), a distance to the road (DR) and a type of vertical profile (VP), for each

transect – maximum relative elevation, and for each group – exposition (EXP), lawn width and a number of lanes. The C3/C4 strategy and the H/G status of species were assigned according to literature. Significant determinants (SiD) of *A. tatarica* cover were selected by R Boruta analysis. The importance of variables was assessed by R Random Forest (RF) models with partial dependence plots showing species response to variables.

Altogether, there were 31 species included. *A. tatarica*. Among them 4 were C4 and 27 – C3, 11 – H and 20 – G species. SiD of the *A. tatarica* cover were: SP group, SP transect, BR, BA, VP, EXP, DR and the cover of *Taraxacum officinale*, *Elymus repens*, *Digitaria sanguinalis* (DS), *Plantago maior*, *Festuca rubra* and *Lolium perenne*. The variance of the *A. tatarica* cover was explained in 78%. Habitat conditions were much more important (40% of the importance sum) than interspecific relationships (25%). The *A. tatarica* cover increased by 12% when BR was above zero, decreased by 10% with a growing DR, was 5% higher on the flat SPs. The *A. tatarica* cover was up to 5% lower in the presence of all significant species except for DS, with which the *A. tatarica* cover was 3% higher. The restricting plants were the C3 and H species, while DS was the only C4 and G plant.

We conclude that *A. tatarica* as the C4 halophyte is able to maintain fast plastic growth during hot and dry summer weather. This might give it an unique advantage over the C3 halophytes, either through direct competition for resources or through higher ability to regenerate after mechanical disturbances.

Assessment of the distribution of alien plant species across the habitats of the Ukrainian forest steppe

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In order to assess the level of anthropogenic transformation of the vegetation cover of the nature protected areas located within the Ukrainian forest steppe ($n = 13$), we analyzed the distribution of alien species in natural and anthropogenic habitats. Almost all recorded species (356 out of total 367) were represented in habitats shaped by human activity (type I). Alien species which did not develop an ecological niche in this type of habitat were mainly stenotopic, hygromesophytes or mesophytes, and occurred in continental water habitats (type C) or/and wet habitats of grassy type (D): *Zizania latifolia*, *Acorus calamus*, *Pistia stratiotes*, *Elodea canadensis*, and *Elodea nuttallii*. A high number of exotic species (127) were recorded in habitats dominated by phanerophytes (type G) which included deciduous and coniferous woodlands as well as shrublands of *Rhamno-Prunetea* class. The last one served as a buffer on the one side and as a hot spot of non-natives on the other. Almost the same number of species (121) was found in grassland habitats (grasslands, steppes and wasteland – type E). The high capacity of this type of habitats in terms of species richness was caused by the huge number of potential ecological niches as a result of the complex structure

and, also, by the proximity of transportation networks and watercourses. Similarly, habitats of type D harbored 71 alien plant species. Biotopes of type F (chamaephytes and nanophanerophytes) and type H (whose development was caused by geomorphologic and accumulative processes), though represented in all the studied sites, often had a very narrow ecological amplitude and occupied small areas, making it difficult for alien species to spread. For this reason, only non-natives with specific edaphic affinity and ubiquitous were recorded: in type F – 65 and in type H – 49 species.

About a third of species (123) were recorded across at least three habitat types; such species may be considered eurytopic in their secondary ranges. Most widespread species were: *Fallopia convolvulus*, *Vicia angustifolia*, *Ambrosia artemisiifolia*, *Conyza canadensis*, *Phalacrolooma annuum*, and *Setaria viridis*. At the same time, there was not a single species which would occur in all habitat types. Recapitulating, agricultural lands and ruderal biotopes were highly invaded; three times fewer alien plant species occurred in woodlands, shrublands, grasslands, and wasteland; and only small number of non-native species were restricted to continental water habitats.

Mechanisms of filamentous green algae domination in water ecosystems of the Wielkopolska region

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Filamentous green algae (FGA) are a very diverse group of macroscopic algae. Mechanisms of FGA dominance are based on algal succession changes throughout the year. This natural succession of algae occurs in response to changes in biotic and abiotic factors. Macroscopic green algae populations are abundant in eutrophic waters forming mats when available light and nutrients are high. Some algal taxa can coexist in one ecosystem, although, *Cladophora glomerata* is always predominant among FGA. However, it was often observed for *Cladophora rivularis* that is filaments woven into the species of *Oedogonium*. The observed species from the *Oedogonium* genera in the Wielkopolska region preferred highly alkaline (pH about 8-9) and saline ($>100 \text{ mg}\cdot\text{l}^{-1} \text{ Cl}^-$) water. Moreover, *Tribonema* and *Ulothrix* were observed first in early spring in shallow water only for two weeks period. Studies were carried out at Lake Zbąszyńskie, the mid-field pond in Konojad

village and the Mogilnica river. A massive development of filamentous algae corresponds to eutrophic water qualities. Among the studied water ecosystems, the highest values of nutrient elements ($1.09 \text{ mg}\cdot\text{l}^{-1} \text{ N-NO}_3^-$, $1.18 \text{ mg}\cdot\text{l}^{-1} \text{ N-NH}_4^+$, $0.85 \text{ mg}\cdot\text{l}^{-1} \text{ P-PO}_4^{3-}$) were recorded in the Mogilnica river. In all examined sites water was alkaline, with the highest value (pH 8.81) in Lake Zbąszyńskie, whereas the highest salinity values were observed in the Konojad pond ($111.97 \text{ Cl}^- \text{ mg}\cdot\text{l}^{-1}$). The value of the electrolytic conductivity fluctuated from $372 \mu\text{S}\cdot\text{cm}^{-1}$ in the artificial pond to $1045 \mu\text{S}\cdot\text{cm}^{-1}$ in the natural pond.

In conclusion, the present study demonstrated that FGA, in particular, *Cladophora glomerata*, are widespread in the Wielkopolska region. The growth of their populations is associated significantly with water fertility and more often occurs in the summer-autumn period.

Post iron-ore mining sites – refugia of native forest species in the northern periphery of the Świętokrzyskie Mountains

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The main aim is to present remnants of old iron-ore mining practices as refuges of native forest species in the northern periphery of the Świętokrzyskie Mountains.

Study area. The investigated area includes mining fields located on two mesoregions: Suchedniowski Plateau and Gielniowski Hummock (Małopolska Upland sub-province). These territories are situated in the bor-

ders of the former Old Polish Industrial Region (OPIR) – the largest (till the end of the 19th century) mining and smelting region in Poland. Among all mining activities, the extraction of iron ores deserves special attention, because it was very intensive and lasted for the longest time, especially in the northern periphery of the OPIR (including area under study). In the borders of the OPIR, there are a lot of habitats transformed by former iron-ore mining – so-called ‘gob piles’ – small heaps built by material brought to surface from deeper rock layers. Aggregations of these remnants create larger old mining fields.

In years 2012-2013, in four old mining fields 50 permanent study plots (each of them covering 100 m²) were established (25 on gob piles and – for the purpose of comparison – 25 in areas non-transformed by old iron-ore mining activities, in the immediate surroundings of heaps). In all plots, floristic lists of vascular plants species were made.

Because of forest management, only herbal species grow in research communities spontaneously. In the herb layer, within the plots of communities growing on the gob piles, a considerable increase in the number

of native forest species was noted (in comparison with plots of communities developing in their surroundings). This increase was caused chiefly by the increased proportion of species characteristic for the syntaxa from the *Querc-Fagetea* class. It is important that most of them were recognized as species distinguishing ancient woodlands. These species were almost exclusively attached to the communities developing in gob piles (their limits were marked by the material extracted and scattered around in ancient times). Despite the long distance of old mining fields (about 50 kilometers), in every plot set on gob piles, there was prevalence of species which slowly colonized new habitats (myrmecochores and endozoochors). Moreover, at present, these species should be regarded as specific bioindicators of habitats transformed by old iron-ore mining practices.

Forest communities growing on post iron-ore sites are remnants of ancient woodlands and presently comprise refugia for genetic resources of native forest species in the northern periphery of the Świętokrzyskie Mountains.

Preliminary results of studies on the distribution of invasive alien species of vascular plants in NW Poland (resources of Western Pomeranian Atlas of Distribution of Vascular Plants and Fungi ZARRiG)

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Pomerania is a region with unique features and is of great importance for studies on diversity among plants. It is a very important area in Europe with respect to phytogeography, where limits of the home ranges of many taxa come together. It is also an area relatively well preserved with respect to the natural environment – sea coast and areas rich in early post-glacial landscape types, numerous wetlands, peat-lands, large forest complexes, lake and river ecosystems, including that

of the Odra River – one of the biggest rivers in Central Europe. Floristic data had been collected in this area for over 150 years, first by German naturalists and then, after 1945, by Polish ones. Unfortunately, these data have not been synthesised so far. In 2006, work started on a web-based Western Pomeranian Atlas of Distribution of Vascular Plants and Fungi (ZARRiG), the objective of which was to supplement and summarise the knowledge on floristic resources of North-Western

Poland on the basis of historical and modern data, with the basic cartogram unit adopted to be a 2.5 x 2.5 square km. As a preliminary result of this research, distribution maps of several dozens of invasive alien plant species in Central Europe were presented: *Acer negundo*, *Anthoxanthum aristatum*, *Aster novii-belgii*, *Bidens frondosa*, *Bromus carinatus*, *Bunias orientalis*, *Clematis vitalba*, *Echinochloa crus-gali*, *Echinocystis lobata*, *Elodea canadensis*, *Epilobium ciliatum*, *Erigeron annuus*, *Helianthus tuberosus*, *Heracleum mantegazzianum*, *H. sosnowskyi*, *Hordeum murinum*, *Impatiens glandulifera*, *I. parviflora*, *Juglans regia*, *Juncus tenuis*, *Lupinus polyphyllus*, *Lycium barbatum*, *Padus serotina*, *Reynoutria sachalinensis*, *R. japonica*, *Robinia pseudoacacia*, *Rosa rugosa*, *Rudbeckia laciniata*, *Setaria pumila*, *S. viridis*, *Solidago canadensis*,

S. gigantea, *Spiraea tomentosa*, *Vicia grandiflora*, *Xanthium albinum*. Distribution of respective taxa was presented against the extent of floristic exploration of this area. When analysing these results, the fact that only some of its parts (e.g. Myślubórz Lakeland, southern part of Nowogard Plain) were systematically examined in recent years (mapped vascular plant flora) should be taken into account. Therefore, the presented maps illustrate only approximately the real density of the presence of invasive species in NW Poland. The authors also refer to the presence of invasive species on the Szczecin seacoast reported from Germany (e.g. *Lactuca tatarica*) as well as to the resources of other problematic species in the examined area in Southern Poland (e.g. *Ailanthus altissima*, *Ambrosia artemisiifolia*). The research work will continue.

Retreat of *Euphrasia* species in the past 15 years

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Research on the *Euphrasia* genus has been carried out in Poland since 2001. The current research comprises: the taxonomic revision, revision of the available herbarium collections and field work, including annual monitoring of rare species. The most common species from this genus are: *Euphrasia rostkoviana* and *E. stricta*. So far, these species have been commonly found in meadows, lawns, roadsides, field verges and often in ruderal and fallow land locations. As hemi-parasites, eyebrights obtain from the host plant water and minerals. In certain conditions, they can survive independently, feed on each other or rely on one or even on a few host species simultaneously. Host availability directly determines sprouting, growth, flowering and seed setting.

It was observed over the past few years that there was a decrease in the occurrence of *Euphrasia* in meadow communities and road verges. The populations, if at all, were most commonly found in woodland habitats. At the same time, overseeding of meadows, paddocks, agricultural fallow land, landscape areas and road verges with widely available ready-made seed mixes became an increasingly popular practice. There is a large selection

of these seed mixes, ranging from general purpose mixtures to highly specialized products used, for example, in highway landscaping, in public landscapes on low nutrient urban soils, on road verges, slopes, woodlands and along water courses as well as for grasslands and flower meadows. There are various treatments that seeds in these mixtures receive, for example, treatments with insecticides, fungicides or with growth stimulants.

The analysis of the species composition in a few locations of the artificially seeded plant communities revealed common presence of possible host species, for example: *Trifolium repens*, *Medicago lupulina*, *Poa pratensis* and *Plantago lanceolata*. However, no eyebrights were found in these locations. The influence of chemical substances used for seed treatment of artificial mixes on the *Euphrasia* species is not known. It is possible that these could potentially inhibit *Euphrasia* ability to penetrate the host plant or affect the ability to produce haustoria. Another possible cause can be the ability to form strong mat roots by grass species used commonly in highway landscaping seed mixtures. They have a very effective, dense root system that can form a solid, impenetrable

mat which could be a barrier for eyebrights and other species. The actual reason for the decreased quantity of *Euphrasia* in Poland is currently not known. Further

research is planned which will include comparable trials of eyebrights cultivated with host plants obtained from seed mixtures and from the wild.

The state of exploration of plant cover in settlements – literature overview

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The study was focused on the level of exploration of plant cover in the settlements, taking into account: geographic situation, type of settlement, subject, period and methods of studies. The analysis covered 410 published papers and as result the information on the

state of knowledge on flora and vegetation of towns and villages in the different regions of Poland was obtained. These data were compared to information concerning other European countries.

Reproductive success *Epipactis helleborine* (L.) Crantz (Orchidaceae, Neottieae) on the anthropogenic habitats

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The process of apophytism or spreading native species to human-made habitats is one of the main elements in the creation of plant cover on anthropogenic areas. Recently, an increase of anthropogenic localities with valuable flora (rare and legally protected species) has been observed. Apophytes are also members of the Orchidaceae family, especially from the *Epipactis* genus.

Specifically, our question was whether the anthropogenic habitats significantly modify the reproductive success of *E. helleborine*. Long term monitoring has been

carried out on several populations of *E. helleborine* throughout Poland. Eight populations of *E. helleborine* were chosen to represent (i) 4 populations from the natural habitats and (ii) 4 populations from the anthropogenic habitats. At each site, the tagged *E. helleborine* plants (up to 30 flowering plants to populations) were monitored on a regular basis throughout the flowering season in 2012 and 2013, recording number of flowering shoots, juvenile shoots, number of flowers and number of capsules. Populations from the anthropogenic habitats

differed significantly in terms of reproductive success from the natural populations. Number of flowers (114 anthropogenic populations /166 natural populations) and fruit (102 anthropogenic populations /121 natural populations) were lower in the case of the anthropo-

genic populations but numbers of juvenile shoots were lower in the natural populations (96 natural populations /264 anthropogenic populations). This might suggest the dominance of vegetative propagation.

Synanthropic flora of ecological margins in the area subjected to strong anthropopressure as exemplified by Dopiewo neighbourhood (Poznań district)

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Dopiewo is a village of about 3000 inhabitants belonging to Poznań agglomeration situated at the distance of approximately 20 km from the city centre. For many years, Dopiewo commune was focused on agriculture. However, rapid transformations taking place in Poznań neighbourhood triggered off changes in methods of management. The farming landscape of Dopiewo surroundings full of lakes and forests has recently been undergoing intensive expansion involving non-agricultural forms of economic activity. This is evident, among others, in the development of many new houses as well as communication routes. A new A2 motorway opened ten years ago also cuts across this commune. In this rapidly changing landscape, many so called ecological margins can be found and others are in the course of development.

This study deals with the flora of vascular plants found along roadsides and in roadside ditches. The performed experiments comprised 50 m long transects

established in ecological margins of various landscape types: forest (3 transects), farming (3) and urban (9). Floristic lists indicating species resources were elaborated for all examined surfaces. Studies were conducted in July and August 2014. The collected materials were subjected to statistical analysis employing, among others, indices of floristic similarity

In all, over 150 plant species deriving from 40 families were recorded on the examined transects. Species from Asteraceae, Poaceae and Fabaceae families were represented most abundantly. Native species (almost 70%) with a considerable share of archeophytes (about 20%) were dominant in the geographic-historical spectrum. From among kenophytes, *Conyza canadensis*, *Echinops sphaerocephalus*, *Medicago × varia*, *Oxalis fontana* deserved attention among herbaceous plants and *Quercus rubra* and *Robinia pseudoacacia* in woody plants.

Anthropopression in the Scots pine forest landscape of the Notecka Forest – both sides of the story

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Investigation of the dynamics and structure of vascular flora of the Notecka Forest was conducted in the years 2005-2011. During field research, 765 species of vascular plants were found in the examined area. The area under study was dominated by Scots pine forests which displayed a wide range of anthropogenic transformations. A compact forest complex was intersected by numerous, varied, mostly man-made elements of the linear system. Their presence indicated a strong influence on the presence and distribution of many rare, threatened as well as alien, invasive and nonforest vascular plant species. The first group of species mentioned above, connected with forest roadsides, includes, e.g.: *Arctostaphylos uva-ursi* (L.) Spreng., *Lycopodium clavatum* L., *Epipactis atrorubens* (Hoffm.) Besser and

Pulsatilla pratensis (L.) Mill.; the second – *Conyza canadensis* (L.) Cronquist, *Echinochloa crus-galli* (L.) P. Beauv. and *Robinia pseudoacacia* L.

Apart from the changes at the level of flora, we also observed some significant antropoghenic shifts at the vegetation and landscape level in the Notecka Forest – degeneration of former natural or seminatural forest communities, formation of new communities and ecotonal zones and fragmentation of the compact Scots pine forest complex.

The aim of this work is to answer the question: are we able to talk not only about negative but also a positive role of antropophression in man-made Scots pine forests?

The association *Veronico-Mimuletum guttati* Niemann 1965 in Pomerania

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The spread of *Mimulus guttatus* in Europe started in the 19th century). In Poland, the first report dates from 1824 (Kowary) in the Sudety Mts. . This is, at the same time, the oldest registered date of the occurrence of this species in Europe. At the same period it was recorded in

Pomerania, it was seen in 1874 in Koszalin. The history of dispersion of this species was investigated by Piękoś (1972) who recorded the occurrence of this species at 112 stations. Nowadays, it is present most often in Lower Silesia and Pomerania. To date, it was recorded

in 326 station in 128 ATPOL squares. Monkey-flower is one of the species that uses banks of rivers, streams and lakes and is found along ditches, rarely in pastures and ruderal habitats.

Field studies were carried out during the vegetative seasons of 2005-2012 in Central Pomerania which is the area between the river Łeba to the east and the river Parsęta to the west. It is the eastern part of Western Pomerania. Phytocoenoses where the species was found were subjected to phytosociological analysis by taking phytosociological relevés of the patches where it was growing, using Braun-Blanquet's method. *Mimulus guttatus* is a characteristic species of the *Sparganio-Glycerietum fluitantis* association. The *Veronico beccabungae-Mimuletum guttati* association was described for the first time for Poland from the Sudety Zachodnie.

Basing on 38 phytosociological relevés, *Veronico-Mimuletum guttati* association from the *Sparganio-Glycerietum fluitantis* alliance was distinguished. It is inside differentiated into two variants: a) spring variant noted in spring areas, b) typicum variant noted along banks of river, ditches and water-logged meadows. The spring variant is florally poor (26 taxa) with dominating characteristic species: *Mimulus guttatus* and *Cardamine amara*. Typicum variant is florally rich (72 taxa). This variant occupies ditches and banks of streams. It is characterized by species composition from *Artemisieta* (e.g. *Galeopsis speciosa*, *Urtica dioica*), *Bidentetea tripartiti* (e.g. *Bidens tripartita*, *Polygonum hydropiper*) and *Isoëto-Nanojuncetea* (e.g. *Gnaphalium uliginosum*, *Juncus bufonius*) classes.

Synanthropization of the flora and vegetation of the National Nature Park “Skolivski Beskydy” (Ukrainian Carpathians)

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The results of field research of synanthropic vegetation and flora in the territory of the national nature park (NNP) “Skolivski Beskydy” performed in the 2003-2008 are presented. A total of about 58 relevés were carried out in the synanthropic habitats within the borders of NNP. The obtained materials were analyzed using JUICE software. A detailed vegetation survey of the NNP “Skolivski Beskydy” prepared with the contribution of the authors was published recently, but synanthropic vegetation was mentioned only occasionally in it.

As the territory of the NNP was situated mainly in the region with high density of rural settlements of ancient land-use history and intensive forest exploration, the synanthropic vegetation of this area was quite diverse. Moreover, the numbers of plots and areas occu-

ried by synanthropic communities increased. The total of 3 classes (*Galio-Urticetea* Passarge ex Kopecký 1969, *Epilobietea angustifolii* Tx. et Preisling ex von Rochow 1951, and *Plantaginetea majoris* R. Tx. et Prsg. in R. Tx. 1950), 5 orders, 6 alliances, 12 associations and some communities were distinguished here.

The synanthropic fraction of the NNP “Skolivski Beskydy” was represented by 164 species (25.9%), including 119 apophytes and 45 adventive plant species. Among the adventive species, there were 16 kenophytes and 29 archeophytes. Hemiapophytes prevailed (45 species), euapophytes comprised 43 and the rest were occasional apophytes (32 species). The level of flora synanthropisation of the NNP was not the highest among protected objects of Ukraine.

Changes in species composition of meadow vegetation patches dominated by *Calamagrostis epigejos* in response to mowing and biomass removal

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In recent decades, a lot of species-rich meadows became abandoned. The long-term lack of frequent mowing caused changes in species composition and habitat conditions of meadow habitats. It is often observed that the abandoned meadow habitats become dominated by *Calamagrostis epigejos*.

It has been shown that communities dominated by *Calamagrostis epigejos* are characterized by low levels of species richness and floristic diversity. Its dominance reduces the number of species typical of meadow and grassland habitats as it prevents the species encroachment and spread in community. This grass effectively competes with other grass species, particularly when the substrate has a high concentration of nitrogen. It spreads very quickly, and threatens the biodiversity of grasslands and meadows. There are reports that an effective method of limiting the *C. epigeios* expansion is mowing at least twice a year. However, this method proved to be the least effective in terms of increasing species richness.

In order to find out about changes in vegetation patches of formerly species-rich meadows overgrown by *Calamagrostis epigeios* caused by mowing and removing the biomass, a set of permanent plots was established. Four types of treatment in five replicates were applied: (i) mowing once a year with biomass removal, (ii) mowing once a year without biomass removal, (iii.) mowing twice a year with biomass removal, (iv.) mowing twice a year without biomass removal and five control plots were established. The species composition and species abundance of all the plots was recorded in spring and autumn since 2007.

The aim of this study was to test the response of vegetation patches dominated by *Calamagrostis epigeios* to the following treatments: mowing once and twice a year with and without biomass removal.

The preliminary results showed that all the treatments increased species richness and diversity measures using diversity indexes. However, it is a slow process.

Share of heathers in transformed anthropogenic communities of Madagascar

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The *Erica* genus is represented in the flora of Madagascar by approximately 35 species. All these species are taxons endemic for this region. They are mainly associated, in a natural way, with shrubby formations developing at higher montane elevations as well as on a mountainous plateau in the central part of the island and also with sclerophilous forests growing on western slopes of the principle mountain range running along the entire island. However, majority of the natural communities underwent strong anthropogenic transformations,

primarily, due to cattle grazing and uncontrolled forest felling as well as to the introduction into cultivation of alien woody species from *Pinus* and *Eukalyptus* genera. In these places, very frequently, after felling, extensive burning is employed dramatically affecting the development of vegetation systems. Very frequently, compact, mostly single-species heather scrubs are formed in these areas. One of the dominating species in such systems is *Erica trichoclada*, a species resistant to fire which can easily regenerate from its base after burning.

Anthropophytes in the flora of rural settlements of the Lubuskie Lakeland

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Agricultural landscapes reflect long-term interactions between natural environment and human impact. Therefore, species composition of ruderal and segetal flora is simultaneously influenced by various environmental factors as well as by different forms of management resulting in spatial structure. As the result of these practices, some species, especially with narrow ecological amplitude, may disappear. Considering the decline of plant diversity in arable areas due to the intensification of agriculture and spatial changes in villages, new surveys of rural flora are highly desirable.

The aim of studies was to examine the diversity patterns of flora against the background of local landscape units in rural areas. The study area was located in the Lubuskie Lakeland region (western Poland). The investigations comprised 30 villages with differently preserved structure of built-up areas and of cultivated fields. Villages had medieval (13th-15th century) origin, and represented one type of structure with central green – oval shape. Albeit the structure of the studied villages was uniform, since they were located according to the same scheme, the spatial structure of the landscape

in their surroundings was differentiated. The area within a 200 m buffer from the village center was divided into spatial complexes such as: central green, built-up areas, fields and ponds. Fields were differentiated in two groups: small fields adjacent to the village and fields of different size situated away from the village. Floristic lists in spatially delimited complexes were compiled. Spatial database was elaborated using data from digitalized orthophotomaps in ArcGis software. The intensity of management was assessed on the basis of chosen landscape metrics. The surrounding landscape was described in the buffer of 1 km from the center of villages. The proportions of arable fields, forests and meadows were measured. Additionally, distances from main roads, railways and larger towns were described.

The total of 770 vascular plant species were recorded in the analyzed area. 436 species were found

in traditional built-up areas, 381 in manors, 450 in central greens, 134 in ponds, 507 in small fields directly adjacent to villages and 437 in fields situated farther away. The highest percent of apophytes was found in ponds (90%). In other complexes, the most numerous were also apophytes – approximately 65 %. The share of archeophytes was similar in traditional built-up areas, manors, fields and varied from 16-19%. The percent of kenophytes was slightly higher in the built-up areas (approximately 20%) in comparison with arable fields (16%). Additionally, rare and endangered archeophytes were noted, for example: *Anthriscus caucalis* M. Bieb., *Coronopus squamatus* (Forssk.) Asch., *Bromus secalinus* L., *Gagea arvensis* (Pers.) Dumort., *Lathyrus tuberosus* L., *Veronica agrestis* L., *V. polita* Fr.

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Anthropogenic disturbance as a factor supporting the development of rare plant species as exemplified by *Botrychium matricariifolium* in the Silesia region of Poland

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Botrychium matricariifolium (Retz) A. Braun ex W. D. J. Koch (daisy-leaved moonwort; Ophioglossaceae), an endangered and strictly protected species of moonwort has lost significant number of its localities during recent decades in Poland. From over 200 known localities from the area of the entire country, only about thirty were confirmed in the period of last 30 years. The majority of known populations usually consists of a few individuals or even a single individual plant. Little is known about the life history of the species, and what is more, until now no monitoring of the existing populations has taken place.

We present the results of monitoring of two populations of *B. matricariifolium* conducted between 2007 and 2014 in the Silesian Uplands (southern Poland).

The species was found for the first time in a forest area in the vicinity of the town of Siewierz in 2007 and in another similar nearby site in 2009. Several individuals of the fern were found to occur here on forest clearings under a high-voltage electricity line at two locations about 1 km distant from one another.

At the sites of occurrence of the fern, phytosociological relevés and floristic lists in the direct surrounding areas were made. In every growing season from 2007 to 2014, all specimens of *B. matricariifolium* were counted in June-July.

The populations of *B. matricariifolium* occupied an open sandy grassland community. In consecutive years a dozen to several dozen individuals of *Botrychium* were recorded in the study plots. In autumn 2009 during

works conducted beneath the high-voltage line, the sites for the fern appeared to have been destroyed. Young trees and shrubs were cut down and the turf formed by the herbaceous plants was damaged completely. However, this damage to the vegetation did not affect the population of the moonwort. In the following year, about 100 individuals of the species were found there.

The results of the monitoring conducted suggest that the disturbance (including the destruction of the vegetation) can be one factor which supports the maintenance of populations of *B. matricariifolium*, a hypothesis which had also been previously put forward by other investigators.

The influence of hiking on anthropofitisation of the beech forest undergrowth in the central part of Częstochowa Upland

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The Częstochowa Upland is distinguished by the richness and originality of natural phenomena. It is recognised as one of the most beautiful and valuable natural sites in Poland. In 1981, owing to the formation of the Jurassic Natural Landscape Parks, it began to be protected. The place is perfect for practicing leisure and adventure tourism such as cycling, caving and rock climbing. As a result of the massive leisure and adventure tourism, the touristic capacity is frequently exceeded and the disruption of ecological processes and the biotic world disturbance takes place. All that lead to the degradation of natural and landscape values. The area requires detailed research into the impacts of tourism on wildlife. Thus, an increasing pressure of tourism encouraged us to ask a question: in what way does it affect the flora diversity along the trails?

The research was conducted along three trails in the region of Niegowa, Sokole Góry Reserve and Parkowe Reserve. On the studied trails, every 200 meters, a measuring point on both sides of the trail 10m long and 2m wide was marked. Moreover, the zones on each side of the trail were divided lengthwise into two parts, each with the width of 1m, in order to assess the impact of the distance from the trail on the flora species composition. In each measuring point, the inventory of encountered species was conducted and their number and degree of coverage area was evaluated. Altogether, 101 species from 43 families were found. Flora of the examined trails was formed, primarily, by native species (96%). Among the species, such protected plants as: *Daphne mezereum*, *Hepatica nobilis* or *Melittis melissophyllum* were found.

Kenophytes in the flora of the Proszowice Plateau

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Proszowice Plateau (Nida Basin, Małopolska Upland) had long been used for agricultural purposes due to favorable natural conditions and was one of the earliest centers of settlement in Poland.

In the course of floristic research, 175 synanthropic species were found there. Besides taxa that arrived to the area along with the man, still in the Neolithic (archaeophytes), there were also numerous plants that arrived later (after the fifteenth century), i.e. kenophytes (97 species). In the arable fields, *Galinsoga parviflora* and *Veronica persica* were, included in the group of epekophytes. Plants that established in semi-natural

(hemiagriophytes) or even natural communities (holoagriophytes) were also frequent. Among numerous species of the hemiagriophyte group (48 species) *Solidago gigantea*, *Echinocystis lobata*, *Parthenocissus inserta* and *Erigeron annuus* were particularly widespread, especially along rivers. Species of the *Heracleum* genus (*H. mantegazzianum* and *H. sosnovskyi*) were rarely observed. The group of holoagriophytes was small and was represented only by 5 taxa: *Acorus calamus* (rare in the reeds), *Elodea canadensis* (water reservoirs) and frequent in the forests *Impatiens parviflora* and *Quercus rubra* and rare *Cerasus mahaleb*.

Pre-kenophytes – species partially established in the vascular plant flora of Poland

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Among alien plant species, two groups can be distinguished: metaphytes – plants permanently established in a given region and diaphytes – plants not fully adapted to the habitat conditions in the new area. Classification of individual species into these two groups is very difficult in many cases. Naturalization is a process that usually lasts very long and to determine definitely whether a species is permanently established, long-term research related to the life cycle and habitat requirements should be carried out.

This study deals with species that cannot be precisely classified as permanently established in the flora of Poland. These species (called: pre-kenophytes) usually persist in one site for a long period (e.g. for decades) but do not tend to expand the occupied area. On the basis of our field studies and available botanical literature, the list of species which, according to authors, should be considered as pre-kenophytes is given. The list includes species brought to a given area without intentional human activity (ephemerophytes) and found

cultivated and, occasionally, escaped (ergasiophytes). These species differ in terms of establishment level. Some of them, such as *Cynodon dactylon* or *Juncus planifolius* can survive mild winter conditions and remain in one place for several growing seasons. Others (*Alyssum argenteum*, *Chenopodium pumilio*, *Tanacetum parthenifolium*) are observed in one site for several years but do not tend to spread. In the next stage of establishment are species that spread in certain regions of Poland and apart from anthropogenic sites, they occur in semi-natural habitats very often (*Campanula rapunculus*, *Cardamine chelidonia*).

Due to lack of detailed observations at the national level, it is impossible to present a comprehensive list of pre-kenophytes in Polish flora. It is difficult to predict whether all these species will start to spread, expand the secondary range or will persist at the same level of establishment. However, it is known that, in many cases, plant species that were not recorded outside cultivation in Poland a few decades ago (*Echinocystis lobata*, *Juglans regia* or *Parthenocissus inserta*) are classified as invasive at the present time.

Dactylo glomerati-Populetea tremulae Y. O. Vorobyov et I. Solomakha 2014 in press – a new class of pioneer-forest and kolki (groves) vegetation

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A new class of vegetation was described from the lower Dnieper Valley (southern steppes subzone). It is represented in this region by so named 'kolki' (groves) with *Betula borysthena*, *Populus tremula*, *Quercus robur*, *Alnus glutinosa* and, rarely, *Ulmus glabra*, situated in depressions on the sandy areas. They are of relict, post-glacial character and are related to deciduous forests of the *Quercus-Fagetea* class.

The *Dactylo glomerati-Populetea tremulae* class includes 6 associations and one community, representing 2 alliances and 2 orders (one of which is provisional). The new class should also include well known from the literature aspen kolki, occurring in the steppe slightly saline patelliform depressions on the loess terraces of Dnieper, Psel and other rivers of the forest-steppe zone of Left-Bank Ukraine. In addition, this class will include the described by us spontaneous woody pioneer communities of quarries and dumps after mining and excavation, as well as fallows and dry-valley meadows situated far from the forest, in which the process of afforestation began, and forest belts in the forest and forest-steppe zones.

Thus, the *Dactylo glomerati-Populetea tremulae* class represents the first stage of spontaneous or, rarely,

cultural afforestation of the long deprived of forest areas or bare mineral (careers) and organic-mineral (fallows) substrates in the forest-steppe and forest zones of Europe; and in the steppe zone – edaphic subclimaxes in patelliform depressions (sometimes slightly saline) on sandy and loess terraces. Plant communities of the class are mostly birch and aspen (also oak and alder) quite open forests with the sparse shrub layer and closed herb cover with the significant participation of meadow grasses and sedges. Forest species are rare.

Floristically, the new class is similar to the *Agropyreteia repentis* class, while more wet communities – to the *Galio-Urticetea* class. In the communities of the forest and forest-steppe zones increases the participation of species of the class *Molinio-Arrhenatheretea*. The physiognomic characteristics of the new class resembles the classes: *Molinio-Betuletea pubescentis*, *Brachypodio pinnati-Betuletea pendulae*, *Quercetea pubescenti-petraea*, *Robinietea*, and, to some extent, also the classes: *Rhamno-Prunetea* (order *Sambucetalia racemosae*) and *Salicetea purpurea*. However, some unique floristic and ecological features of the class *Dactylo glomerati-Populetea tremulae* make it equally distant from all these classes and, therefore, the new

class cannot be reduced to the synonym of any of these classes.

The diagnostic species for the new class are: *Betula pendula*, *B. borysthena*, *Populus tremula*, *Quercus robur*, *Alnus glutinosa*, *Frangula alnus*, *Rhamnus cathartica*, *Salix rosmarinifolia*, *S. cinerea*, *Sambucus nigra*, *Rubus caesius*, *Dactylis glomerata*, *Elytrigia repens*, *Phragmites australis*, *Calamagrostis epigeios*, *C. canescens*, *Agrostis capillaris*, *A. gigantea*, *Festuca rubra*, *Poa pratensis*, *P. angustifolia*, *P. sylvicola*, *P. trivialis*, *Milium vernale*, *Carex hirta*, *C. ovalis*, *C.*

contigua, *Asparagus tenuifolius*, *Tanacetum vulgare*, *Solidago virgaurea*, *S. canadensis*, *Erigeron canadensis*, *Phalacrolooma annuus*, *Eupatorium cannabinum*, *Achillea millefolium*, *A. euxina*, *Leontodon hispidus*, *Taraxacum officinale*, *Anthriscus sylvestris*, *Chaerophilum temulum*, *Glechoma hederacea*, *Prunella vulgaris*, *Vicia tetrasperma*, *Solanum dulcamara*, *Melandrium album*, *Agrimonia eupatoria*, *Thalictrum simplex*, *Urtica dioica*, *Veronica chamaedrys*, *Campanula patula*, *Equisetum pratense*.

Occurrence of synanthropic species in plant communities of the Vistula and Brennica Rivers gravel banks (Western Carpathians)

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Gravel banks are the initial habitats inseparably connected with mountain streams. On the one hand, they are an unstable substrate, influenced by the overflows and high waters and, on the other, they are also exposed to strong sunlight and heat. This situation determines specific vegetation which, due to dynamic changes in the habitat, has a pioneer character. What is more, gravel banks are areas where many river migratory species and many random species appear. Among them, there are also synanthropic ones.

In 2011-2012, floristic and phytosociological studies were conducted in the Silesian Beskids. The goal of these studies was to recognize the vegetation of the gravel banks of the Vistula and the Brennica Rivers – from their springs in the Silesian Beskids to the point where the Brennica River flows into the Vistula River

in the Silesian Foothills. The studied section of the two rivers is regulated. Particular attention was paid to the synanthropic species which pose a threat to the native flora.

The aim of this study was to recognize the synanthropic flora of the discussed area and to determine its occurrence at subsequent stages of the gravel banks succession.

The study allowed description of a series of succession stages of the vegetation of the river banks. Moreover, the obtained results showed that synanthropic species were present in all of them. The most common invasive species that were spotted comprised: *Impatiens glandulifera*, *Heracleum mantegazzianum* and *Reynoutria japonica*.

Floristic diversity of *Cnidion* meadows in the lower and middle Odra River valley

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Cnidion meadows occur in Central Europe, mainly in valleys of lowland rivers characterized by strong annual water level fluctuations. In the past, they were largely under low-intensity use (mowing and grazing). Today, many river valleys are regulated, the area of naturally flooded habitats has strongly decreased and *Cnidion* meadows are endangered and in need of protection. The floristic definition of *Cnidion* meadow is different in Germany, Poland, and in the EU. It makes the Odra river valley an interesting model to compare approaches to *Cnidion* meadows in Germany and Poland.

Our research is part of a testing and developing project for the conservation of characteristic birds and vegetation of alluvial meadows (2011-2015). Here, we present data on the floristic condition of *Cnidion* meadows in the Lower Odra Valley National Park (Germany). They occur in three polders (A, B, and 10) which are flooded in winter, pumped in spring and rather dry in summer. They were compared to meadows from two Polish Natura 2000 sites: the Middle Odra Valley

(Dolina Śródkowej Odry) and the Lower Odra (Dolna Odra). These meadows are subject to unregulated flooding. In total, 122 floristic relevés (25 m²) were analysed. We also included various environmental data (e.g. elevation, P content in the soil) and the previous land use.

Cnidion meadows in the lower Odra valley (both Polish and German sites) show floristic differences to those in the middle Odra valley. Since the hydrological regime in the polders of the Lower Odra Valley National Park is rather similar to the natural water fluctuation, patches of similar floristic composition occur.

Most species rich *Cnidion* meadows in the Lower Odra Valley National Park were restricted to polder 10. They were floristically close to *Cnidion* meadows in the Polish Lower Odra Valley Nature 2000 site and to several plots in the Middle Odra Valley. The relevés from polders A and B included partly only one or two *Cnidion* species and their environmental conditions and floristic composition were very diverse.

Rare, endangered and poorly documented plant communities of rural areas of the Lubuskie Lakeland (western Poland) and of central Pomerania

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The study areas, located in northern and western Poland, comprised 30 villages of the Lubuskie Lakeland

region and 18 in central Pomerania. The aim of our research was to assess and to document the diversity

of vegetation of rural landscape, as well as the state of preservation of its plant communities. The investigations, conducted in the years 2011-2014, were supported by National Science Center Grant NN 305 062440.

A total number of recorded associations was accounted as 232 (besides fragmentarily developed local communities of similar rank, including communities without diagnostic species of units of lower rank). These associations belong to 28 classes, 35 orders and 64 alliances within phytosociological classification. The analyses were conducted only in regard to the data concerning well developed phytocoenoses, i.e. undoubtedly recognizable after their species composition.

There was also assessed the share of endangered associations, which compose about 25% of the whole

list of communities. Altogether 9 communities assessed as directly endangered occurred in villages or their vicinity. In the list prevailed natural and seminatural communities.

The comparison of both studied regions has shown that the diversity of vegetation was slightly higher in Pomerania. The rural landscape of the Lubuskie Lakeland is more transformed, richer in ruderal communities, whereas in Pomerania more represented are natural and seminatural communities.

The rural landscape of both studied areas is still rich and diversified but undergoes recently transformations leading to its impoverishment and unification as result of either abandonment of cultivation or its intensification.

Patterns of expansion of *Solidago* spp. in changing landscape and forecast of its future course using GIS

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The paper presents the results of studies on the dispersal of *Solidago canadensis* and *S. gigantea*, invasively expanding in the mosaic and changing landscape of the suburbia of the City of Białystok, NE Poland. The distribution of 45 197 ramets of the species was mapped on the area of 60 km². The proportion of the colonized area varied from 29 to 93%. The range of effective spread of the species did not exceed a few dozen meters. The *Solidago* species were distributed in clusters, but the strength of clustering varied depending on the spatial scale. The largest populations of *Solidago* spp. occurred in areas with the participation of abandoned farmlands reaching 57-60%. There was also a significant relationship between the size of habitat patches and susceptibility to colonization by these alien species. The group of patches of abandoned farmland (which were the most favorable habitats for goldenrods) but not inhabited by these alien species, were dominated by small ones with the area of 0.5 ha, at the most. Such smallest patches represented almost 70% of those not colonized by *Solidago* spp. The possibility of effective spread of goldenrods was associated with the pat-

tern of landscape mosaic. The areas not occupied by the species were characterized by the lowest coefficients of habitat diversity and landscape mosaic, and dominated by vast patches with a uniform type of land use. The probability of occurrence of the goldenrods in a particular area depended on the degree of occupancy of adjacent squares. The chances of appearance of these species were less than 0.3 in the immediate vicinity of the squares not colonized by it, while in the vicinity of the squares with the largest populations of *Solidago* spp – about 0.6-0.7. The forecast of further expansion of *Solidago* spp. was based on cellular automaton rules. Furthermore, a hypothetical course of expansion of the goldenrods could lead to an increase in the number of colonized squares by 78% in the first prognostic period. Minimum proportion of the areas inhabited by the goldenrods would increase from 29 to 52%. In the second prognostic period, the participation of colonized squares would increase, perhaps, to 62%. The decrease in the rate of projected expansion could be attributed to scarcity of the most suitable habitats and uninhabited areas.

Reproductive capacity of the invasive species of *Fraxinus pennsylvanica* in comparison with native species of *Fraxinus excelsior*

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Fraxinus pennsylvanica (green ash) is a dioecious species which was introduced to Europe around 1780. In Poland, it was recorded for the first time in 1817 in Niedźwiedź near Krakow. This species was planted in forests, parks and gardens in cities for decorative purposes. And from these places, the species began to spread onto unused areas in cities and wastelands.

No detailed ecological studies of this species in Poland were conducted until now, although it expands its reach also in natural habitats. Because of the similarity of habitat requirements, it can be dangerous for native species from *Fraxinus* (*F. excelsior*) genera.

The production of a large number of seeds and anemochory can influence the rate of colonization of new habitats by this species. The main aim of the study was to compare the reproductive capacity of these species. Randomly selected 100 seeds were collected from each of 20 trees located in parks (10 trees for one species) and weight of fruits and vitality of seeds were tested. The cutting tests were used to check the quality of seeds. Seeds were classified according to four traits: non-damage, damage, yellow,

with larvae and results were compared with species of trees and their gender.

F. pennsylvanica is a dioecious species, so male trees do not produce seeds. On the other hand, *Fraxinus excelsior* is monoecious and, what is more, polygamous. It means that also male trees can produce seeds. It was observed that in the year after flowering, the percentage of seeds which could germinate were similar in two species. For *F. pennsylvanica*, it is characteristic that a significant percentage of seeds were damaged by pest larvae. In contrast, *F. excelsior* some part of seeds was allocated to the soil seed bank. Consequently, *F. excelsior* had more seeds which could germinate at all. It could mean that it was not so much threatened by alien species. The study failed to give a simple answer which of the tested species had a higher reproductive potential. Based on the study, it cannot be clearly concluded which of the species had greater reproductive potentials and whether *F. pennsylvanica* could displace the native species. More research is needed to determine the scale of the problem of the increase in the number of posts of *F. pennsylvanica* in Poland, especially in natural and semi-natural habitats.

The occurrence of alien species along railway lines depending on their use intensity. A case study in agricultural landscape

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The agricultural landscape is under continuous anthropogenic pressure. In last decades, the fragmentation of natural habitats and, as a results, the homogenisation of agricultural landscape has been observed. Fragmentation by transportation corridors, i.e. highways, railways and other linear structures, disturbs and changes natural regimes of ecosystems in many parts of the world, including Poland. There is an opinion that, the traffic on railway tracts enhances the dispersal of non-native species into surrounding habitats.

The aim of this study was to compare the frequency of non-native plant species along railway areas in agricultural landscape. We tried to answer the following questions (*i*) does the frequency of non-native species decrease, if the distance from railway tract increases? (*ii*) are non-native species more abundant on fields or on meadows adjacent to railways? (*iii*) to what extent, the intensity of exploitation of railway tracts affects the frequency of non-native species?

The study was conducted in the central-eastern part of Poland. Three types of railway lines based on their usage intensity were analysed, i.e., weak, mid- and intensely explored. The railway lines were also categorized based on the habitat across which they were

run, i.e., semi-natural (meadows, pastures, grasslands) or anthropogenic (cultivated fields). We analysed 343 transect plots, with 5 replicates in each habitat type and each distance criteria 5, 10, 20 and 50 m from the railway line edge.

In total, 752 species of vascular plant species were identified, of which 29.12% were alien species. Most of alien species were kenophytes (101 – 46.11%). The participation of archaeophytes and diaphytes was 89 – 40.63% and 29 – 13.24%, respectively. The participation of archaeophytes: kenophytes: diaphytes comprised 63 spp. – 28.7%, 57 – 26.02% and 12 – 5.47% on weakly explored railways; 84 – 38.3%, 86 – 39.26% and 16 – 7.3% on mid- explored, and 71 – 32.4%, 72 – 32.8% and 15 – 6.8% on intensely explored. The number of alien species was higher on transects that run near cultivated fields compared to transects that run across semi-natural habitats. The number of alien species in the surrounding of railways decreased, if the distance from railway line was > 20 m. This suggests that railway areas play only a minor role in the dispersion of alien plants to the surrounding areas and are far more important as a reservoir of native species.

The geographic structure of the synanthropic flora of Biloozersky National Nature Park (Ukraine)

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Current status of the flora of Ukraine is characterized by a significant increase in human impact. Degree of synanthropisation, primarily, flora adventization, of protected areas is an indicator of the potential threat types that determine floral unique protected area.

The left bank part of the Middle Dnipro region (Ukraine) belonged, until recently, to regions that were not represented in protected areas of the highest category rank. To improve this situation, in 2009, the Decree of the President of Ukraine No 1048/2009 on creation of the “Biloozersky” National Park was issued. It was to comprise lands of the State Forest “Biloozersky” located in Pereyaslav-Khmelnytsky district of Kiev region and Kaniv district of Cherkassy region, with the total area of 7014.44 ha.

The inventory of the flora and its analysis is one of the major tasks in the study of the flora of any region. We analyzed the geographical structure of the synanthropic flora of the park.

Commensal flora fraction of the park includes 205 species or 39.3% and is significantly higher than

the synanthropisation in Ukraine. Among families, synanthropic flora is dominated by Asteraceae (40 species, 19.5%), Brassicaceae (19 species, 9.3%), Poaceae (16 species, 7.8%), Fabaceae (16 species, 7.8%), Caryophyllaceae (12 species, 5.9%)

The results of geographic study of the synanthropic flora of Biloozersky National Nature park showed that the temperate-submedial species (43.7%) are prevailing in the latitudinal spectrum of chorological groups. It is typical for flat temperate latitudinal floras of Holarctic region. This group includes *Geum urbanum* L., *Sambucus nigra* L. and others.

The species of Eurasian group (48.7% – *Tanacetum vulgare* L., *Stellaria graminea* L. and others), characteristic for Europe and circumpolar area, are distributed in temperate area of boreal zones, are predominant in the spectrum of regional chorological groups of flora.

The species of Euryoceanic (53.3% – *Urtica dioica* L., *Rubus idaeus* L. and others) and indifferent (*Equisetum arvense* L., *Picris hieracioides* L. and others) groups are predominante by oceanic-continentiality.

South-African species *Senecio inaequidens* (Asteraceae) in southern Poland

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Among alien vascular plants that were reported from Poland, members of the Asteraceae family constitute the

most numerous group. Some of them are invasive species which pose a threat to biological diversity. *Senecio*

Senecio inaequidens belongs to this group. This is a taxon of South-African origin which has spread in some regions of Poland during recent years.

In southern part of Poland, *Senecio inaequidens* has been reported from the Nizina Śląska, Pogórze Sudetów, Brama Morawska and Carpathians. Altogether, its populations comprise over a thousand of individuals, majority of which form small groups of several to several dozen plants that flower and produce fruits. This taxon usually prefers dry and stony places related to railway transport and mining areas, where it belongs to ruderal plant communities from the *Artemisietea vulgaris* class (*Artemisio-Tanacetetum vulgaris*, *Echio-*

Melilotetum). Penetration of single individuals into other ecosystems (*Bidentetea tripartitae*, *Phragmitetea* classes) has also been reported.

Till recently, the taxon has been regarded as ephemero-phyte. However, because of long (>10 years) persistence in some of the investigated localities and its ability to colonize adjacent areas, it is now considered to be an anthropophyte, established and potentially invasive. Its invasiveness is facilitated by species biology, e.g. production of very large number of light diaspores. Moreover, air turbulences that occur along actively used railways help to spread its achenes.

The spread of the *Heracleum sosnovskyi* in the Sanok district

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The object of the research was to conduct botanical inventory of *Heracleum sosnovskyi*, a species that has a significant impact on changes in native flora of the Sanok district. The fieldwork was carried out by patrolling individual grid squares ATPOL. The data was applied to the terrain forms and then analyzed.

Anthropogenic plant changes comprise modifications taking place on Earth as a result of human activity. Sanok district has a unique location on the Polish map and has specific natural conditions which contribute to the development of invasive and foreign species. It is also an important place on the Carpathians map due to the boundary between the eastern and western Carpathians located mainly in the Oślawa river valley. The Oślawa river is a significant migration corridor of plants from south to north. Many species, including mountain species and East Carpathians species, reached this location also with the assistance of the San, the Wisłok and the Sanoczek rivers. In the past, transport routes from the south and east led through this district.

Currently, this role is played by roads and railway lines which are the main migration routes of invasive species in this extremely strongly forested region. Then, from this district, many plants species penetrate deep into higher parts of the Carpathians.

The greatest threat to this area is *Heracleum sosnovskyi*. Its presence is a remnant of broad areas under cultivation in former state farms and prisons. Location of the largest surface (Karlików-Płonna, Wisłok Wielki, Rakowa), poses a serious risk of further rapid spread along its roads and waterways. This process has already started and we can expect its strong acceleration in near future. Another invasive species for the entire Polish or regionally invasive also cause large changes in the environment, mainly in the flora and fauna as well as economic losses. They pose a serious threat to ecological, economic and social spheres. Preventing invasion of alien species means protecting the biodiversity of the region, so appropriate corrective actions should be taken.

Synanthropization of vegetation cover in forest gravel pit in Wipsowo (Warmia and Mazury)

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Synanthropic plants are accompanied by man. There are areas accidentally or unknowingly transformed by man. The mid-forest, illegal gravel pit in Wipsowo occupies an area of about 0.45 hectares. This place was used by local residents, initially, for the extraction of gravel, then to discard garbage. Currently, the area is characterized by workings of different process of spontaneous overgrowth (secondary succession).

The aim of the study was to investigate the degree of anthropogenic transformation of the flora in a gravel pit in Wipsowo. The area of gravel pit located at the edge of the forest is strongly polluted by jerusalem artichoke (*Helianthus tuberosus* L.) which is classified as invasive species. Stinging nettle (*Urtica dioica* L.), field bindweed (*Convolvulus arvensis* L.), downy burdock

(*Arctium tomentosum* L.) and henbit deadnettle (*Lamium amplexicaule* L.) also occurred at the excavation forming plant communities in areas far from the forest characterized by a scant amount of species. Among others, dwarf everlast (*Helichrysum arenarium* L.) and sheep fescue (*Festuca ovina* L.) were observed. A few clusters of grey hair-grass (*Corynephorus canescens* L.) were also visible.

Conditions of vegetation, especially species composition and coverage of the substrate, can attest to the rate of secondary succession. In addition, the occurrence of synanthropic species testifies to flora transformation by humans and the share of these species indicates the degree of transformation.

Current state of the alien fraction of Kharkiv urban flora (Ukraine)

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The adventive fraction of Kharkiv urban flora is represented by 340 species related to 209 genera of 64 families which make up 32% of the entire urban flora.

With respect to the time of introduction, among the analyzed fraction of the urban flora, kenophytes predominated (233; 68.5%), while archaeophytes

were represented by 107 species (31.5%). Ergasiophytes (152 species; 44,7%) and akolutophytes (131 species; 38%) predominated in the classification according to the way of introduction, while xenophytes were represented by 57 species (17%). Regarding the degree of naturalization, epocophytes (187 species; 55%) and ergasio-

phytes (105; 31%) prevailed over ephemerophytes (23 species; 7%), agriophytes (20 species; 6%) and colonophytes (5 species, 1%).

The leading families of the adventive element of the analyzed fraction of urban flora were Asteraceae (54 species), Brassicaceae (40), and Poaceae (38). The spectrum of the adventive fraction differed from the general spectrum of the leading families among the analyzed urban flora in: the higher rank of the Brassicaceae family (2nd position), the displacement of Fabaceae (5th position), the appearance of Chenopodiaceae (4th position), Solanaceae, Malvaceae, and Amaranthaceae (7th, 8th and 10th position, respectively). Among the leading genera in the adventive fraction of the analyzed urban flora, the *Amaranthus* genus (7 species) occupied the first position, *Malva* (6) was the second one, and positions 3rd-8th were taken by, respectively, *Chenopodium*, *Atriplex*, *Lepidium*, *Helianthus*, *Setaria* (5 species each).

There were 35 arealogic groups identified by primary natural habitat as a result of the distribution of the adventive element of the analyzed urban flora. The spectra of these groups were predominated by the species of ancient Mediterranean and North American origin.

The data of the biomorphological analysis (Raunkiaer's classification) of the adventive fraction of the analyzed urban flora revealed domination of therophytes – 183 species (53.8%); hemicryptophytes were represented by 88 species (25.9%), phanerophytes – by 58 (17.1%); the remaining groups were not numerous:

geophytes (8; 2.4%), chamaephytes (2; 0.6%) and hydrophytes (1; 0.3%).

The result of the ecological analysis of the adventive fraction of the analyzed urban flora showed the predominance of mesophytes (246 species; 72.4%), heliophytes (216; 63.5%), and subacidophils (134; 39.4%).

The data of the species distribution of adventive plants in accordance with their linkage to the city zones showed the predominance of the species in urban and suburban zones (206 species; 60.6%). 92 species grew only in the urban zone on synanthropic ecotopes; 42 species (12.4%) could be found in the suburban zone.

The vast majority of species (30.6%) were meso-, euhemerob. Fewer species were euhemerob (25%) and mesohemerob (23.8%). The meso-, eu-, polyhem-erob (8.8%) and polyhem-erob (4.4%) species were not numerous. The smallest quantity of species were allocated to oligohemerob (3.5%), oligo-, mesohemerob (3.2%), eu-, polyhem-erob (0.3%) and meso-, oligo-hemerob (0.3%) groups.

The original maps of distribution of the species of the adventive fraction of Kharkiv urban flora were made.

Thus, the taxonomic structure of the adventive fraction of Kharkiv urban flora is similar to the flora of the forest-steppe zone, but the distinctions can be found in the evident influence of the ancient Mediterranean flora, and, above all, in the spectra of the leading families and life forms. A big quantity of epoecophytes is connected with a variety of anthropogenic ecotopes as a result of the intensive development of the city.