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Ecological and coenotic characteristics of rare endemic species *Spiraea polonica* Błocki and *S. pikoviensis* Besser (Rosaceae), Ukraine

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Abstract: The descriptions of habitats of two rare endemic species – *Spiraea polonica* Błocki and *S. pikoviensis* Besser*,* the species status of which requires a clarification, are given. Both studied species are critical species from *S. crenata* L. aggr., the status of which is doubtful. The preliminary morphological and biochemical results give us all reasons to be sure of their species status. To confirm this assumption we analysed ecological and coenotical paculiarities of these species in their *locus classicus*. The results of areas descriptions involving *S. polonica* and *S. pikoviensis* were stored into TURBOVEG database and analysed using TWISPAN and Statistica 7.0 software, that showed the distribution of syntaxa according to 12 major ecofactors in point scale. To determine the limit of ecofactors points boundaries, the methods of indirect ordination was used and the dendrogramme was made. It reflected the degree of similarity of coenosis ecofactors on the basis of the assessment values of coenosis, together with *S. polonica* and *S. pikoviensis;*. The estimation of quantitative indicators of ecofactors as well as ecological and coenotic characteristics shows that *S. pikoviensis* and *S. polonica* exist in the form of local populations, the area of which constantly decreases. They grow in ecotone conditions of forest fringes and are characterized by narrow ecological and coenotic amplitude. These characteristics can be considered as a threat to the existence of species caused

by a low number of repatriation places, limitness of seeds move agents (because of forest surrounding), so exsist high probability of the populations loss . According to developed estimation criteria for risk of populations losses, this risk is extremely high and is over 83%. Habitats with such indicator belong to I st class, a very rare one. According to IUCN classification, these types should be referred to the category CR (threatened) that require a complex of special protection measures.

Keywords: genus *Spiraea*, geographical distribution, population, locus classicus, econiche, synphytoindication, plant conservation.

Introduction

The genus *Spiraea* L. includes to 100-120 species, it is widespread in the areas of temperate and subtropical climate of the Nothern hemisphere – in Europe, Asia, North America (LIS 2014). The centre of species diversity is located in Southeast Asia and North America (GLADKOVA 2001). A lot of species of the genus are decorative plants and are widely used in ornamental gardening planting. The plants of the Asian and North American origin are often cultivated in gardens, parks and landscape gardening. There are seven wild species in flora of Ukraine, three of which are endemic (*S. litwinovii* Dobrocz., *S. pikoviensis* Besser, *S. polonica* Błocki), the last two are very rare and critical, and *S. polonica* is included into the Red Data Book of Ukraine (Red Data Book... 2009). Therefore to specification taxonomic status of critical species it is important to analyse both morphological features and the specification of ecology and coenotic conditions of their populations localities.

Material and methods

The habitats of *S. polonica* and *S. pikoviensis* are described using typical phytosociological methods. These are small areas that occupied the loci of above mentioned species. The population *S. polonica* was studied on 7.06.2012 in the outskirts of the Zelenyy Gay village, Zalishchyky district, Ternopil region, in the place of primary description of species (*locus classicus*). Because of this area is located on the top of a steep hill and occupies only a few dozen square meters, surrounded by the forest above and a steep cliff below, so the mapping was not performed there.

The population of *S. pikoviensis* was studied in detail in *locus classicus* (in the outskirts of. Pykiv village, Kalynivka district, Vinnytsia region), which we visited twice (on 10.05.2015 and 24.06.2015). On the glade, 30 x 50 m in size, where *S. pikoviensis* is present, the boundary points were fixed using GPS. We designed the location scheme of the communities groups of studied species and rock (granite) plates, on which sparse xerophytic communities were formed that visually stand out. The gaps between thickets of *S. pikoviensis* are occupied by grassland with dominance of *Arrhenatherum elatius* (L.) J.Presl & C.Presl. It

should be noted that the location of groups was estimated without the proper tools, so this distribution is rather schematic.

Within the glade with *S. pikoviensis*, the relevés of each of five communities of this population (10 May and 24 June 2015) were made, as well as the relevés of the surrounding grassland, forest and rock communities. Plant communities were identified according to the existing syntaxonomical classification (SOLOMAKHA 2008).

Phytosociological data were stored in database in TURBOVEG software (HENNEKENS & SCHAMINÉE 2001) and were analysed using TWISPAN and Statistica7.0 software In order to estimate the growth conditions we used the synphytoindication methods (DIDUKH 2011, 2012), that reflects the syntaxa distribution by 12 main ecofactors on the point scale. On the basis of assessment values of cenosis a chart that described econiche of these species was made taking into consideration *S. polonica* and *S. pikoviensis*. The map of species distribution was made using SimpleMappr (SHORTHOUSE 2010).

Results

Systematics, distribution, ecological, and coenotic features *Spiraea polonica and S. pikoviensis* populations

Spiraea polonica was described by the Polish botanist B. Błocki in 1892 (BŁOCKI 1892) from Podillya – outskirts of the village Zhezhava (Zezawa, now v. Zelenyy Gay of Zalishchyky district) and from the banks of the Seret river in the vicinities of v. Lesichnyky, Ternopil region. The species is morphologically similar to the Europe-Asian *S. media* Schmidt, but differs from the latter one by considerably denser silk pubescence, particularly in the upper stem leaves and inflorescence, and slightly yellowish with grooved petals of flowers on the top (leaves and inflorescences of S. *media* are almost bare and the petals are white, undivided). That allowed to consider this taxon as a subspecies (*S. media* Schmidt subsp. *polonica* (Błocki) Pawł.).

GLADKOVA (2001) does not consider reasonable to differentiate *S. polonica* as a separate species or subspecies, but suggests to refer it to the variety *S. media* var. *mollis* (C. Koch & Bouche) Schneid., spread in the Western Europe. There are specimens of plants *S. media* var. *mollis* in collection of the O.V. Fomin Botanical Garden (Kyiv) that were received in 1998 from Sarayevo. According to our observations the principal phases of seasonal development of plants of typical diversity *S. media*, which are also cultivated in the Botanical Garden, coincide with phenological phases *S. media* var. *mollis.* According to the morphological features the last variety differs from the typical one by dove-coloured leaves on both sides and felt pubescence, while the typical variety (as well as *S. polonica*) has less felt leaves.

The biochemical research of secondary metabolites of leaves of *S. media* (*S. media* var. *media*) and *S. polonica* plants has shown that the specific biochemical features of these species were a high content and diversity of flavonoids – over 10 glycosides of quercetin and kaempferol, a great number of

flavone compounds (catechol and proantocyanides) and phenilpropanoids (neolignans, derivatives of cinnamic acid) (BELEMETS et al. 2015). The last, but not least a determined group of secondary metabolites for these species was the polar hemi- and monoterpenoids, probably in the form of glycosides, which are also typical of some other species of *Spiraea.* In general, the chromatographic profiles (HPLC fingerprints) and composition of leaves components of *S. media* and *S. polonica* are quite similar, and it indicates of their taxonomic similarity. But the comparison of flavonols composition as significant hemotaxonomic markers indicates the sufficient systematic distance of these taxa, probably at the level of subspecies, because according to the chromatographic data *S. media* contains mainly quercetin glycosides and *S. polonica* contains mostly kaempferol glycosides. Thus, as a result of these data, the samples of close species *S. media* and *S. polonica* are worth considering according to profiles of secondary metabolites within two subspecies: *S. media* subsp. *media* (western part of the area) and *S. media* subsp. *polonica* (eastern part of the area), as represented in Flora Europaeae (DOSTAL 1968).

It is worth mentionig that by pubescence pattern *S. polonica* resembles the Far eastern species *S. sericea* Turcz. ZAVERUKHA (1985) explained such mega disjunction between the European and Far eastern species by the archaic and relict features of S. *polonica*.

According to the samples collected by A. Andzheyovsky in 1816 from outskirts of the village Pykiv, Vinnitsa region, the southern part of Podillya, W. Besser (BESSER 1822) described *S. pikoviensis* Besser (in accordance with protologue: “Circa Pikow in Pod [olia], legi A. 1816”). For a long time this species was considered to exist only in five authentic specimens stored in herbaria KW (Kyiv) and LE (St. Petersburg), as repeated attempts to collect it in nature were unsuccessful. This species was not put in Red Data Book of Ukraine (2009) as it was considered to be extinct.

DOBROCHAEVA (1954), presenting *S. pikoviensis* for “Flora of the USSR” as a typical sample, which she had found in herbarium KW, assumed that it belonged to the series *Crenatae* A. Pojark. (section *Chamaedryon* Ser.) with a wide areal (Eastern Europe, Caucasus, Siberia, Middle and Central Asia (Mongolia), Western Tibet). Significant disjunction of *S. pikoviensis* with similar species of this series can indicate of the ancient type and relict origin of this species. DOBROCHAEVA (1954), and later ZAVERUKHA (1985), denied the hybridogenic origin of *S. pikoviensis*, in the formation of which *S. media* Schmidt and *S. crenata* L. could participate. They believed that taxon, described by W. Besser, is an independent species unit because in *S. pikoviensis* features inherent of *S. media* are absent.

GLADKOVA (2001) also accepted the status of species *S. pikoviensis*. She confirmed the similarity of this species to *S. crenata* L., from which *S. pikoviensis* differs by pubescence absence and larger petals. *Spiraea pikoviensis* is not mentioned at all in Flora Europaea (DOSTAL 1968). According to our data samples, first collected by us from locus classicus, *S. pikoviensis* differs from *S. media* and *S. crenata* also by the sepals shape (lanceolate, long-pointed, while the last two species have wide-triangle, short-pointed sepals) (Fig. 1).

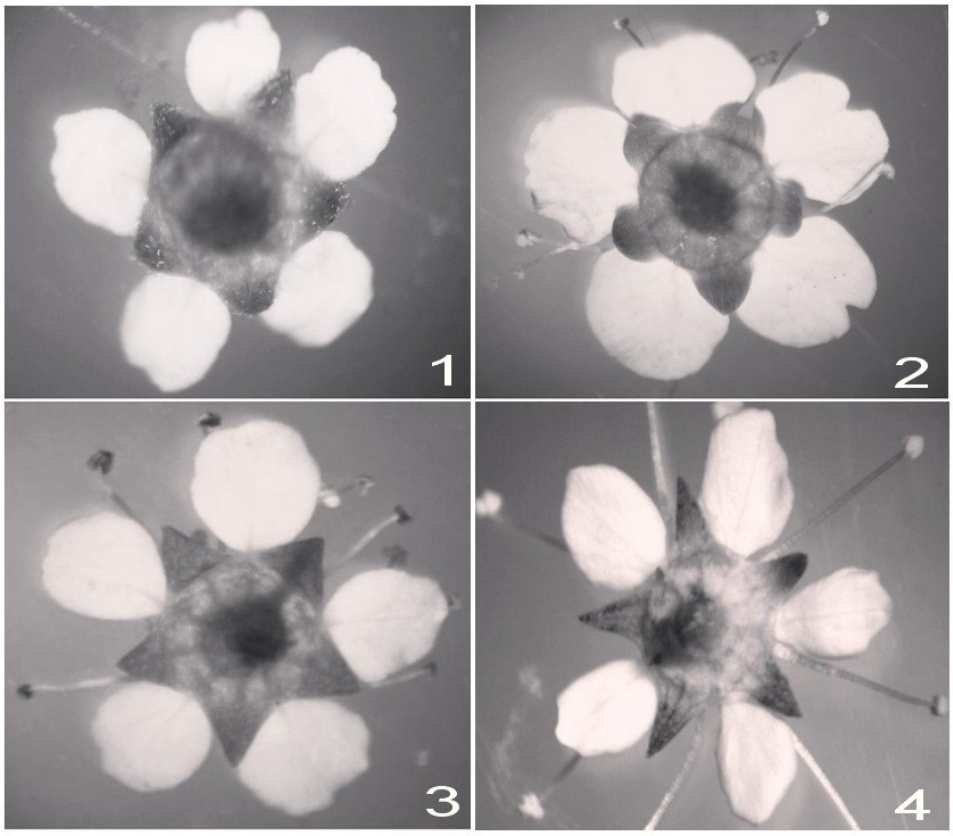

Fig. 1. Form of sepals and petals of species *Spiraea* (x 25): 1 – *S. crenata*, 2 – *S. media*, 3 –*S. litwinovii*, 4 – *S. pikoviensis*

At present it is a sufficiently rare species which, according to ZAVERUKHA (1985), could be separated from the archaic type *praecrenata* s. l., that in the past had wide East European-Central Asia-Mongolian areal, associated mainly with the northern part of the ancient Mediterranean. *Spiraea pikoviensis* is also close to the one described by DOBROCHAEVA (1954) *S. litwinowii* Dobrocz. from the north-eastern forest-steppe areas of the eastern part of Ukraine (Luhansk region), which is also not mentioned in Flora Europaea (DOSTAL 1968). The last one, no doubt, has the same genetic roots as *S. pikoviensis*, and differs from it by the presence of three longitudinal veins on all leaves of infertile shoots, and triangular, obtuse on the apex sepals (Fig. 1), while *S. pikoviensis* has only 2–3 lower leaves of infertile shoots with three longitudinal veins, and the rest – with one midrib and 2–3 pairs of lateral, which are apart from the median, its follicles from ventral side are slightly pubescent and sepals are lanceolate, long-pointed on the apex.

Until recently, the species *S. polonica* has been authentically presented only for locus classicus, from where it was described. However, the analysis of

recently published data (CHORNEY 1999; CHORNEY et al. 2001, 2010; VOLUTSA 2005, 2009; FEDORONCHUK et al. 2013), and collected samples that are stored in the herbarium of Chernivtsi National University (CHER) showed that S. *polonica* went beyound the limits of locus classicus. Besides three samples from the place of the primary description ("Zezawa, 22.07.1932, Gajewsky"), the others were collected on the right bank of the river Dniester in Chernivtsi region, Zastavnivsky district (outskirts of v. Balamutivka: "Balamutowka, 28.05.1936, E. Tora"; in the outskirts of the village Hreshchatik: "Cresceatec, 22.05.1932, unknown collector") and Kelmenetsky district (outskirts of v. Babin " … limestone slopes over the Dnestr, 06.13.1952, I.V. Artemchuk"; outskirts of v. Bernove: "... a steep wall of the northern exposition over the Dniester, 12.06.2008, O. Volutsa").

Thus, based on the published data, herbarium materials and our field studies, it can be stated that *S. polonica* is narrowly endemic, reliably known only from the Middle Transdniestria, where it grows on cleavage of sarmatian limestones and devonian carbonate slates on the steep and rocky banks of the Dniester canyon (Fig. 2, 3). According to the geobotanical zoning, the area belongs to the Forest zone of Pokutsko-Medoborskyy geobotanical district of beech, hornbeam-oak and oak forests, real and steppizated meadows and meadow steppes (DIDUKH & SHELYAG-SOSONKO 2003).

Fig. 2. Photo of biotope with *Spiraea polonica*.

In 2012 during field studies, we confirmed the habitat of *S. polonica* in locus classicus (N: 48°41'226"; E: 25°38'101", height 233 m asl) on the left bank of the Dniester river in the outskirts of the village Zelenyy Gay, area “Zhezhava”, on basis of which in 1974 the botanic reserve “Zhezhavskyy” was established (FEDORONCHUK et al. 2013). It is a forest area of 155 hectares, the upper eastern part of which is represented by oak and hornbeam forest (all. *Carpinion betuli*), mostly of coppice origins – *Quercus robur* L. (0,4), *Carpinus betulus* L. (0,6), with impurities of *Acer platanoides* L., *Fraxinus excelsior* L., *Ulmus laevis* Pall., *Sorbus aucuparia* L., *Acer tataricum* L. and shrubs – *Corylus avellana* L., *Sambucus nigra* L., *Berberis vulgaris* L., *Rosa canina* L., *Prunus spinosa* L., *Crataegus rhipidophylla* Gand. (= C. *curvisepala* Lindm.), *Cornus mas* L.

In the lower part, near the Dniester, on steep rocky slopes there are small glades with steppe vegetation among shrubs. S. *polonica* occurs in ecoton communities of shrubs (all. *Berberidion*, ass. *Corno-Prunetum spinosae* (R.Tx. 1952) Wittig 1975) and forest margin grasslands (cl. *Trifolio-Geranietea*, all. *Geranion sanguinei* Tx. in Th. Muller 1962).

Spiraea polonica population is located on the open sunny plot of the south-western slope with inclination of 10–15º, above the edge of the steep rocky cliff, of 85–90º steepness, and occupies a small lawn, of 2,5 x 3,5 m. It is presented by tight “weaving” of vegetative shoots of root growth, without notable seed undergrowth. From numerous shoots (72 per 1 m²), only two were generative ones, which by the time of study (03.06.2012.) had faded and started to bear fruit.

The population is in regression state, which can be observed by the total absence of seed recovery, a small area it occupies and its oppression with the surrounding trees and bushes.

From wood species there are (at the edge of area from forest side) *Quercus petraea* Liebl., *Tilia cordata* Mill., *Acer tataricum* L.; from bushes, besides *Spiraea polonica*, which has cover about 70%, presented by *Cotoneaster laxiflorus* Jacq. ex Lindl. (= *C. melanocarpus* Fisch. ex Blytt) (2%), solitary *Berberis vulgaris* L., *Cornus mas* L., *Euonymus verrucosus* Scop., *Lembotropis nigricans* (L.) Griseb, *Prunus spinosa* L., *Rosa canina* L., *R. spinosissima* L. (= *R. pimpinellifolia* L.), *Rhamnus cathartica* L., *Swida sanguinea* (L.) Opiz, *Viburnum lantana* L. The herbal layer represented by *Poa verrsicolor* Besser (10%), *Stellaria holostea* L. (3%), *Potentilla alba* L. (2%), *Anthericum ramosum* L. (1%), *Campanula bononiensis* L. (1%), *Euphorbia cyparissias* L. (1%), *Hylotelephium maximum* (L.) Holub. (1%), *Vincetoxicum hirundinaria* Medik. (1%), separately with *Betonica officinalis* L., *Dictamnus albus*, *Euphorbia cyparissias* L., *Filipendula vulgaris* Moench, *Galium mollugo* L., *Geranium sanguineum* L., *Hypericum perforatum* L., *Hylotelephium maximum* (L.) Holub., *Inula hirta* L., *Melica nutans* L., *Peucedanum cervaria* (L.) Lapeyr., *Primula veris* L., *Stellaria holostea* L., *Pyrethrum clusii* Fisch. ex Rchb., *Vincetoxicum hirundinaria* Medik., *Viscaria vulgaris* Bernh. (= *V. viscosa* (Gilib.) Asch; = *Steris viscaria* (L.) Raf.), with ferns *Polypodium vulgare* L. Well defined moss layer was represented by *Hypnum cupressiforme* Hedw. and *Dicranum scoparium* Hedw., which formed a thick cushion. Although this place is now sufficiently protected

from the influence of anthropogenic factors, the formation of forest and shade of surrounding trees could cause the depletion of this population in future.

Another species we studied – *Spiraea pikoviensis* is reliably known only from the locus classicus, but old herbarium materials, collected almost 200 years ago and not confirmed by the new collections, made researchers doubt about the existence of this taxon. After the release of "Flora of the USSR" (1954, vol. 6) (DOBROCHAEVA 1954) in the literature there appeared indications of probable location of *S. pikoviensis* in other areas, adjacent to places of the species description. Today, according to the literature (ZAVERUKHA 1985) *S. pikoviensis*, besides locus classicus, is also mentioned for Ternopil, Khmelnytsky and Zhytomyr regions. However, short primary description of species and lack of typical herbarium materials didn't allow to identity properly these samples, so it was extremely important to find a place in nature of the primary description of *S. pikoviensis*.

In 2015, for the first time after 200 years, when the species was described, we succeeded to find this habitat (FEDORONCHUK et al. 2015). As a result of the comparing of samples from the locus classicus with samples stored in herbarium KW, collected in Ternopil, Khmelnytsky and Zhytomyr regions and identified as *S. pikoviensis,* it was found that they were not identical and the latter ones should be related to *S. media*. This is also confirmed by a comparative analysis of the nucleotide sequence ITS1-5,8S-ITS2 cluster of ribosomal nuclear gene of plants collected in the Kremenets mountains, Ternopil region with sequences of other species of the genus *Spiraea*, contained in the NCBI database. It was stated that plants from Kremenets mountains, which were mistakenly misnamed in literature as *S. pikoviensis*, are actually the closest to *S. media* (BELEMETS et al. 2014). So, today only one habitat of S. *pikoviensis* (Vinnytsia region, ouskirts of. v. Pykiv) is known (Fig. 3), from which species, as mentioned, above was described by Besser on samples collected by Adzheyovsky in 1816 (BESSER 1822).

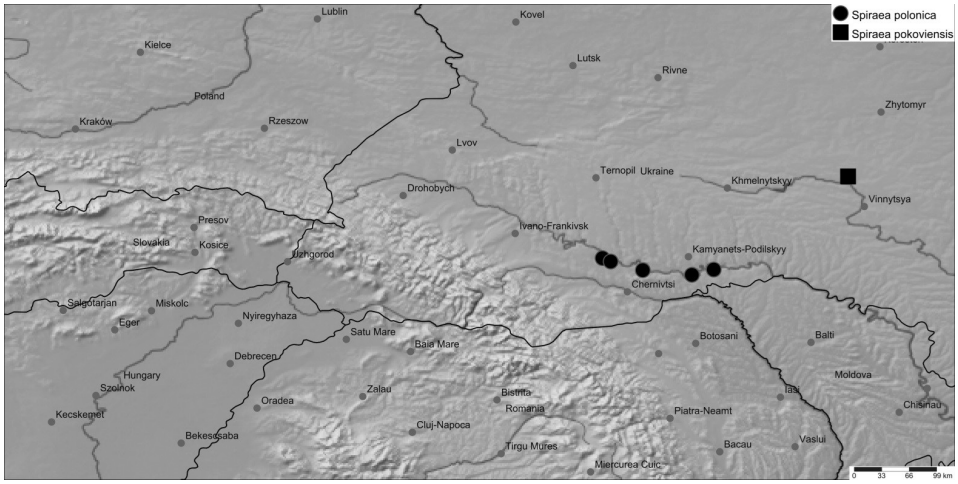

Fig. 3. The map of distribution of *Spiraea polonica* and *S. pikoviensis* (general area).

We visited this habitat (locus classicus) twice during the vegetative period (10.05.2015 and 24.06.2015). This small population (0.5 hectares), located in the northwest of the village Pykiv on overfloodplain terrace of the Snyvoda river, in the area "Pykivska dacha" (quarter 46; coordinates: N: 49º33'593"; E: 28º19'043", height 243 m asl), Khmelnykivsky forest growing company, Koziatyn forestry, Vinnytsia region. According to geobotanical zoning, the area belongs to the forest-steppe zone of the North Right-bank Dnieper geobotanical district of hornbeam-oak, oak forests, steppizated meadows and meadow steppes (DIDUKH, SHELYAG-SOSONKO 2003), and according to physical and geographic zoning – the North-West Dnieper hill area (MARYNYCH et al. 2003).

The area is slightly raised (200–250 m asl), with a slightly wavy relief, it looks like a low illuminated ridge with ledge of flat granite boulders. Natural cover is singnificantly transformed, broken and fragmented. From the floodplain of the Snyvoda river and its tributaries, the overfloodplain terrace, composed of sand light accumulative-aeolian sediments, gradually rises. There could be Ledges of Ukrainian crystalline shield in the form of low (up to few meters) flat elevations, observed which are well defined in the change of vegetation cover. On the basis of synphytoindication methods we calculated indicators of 10 main ecofactors, which can be seen in the ecologlical and coenotic profile (Fig. 4).

The communities all. *Agrostion vinealis* Sipailova, Mirkin, Shelyag et V. Solomakha 1985, ass. *Festuco valesiacae-Agrostidetum vinealis* Shelyag, Sipailova, V. Solomakha et Mirkin 1985 are formed on the accumulative sand sediments, and cl. *Sedo-Scleranthetea* (*Festuco-Sedetalia* R. Tx. 1950, all. *Thymo pulegioides-Sedion sexangulare* Didukh, Kontar 1998; ass. *Artemisio austriaci-Teucrietum chamaedrycis* Didukh, Kontar 1998) are formed on the ledges of crystalline rocks. The next terrace is composed of loam weak loess, in which crystalline rocks are inserted. Washed away grey or podzolized black soils are accumulated on loess, where the meadow and meadow-steppe communities all. *Arrhenateretalia* (*Trifolion montani* Naumova 1986, ass. *Poetum angustifoliae* (Domin 1943) Shelyag-Sosonko et al. 1986 subass. *Arrhenatherosum elatioris* Kuzemko 2009) and all. *Festucetalia valesiacae* (*Fragario viridis-Trifolion montani* Korotchenko, Didukh, 1997, ass. *Medicago romanicae-Poetum angustifoliae* Tkachenko, Movchan et V. Solomakha 1987) are formed, and cl. *Sedo-Scleranthetea* (*Artemisio austriaci-Teucrietum chamaedrycis* Didukh, Kontar 1998) are formed on the crystal plates covered with fine detritus, which turn into the dense crystalline plates.

Similar changes are observed for forest vegetation, which is rather transformed here and is presented by artificial. On sandy sediments *Pinus sylvestris* L., *Betula pendula* Roth (= *B. verrucosa* Ehrh.), *Populus tremula* L. grow, and on the grey forest soils among artificial pine plantations *Carpinus betulus* L., together with *Fraxinus excelsior* L., *Acer platanoides* L., *Cerasus avium* (L.) Moench, *Pyrus communis* L., *Malus sylvestris* (L.) Mill., form the second layer, among the shrubs *Crataegus* x *kyrtostyla* Fingerh. (= *C. fallacina* Klokov), are found and on the lawn there are thickets of *Prunus spinosa* L., separately – *Rosa dimorpha* Besser.

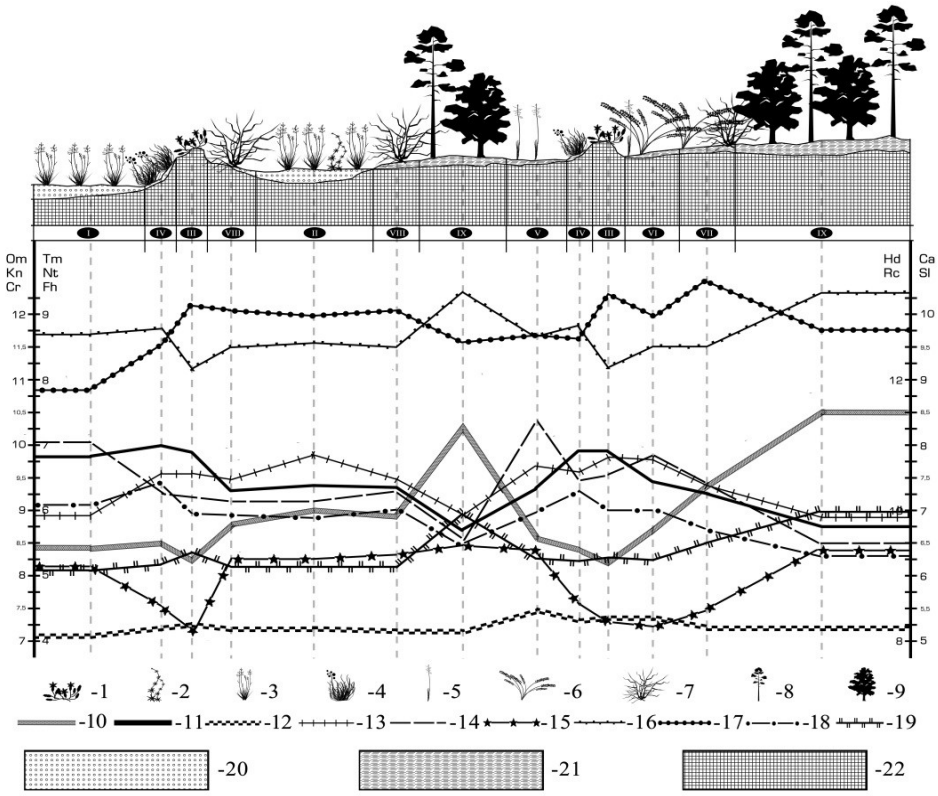

Fig. 4. Ecological and coenotic profile of the catena on the left bank of the Snyvoda river involving *Spiraea pikoviensis*.

Description of profile. **Species**: 1. *Sedum acre*; 2. *Galium verum*; 3. *Agrostis vinealis*; 4. *Festuca valesiaca*; 5. *Arrhenatherum elatius*; 6. *Spiraea pikoviensis*; 7. *Prunus spinosa*; 8. *Pinus sylvestris*; 9. *Carpinus betulus*. **Factors**: 10 – soil water regime (Hd), 11 – variability of damping (Fh), 12 – soil acidity (Rc), 13 – total salt regime (Sl), 14 – carbonate content in soil (Ca), 15 – nitrogen content in soil (Nt), 16 – thermal climate (Tm), 17 – ombroregime (Om), 18 – continentality of climate (Kn), 19 – cryoclimate (Cr). **Soils**: 20 – accumulative meadow sandy soil, 21 – podzolized gray forest soils, 22 – crystalline rocks. **Plant communities**: 1 – *Festuco valesiacae-Agrostidetum vinealis* (dom. *Festuca rubra*, *F. valesiaca*, *Agrostis vinealis*), II – *Festuco valesiacae-Agrostidetum vinealis* (dom. *Galium verum*, *Agrostis vinealis*), III – communities of *Racomitrium canescens*, *Sedum acre*, IV – *Thymo pulegioides-Sedion sexangulare* (dom. *Festuca valesiaca*, *Sedum acre*); V – *Trifolion montani*, ass. *Poetum angustifoliae* in the complex with *Fragario viridis-Trifolion montani*, ass. *Medicago romanicae-Poetum angustifoliae* (dom. *Arrhenatherum elatius*), VI – dom. *Spiraea pikoviensis* with *Arrhenatherum elatius*, VII – dom. *Prunus spinosa*, *Spiraea pikoviensis*, VIII – *Prunion spinosae*, IX – planting of *Pinus sylvestris* presence of *Carpinus betulus* and nitrophilous grasses.

The herb layer in such forests has no specific species, it is represented by atypical neutrophils (*Chelidonium majus* L., *Impatiens parviflora* DC., *Geranium robertianum* L.). Although there were hornbeam forests here before, large areas were open. In such conditions in the past numerous population S. *pikoviensis* could grow, while now these places are overgrown with dense mixed forest and the studied population is preserved only, as mentioned above in a small lawn.

The evidence of anthropogenic disturbance of this area is the remains of trenches, dugouts, which stretch through the forest. Previously, there also functioned crystalline rocks (granite) quarry. Therefore, large areas of the territory were open and later, they were planted with pine. All above mentioned indicates that almost 200 years since the discovery by A. Andzheyovsky and description by Besser *S. pikoviensis*, the possibility for existence of this species has significantly reduced. So we marked only a few places each of which occupies a few dozens square meters, where the studied species could be repatriated. Now, in the area of overfloodplain terrace, ledges of crystalline rocks are observed also in open areas outside the forest, but such conditions are not favourable for the growth of *S. pikoviensis*. Besides, there is intensive grazing.

Like in previous species (*S. polonica*), in the studied population S. *pikoviensis,* plants are also presented with dense weaving of vegetative shoots of root growth, the density of which sometimes reaches 80-85%, with thick moss cover and underlay with dead remains of grass which prevents seed recovery. However, S. *pikoviensis* population is in better condition here and only in its edger we can observe oppression of plants of studied species by the surrounding trees and bushes, that penetrate it.

Today the population of *S. pikoviensis* exists as five local parts, with 10 meters in diameter each (Fig. 5).

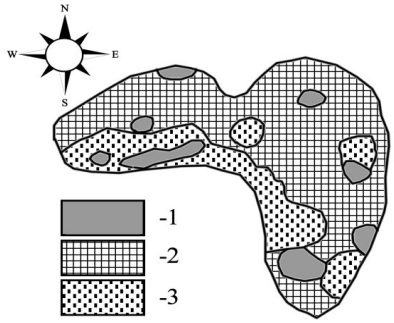

Fig. 5. Scheme of placing loci of *Spiraea pikoviensis* on the forest glade.
Symbol indicates: 1. – outputs of granites; 2 – herbal communities with the domination of *Arrhenatherum elatius*; 3 – colomy of *S. pikoviensis.*

On this glade near the surface there approach crystalline rocks, so it was not forested. We can see here the “window effect”, when surrounded by forest a lawn overgrows with shrubs (*Spiraea pikoviensis, Prunus spinosa, Chamaecytisus ruthenicus* (Fisch. ex Woł.) Klásková). The herb cover is scarce:

such species as *Arrhenatherum elatius* (10–25%), *Galium verum* L. (3–4) together with *Poa angustifolia* L. (3), *Fragaria viridis* Duchesne (3), *Euphorbia cyparissias* L. (5), *Filipendula vulgaris* Moench (3–5), *Veronica incana* L. [≡ *Pseudolysimachion incanum* (L.) Holub] (1), *V. chamaedrys* L. (2–4), *Asperula cynanchica* L., *Thymus pannonicus* All. (= *Th. marschallianus* Willd.), pre dominate, *Trifolium montanum* L., *T. alpestre* L. occur separately, so they can be considered as ecotonic ones among associate (ass.) *Carici praecocis-Thymetum marschalliani* and all. *Arrhenatherion elatii*, sometimes moss cover of *Abietinella abietina* (Hedw.) M. Fleisch is formed. These communities belong to the alliance *Prunion fruticosae* R. Tx. 1952. The thick underlay (over 10 cm) is accumulated in the thickets. The latter indicates that burning is absent here, to which *S. pikoviensis* is quite sensitive. Grasslands are dominated by *Arrhenatherum elatius*. Frequents species are *Festuca valesiaca* Gaudin (5–10), *F. rubra* L. (1), *Elytrigia repens* (L.) Nevski (5–7), *Poa angustifolia* (3), *Agrostis vinealis* Schreb. (1), *Dactylis glomerata* L. (1); *Chamaecytisus ruthenicus* (5), *Trifolium alpestre* and *T. montanum* (separately); sedges: *Carex praecox* Schreb. (5); herbs: *Fragaria vesca* L. (5), *Potentilla argentea* L. (5), *P. arenaria* Borkh. (4–7), *Filipendula vulgaris* (3–5), *Cerastium arvense* L. (5), *Galium verum* (3–4), *Euphorbia cyparissias* (5), *E. sequieriana* Neck. (+), *Veronica chamaedrys* (2–4), *V. dillenii* Crantz (1–3), *V. incana* [≡ *Pseudolysimachion incanum*] (1), *Viola tricolor* L. (= *V. matutina* Klokov) (2–3), *Achillea millefolium* L. (1–3), *Oreoselinum nigrum* Delarb. (= *Peucedanum oreoselinum* (L.) Moench (1), *Galeopsis tetrahit* L. (1), *Hylotelephium maximum* (L.) Holub. (= *Sedum telephium* (L.) (1 – in the outskirts of granite boulders), *Viscaria vulgaris* (1); occasionally occur *Iris hungarica* Waldst. & Kit., *Thalictrum minus* L., *Strophiostoma sparsiflora* (J.C. Mikan ex Pohl) Turcz. [≡ *Myosotis sparsiflora* J.C. Mikan ex Pohl], *Ranunculus auricomus* L., *Geum urbanum* L., *Taraxacum officinale* Webb. ex Wigg. aggr., *Viola hirta* L., *Ajuga reptans* L., *Anthriscus sylvestris* (L.) Hoffm. Well observed moss cover, is presented with *Racomitrium canescens* (Hedw.) Brid. (it dominates here, especially in the granite ledges), *Brachythecium albicans* (Hedw.) Schimp., *Pladiomnium cuspidatum* (Hedw.) T.J. Kop., *Abietinella abietina*, *Polytrichum juniperinum* Hedw., *P. piliferum* Hedw.

On the edges of stone plates the herbage rarefies, *Festuca valesiaca*, *Sedum acre* L. dominate, and in the center there are spots of mosses *Racomitrium canascens*, *Polytrichum juniperinum*, *P. piliferum*, *Ceratodon purpureus* (Hedw.) Brid.

Characteristics of econiches of *Spiraea polonica* and *S. pikoviensis* species

For the taxonomic estimation of these taxa, both analisys of morphological features and the character of their spreading and ascertainment of ecological and coenotic conditions of population habitats, i.e. evaluation of their ecological niche are equally important.

The estimation of econiche suggests the characteristics of its biomorphological and ecological and coenotic properties, allowing species to

adapt to ecospace of corresponding biotope and compete with other species (DIDUKH 2014).

The studied species of the *Spiraea* genus, biomorphologically are bushes, nanophanerofits of 60–80 cm height. From coenotic point of view, these are very powerful edificators (dominant species), which form dense thickets, with a high cover. In general, the plants of this type vegetate, blossom and bear fruit well, but in natural environment the seed recovery is not observed. However the conditions, where such recovery could be possible, is limited by trees shading, by the ledges of crystalline rocks where the soil is absent, that prevents seed germination as well as plants rooting.

The estimation of quantitative indices of ecofactors (Fig. 6) and ecological and coenotic characteristics shows that *S. pikoviensis* and *S. polonica* grow in ecotonic conditions of forest edges and are characterized by narrow ecological and coenotic amplitude.

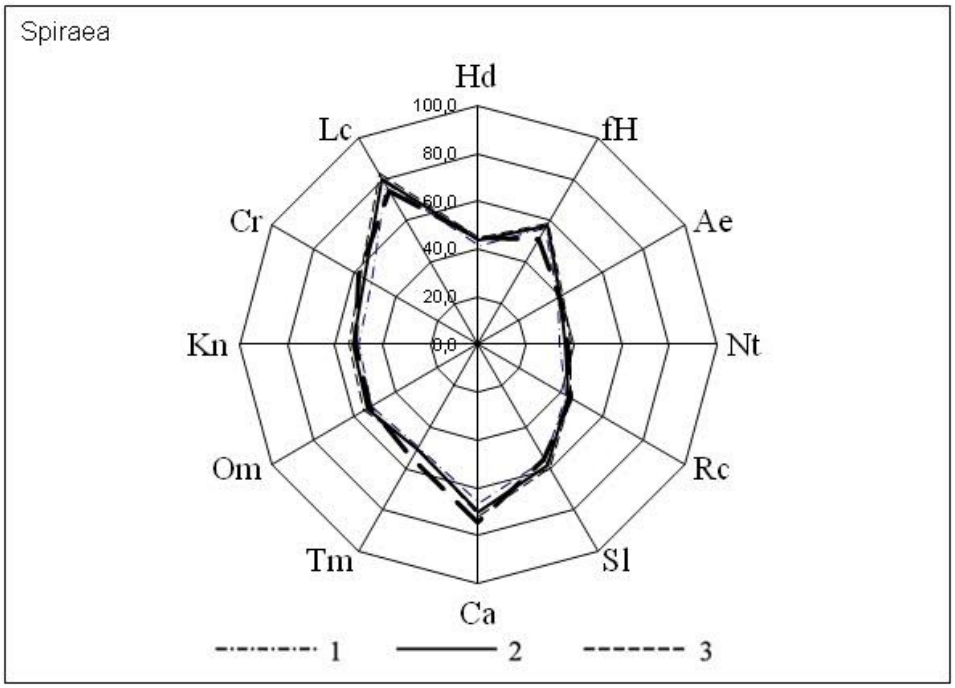

Fig. 6. Graphic representation of econishe by the leading ecofactors for *Spiraea pikoviensis* and *S. polonica* (as a percentage of corresponding larger scales). Factors: (Fig. 4). Hd – moisture of soil (max. 23 points), fH – variability of moisture (11), Ae – aeration of soil (15), Nt – content of mineral forms of nitrogen (11), Rc – acidity of soil (15), Sl – salt content of soil (19), Ca – carbonate content of soil (13), Tm – termorezhym (17), Om – ombrorezhym (23), Kn – continental of climate (17), Cr – crioclimate (15), Lc – luminosity (9); 1 – minimum value, 2 – mean value, 3 – maximum value.

Figure 6 shows that econiches of these taxa are rather similar, but *S. polonica* grows in conditions with lower factors of moisture and ombroregime, and with higher temperature conditions and carbonate content.

Conclusions

Thus, the studies have shown that *Spiraea polonica* and *S. pikoviensis* exist as local populations, the area of which decreases. The main limiting factors of these populations functioning are: the presence of thick moss cover and underlay with dead remains of grass, that prevent seed recovery; the shading with high trees surrounding the lawns; the replacement of plants with trees and shrubs that penetrate into thickets; and full areas openness, where the grazing or burning occur which are observed outside the forest (for *S. pikoviensis*).

These characteristics can be viewed as threats to species existence, which behavior fits the theory of the relics replacement (DIDUKH 1988). The idea of "withdrawing relicts" theory of Darlington is that a lot of species grow not in broken coenosis but in conditions of small coenotic competition, because of immediate influence of anthropical factor. Because of low number of repatriation places, limitness of seeds move agents (because of forest surrounding), the probability of the populations loss is high. According to our estimation criteria of risk losses (DIDUKH 2014), which is estimated according to the effect of surrounding threats and natural conservation of biotopes for species existence, this risk is extremely high and is over 83%. Biotopes with such indicator belong to the I st class – a very rare one. According to IUCN classification, we refer these types to the category of CR (threatened) that require complex of special protection measures. Therefore, the conservatin of these species localities requires in the first turn stopping the overgrowth of areas with trees and shrubs, their regular thinning out and further observation of the state of populations.

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