Acta Bot. Croat. 78 (2), 155–163, 2019
DOI: 10.2478/botcro-2019-0013

CODEN: ABCRA 25
ISSN 0365-0588
eISSN 1847-8476

Phytosociology and biodiversity patterns of annual wetland communities of Pyriatynskyi National Nature Park (Poltava Oblast, Ukraine)

Oleksii Kovalenko*, Mariia Kalista

Department of Botany, National Museum of Natural History of NAS of Ukraine, Bohdana Khmelnytskoho 15, 01607 Kyiv, Ukraine

Abstract – The results of a comparative structural analysis of the annual wetland herb vegetation syntaxa (class *Isoëto-Nano-Juncetea*) of Pyriatynskyi National Nature Park (Poltava Oblast, Ukraine) are presented. The systematic, biomorphological, ecological and geographical structures of syntaxa were studied using cluster, discriminant and factor analysis. The principal conformity of the floristic similarity dendrogram and the previously developed classification scheme were analysed. It was revealed that the leading factor of coenosis development is the soil moisture, while most parameters of these ecotopes are constant. The critical differentiation of *Nano-Cyperion* and *Eleocharition ovatae* alliances and the legitimacy of the recognition of the *Radiolion linoidis* alliance and *Polygono recti-Juncetum juzepczukii* association as separate syntaxa of the main ranks are emphasized.

Keywords: analysis of syntaxa, annual wetland, herb vegetation, Isoëto-Nano-Juncetea vegetation, syntaxonomy

Introduction

One of the problems of modern phytosociology is the harmonization of regional systems of classification and monographic processing of some classes of vegetation. This fully applies to dynamic and compositionally complex communities of the annual wetland herb vegetation belonging to the class *Isoëto-Nano-Juncetea* Br.-Bl. et Tx. ex Br.-Bl. et al. 1952. Despite more than a century of research in Western and Central Europe (Ellenberg 1982), as well as recent intensive research in Siberia and Eastern Europe (Taran 1993, 1995, 2001, Senchylo and Goncharenko 2008a, b, Shapoval 2006, Golub et al. 2007, Kovalenko 2014), there is considerable confusion in the definition and interpretation of the main associations and alliances of this class. To build a stable hierarchical system of *Isoëto-Nano-Juncetea,* we propose to use a complex comparative and structural analysis of determined syntaxa as multiparameter systems (Senchylo and Goncharenko 2008a).

Materials and methods

We studied the annual wetland herb vegetation of the Pyriatynskyi National Nature Park (NNP) (Poltava Oblast, Ukraine) in 2010–2012. We have already proposed its syntaxonomical scheme and described 2 associations as new for science (Kovalenko 2014).

The floristic similarity of the syntaxa determined was counted using the Index of inclusion of Kulchytsky (Semkin and Komarova 1977). Peculiarities of ecological differentiation of communities of the annual wetland herb vegetation were assessed by the method of synphytoindication (Didukh and Pliuta 1994), using the ecological scales of Didukh (2011). The comparative and structural analysis of the syntaxa was carried out according to 5 groups of parameters: taxonomical, biomorphological (the main type of biomorph, the character of seasonal vegetation, the structure of the above-ground and underground shoots, the type of the root system, the type of pubescence, the methods of pollination and dissemination), the chorological (type of range, chorionic element and activity), ecological and coenotical (tolerance for climatic and edaphic factors, ecological strategy) block and the block of transformation of flora (tolerance for anthropogenic factors, resistance to conditions of urbanization and hemeroby). The basic principles of the allocation of these categories are justified in the works of Novosad and Krytska (2010) and also Senchylo and Goncharenko (2008a).

* Corresponding author e-mail: corydalis@ukr.net, crambe@ukr.net

In our analysis we used the parameter "purity of syntaxon", which means the percentage ratio of the diagnostic species to the general list of flora. It indicates a role of the ephemeral annuals in the composition of communities that are critically important for the determination of the syntaxa of the *Isoëto-Nano-Juncetea* class.

For factor analysis, we used 121 non-discrete parameters of the systematic, biomorphological, ecological-coenotical and geographical structures. This data set includes floristic information and results of ordination by the phytoindication method.

The data obtained were used for cluster, canonical discriminant and factor analysis in the Statistica 7.0 program (StatSoft).

Results

Annual wetland communities of Pyriatynskyi National Nature Park are presented by 1 order, 4 alliances and 7 associations:

Cl. *Isoëto-Nano-Juncetea* Br.-Bl. et Tx. ex Br.-Bl. et al. 1952
Ord. *Nano-Cyperetalia* Klika 1935
All. 1. *Nano-Cyperion flavescentis* Koch ex Libbert 1932
Ass. 1. *Cyperetum flavescentis* Koch ex Aichinger 1933
2. *Juncetum bufonii* Felföldy 1942
All. 2. *Eleocharition ovatae* Philippi 1968
Ass. 3. *Cyperetum micheliani* Horvatić 1931
4. *Eleocharito acicularis–Limoselletum aquaticae* Wendelberger-Zelinka 1952
All. 3. *Radiolion linoidis* Pietsch 1973
Ass. 5. *Psammophiliello–Juncetum nastanthi* Kovalenko 2014
All. 4. *Verbenion supinae* Slavnič 1951
Ass. 6. *Polygono recti–Juncetum juzepczukii* Kovalenko 2014
7. *Eragrostidetum suaveolentis* Golub et al. 2007

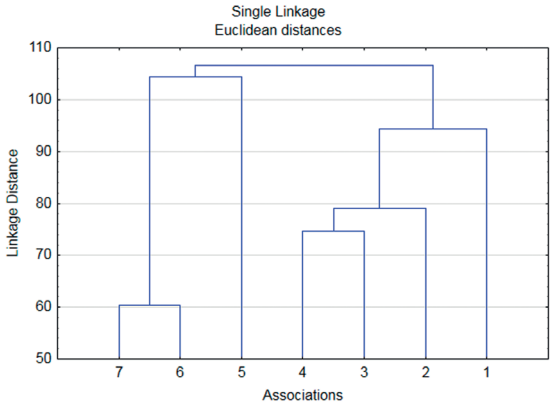

Fig. 1. Dendrogram of the floristic similarity of associations of the annual wetland herb vegetation of Pyriatynskyi NNP: 1 – *Cyperetum flavescentis*; 2 – *Juncetum bufonii*; 3 – *Cyperetum micheliani*; 4 – *Eleocharito acicularis–Limoselletum aquaticae*; 5 – *Psammophiliello–Juncetum nastanthi*; 6 – *Polygono recti–Juncetum juzepczukii*; 7 – *Eragrostidetum suaveolentis.*

The analysis of the floristic similarity of syntaxa (Online Suppl. Tab. 1) with subsequent clustering is followed by dendrogram (Fig. 1). The branching of trees did not change significantly depending on the chosen binding parameters.

The first clade was formed by associations of *Verbenion supinae* and *Radiolion linoidis* alliances. The associations of *Verbenion supinae* are the most similar to each other by floristic criteria. *Psammophiliello–Juncetum nastanthi* association is well-separated from this alliance. The second cluster of the dendrogram was formed by associations belonging to two alliances (*Nano-Cyperion flavescentis* and *Eleocharition ovatae*).

The basic coeofloristic proportions are the parameter that shows the systematic richness of the syntaxa (number of genera and species per one family). This parameter is similar for the determined syntaxa of *Isoëto-Nano-Juncetea* (Tab. 1).

Tab. 1. Coenofloristic proportions of the syntaxa of the Isoëto-Nano-Juncetea of Pyriatynskyi National Nature Park.The basic proportions are parameters that indicate an average number of species in families and average number of genera in families in floristic composition. Generic coefficient is an average number of species in all genera. Magnoliopsida to Liliopsida ratio is a ratio of monocots to dicots. Species richness of coenoses is a parameter that indicates a number of species in one relevé with average standard deviation as numbers. The "Purity of syntaxon" is a ratio of diagnostic species within the floral composition (first number indicates absolute number of community diagnostic species; the second number indicates a percentage contribution).

Syntaxon	Basic proportions	Generic coefficient	Magnoliopsida to Liliopsida ratio	Species richness coenoses	«Purity syntaxon» (%)
Cyperetum flavescentis	1 : 1.47 : 1.73	1.18	2	11.08±3	10; 38.46
Juncetum bufonii	1 : 1.27 : 1.64	1.29	2.6	6.64±3	13; 72.22
Cyperetum micheliani	1 : 1.38 : 1.75	1.27	3.67	10.64±7.81	21; 75
Eleocharito-Limoselletum	1 : 1.76 : 2.44	1.39	2.42	7.55±5.45	16; 26.23
Psammophiliello-Juncetum	1 : 1.08 : 1.33	1.23	2.2	9.26±3.74	12; 75
Polygono-Juncetum	1 : 2.4 : 3.2	1.33	3.2	9±5	13; 40.63
Eragrostidetum suaveolentis	1 : 1.62 : 1.77	1.1	3	8.46±2.54	17; 73.91
Nano-Cyperion	1 : 1.39 : 1.94	1.4	1.5	8.96±4.04	17; 48.57
Eleocharitionovatae	1 : 1.71 : 2.54	1.48	2.63	7.88±7.62	23; 32.39
Radiolion linoidis	1 : 1.08 : 1.33	1.23	2.2	9.26±3.74	12; 75
Verbenion supinae	1 : 2.38 : 2.93	1.33	2.73	9.12±3.78	18; 43.9
Nano-Cyperetalia and *Isoëto-Nano-Juncetea*	1 : 2.41 : 3.89	1.62	1.94	8.74±8.63	41; 39.05

The percentage ratio of diagnostic species to the general list of flora ("purity of syntaxon") negatively correlates with the duration of vegetation of communities, reaching the minimum values for the most trivial association of *Eleocharito-Limoselletum* (On-line Suppl. Fig. 1).

The genus *Juncus* dominates in the annual wetland herb vegetation of Pyriatynskyi NNP (6 species, 5.7%). This also corresponds to the phytocoenotic role of its representatives in characteristic coenoses. The *Carex* genus in the communities studied is represented by 5 species (4.77%), but with no typical ephemerals among them. The third position is occupied by the temperate-tropical *Persicaria* genus (4, 3.81%), whose representatives are particularly active in the coenoses of the *Eleocharition ovatae* alliance. Also, four species in the phytocoenoses of the annual wetland herb vegetation belong to the *Polygonum* genus, which has the highest constancy in the *Verbenion supinae* alliance.

Among the morphological traits (Tab. 2) of the floristic composition of the class *Isoëto-Nano-Juncetea*, monoecious plants (including facultative ones) take the first place, slightly ahead of the relative number of herbaceous perennial plants. An almost equal ratio of these two life forms is characteristic for the communities *Cyperetum flavescentis* and *Eleocharito-Limoselletum*, and also in general for the unions of *Nano-Cyperion* and *Eleocharion ovatae*, while the remaining syntaxa have a considerable dominance of annuals. Perennial plants, as a rule, do not undergo a full cycle of development and are represented mainly by pregenerative age states in communities of the annual wetland herb vegetation.

According to the type of above-ground shoots, the main group is composed of erosulate plants; only in the association *Cyperetum flavescentis* do semirosette forms have the main position. A distinctive feature of the communities *Isoëto-Nano-Juncetea* is the high share of species with an ephemeral type of vegetation. With decreasing humidity of specific habitats, the relative participation of summer-green plants increases, reaching the maximum values in the communities of the *Verbenion supinae*. The plants with fibrous root systems are more common in mesohygrophytic conditions, whereas with increasing xerophyticity the specific gravity of the tap root species increases. In the type of underground shoots, plants without rhizomes predominate, although the involvement of the short rhizome species is noticeable in the composition of the vegetative cover of hygrophytic and mesophytic alliances of *Nano-Cyperion*, *Eleocharion ovatae* and *Radiolion linoidis*.

Most annual wetland herbs are insect-pollinated or wind-pollinated plants (Fig. 2a), however, self-pollination has a significant part in the phytocoenosis of the class. The specific gravity of the latter increases in the most extreme habitats typical of the associations *Juncetum bufonii* and *Psammophiliello-Juncetum*.

The leading ways of diasporas dispersal are anemochory, barochory, zoochory (mainly epizoochory) and hydrochory (Fig. 2b). The ratio of representatives of these dissemination strategies does not change significantly in each individual syntaxon.

Seasonal fluctuations of moisture conditions from hygrophilic to xeromesophilic are reflected in the distribution of species according to the degree of pubescence (Fig. 2c). In all coenoses, the group of non-pubescent plants is dominant, and in communities with the shortest period of flooding (*Radiolion linoidis* and *Verbenion supinae*), the proportion of heavily pubescent species is increased, while the prolonged phase of moistening promotes the groups of medium-inferior species.

Tab. 2. Morphological traits structure of the annual wetland herb vegetation syntaxa of Pyriatynskyi National Nature Park.

Syntaxon	Life form %)			Aboveground shoots (%)			Root system (%)		Phenological groups (%)			Underground shoots (%)			
	Annuals	Perennials	Trees	Rosette	Semirosette	Eosulatete	Taproot	Fibrouse	Ephemerals	Summer-green	Summer-winter-green	Without rhizome	Long-rhizome	Short rhizome	Caudex
Cyperetum flavescentis	50.0	50.0	0.0	11.5	53.9	34.6	38.5	61.5	62.3	29.2	38.5	50.0	19.2	23.1	7.7
Juncetum bufonii	77.8	22.2	0.0	16.7	38.9	44.4	66.7	33.3	66.7	22.2	11.1	72.2	0.0	22.2	5.6
Cyperetum micheliani	78.6	21.4	0.0	7.1	32.1	60.8	60.7	39.3	71.4	21.4	7.1	78.5	3.6	14.3	3.6
Eleocharito-Limoselletum	55.7	42.7	1.6	9.8	39.4	50.8	50.0	50.0	31.1	42.7	26.2	47.6	18.0	24.6	9.8
Psammophiliello-Juncetum	75.0	25.0	0.0	18.8	25.0	56.2	50.0	50.0	43.8	37.5	18.7	75.0	0.0	25.0	0.0
Polygono-Juncetum	71.8	21.9	6.3	0.0	58.5	41.5	53.1	46.9	40.6	501	9.3	78.1	3.1	9.4	9.4
Eragrostidetum suaveolentis	87.0	8.7	4.3	0.0	43.5	56.5	60.9	39.1	56.5	34.8	8.7	91.4	4.3	4.4	0.0
Nano-Cyperion	54.3	45.7	0.0	11.4	48.6	40.0	48.6	51.4	42.9	25.7	31.4	54.2	14.3	22.9	8.6
Eleocharition ovatae	51.4	47.1	1.5	58.6	35.7	45.7	50.0	50.0	30.0	45.7	24.3	52.8	15.7	22.9	8.6
Radiolion linoidis	75.0	25.0	0.0	18.8	25.0	56.2	50.0	50.0	43.7	37.5	18.8	75.0	0.0	25.0	0.0
Verbenion supinae	77.8	17.8	4.4	0.0	44.5	55.5	66.7	33.3	37.8	48.9	13.3	82.2	4.4	6.7	6.7
Nano-Cyperetalia and *Isoëto-Nano-Juncetea*	55.8	42.3	1.9	6.7	48.2	45.1	51.0	49.0	29.8	26.0	44.2	58.7	14.4	20.2	6.7

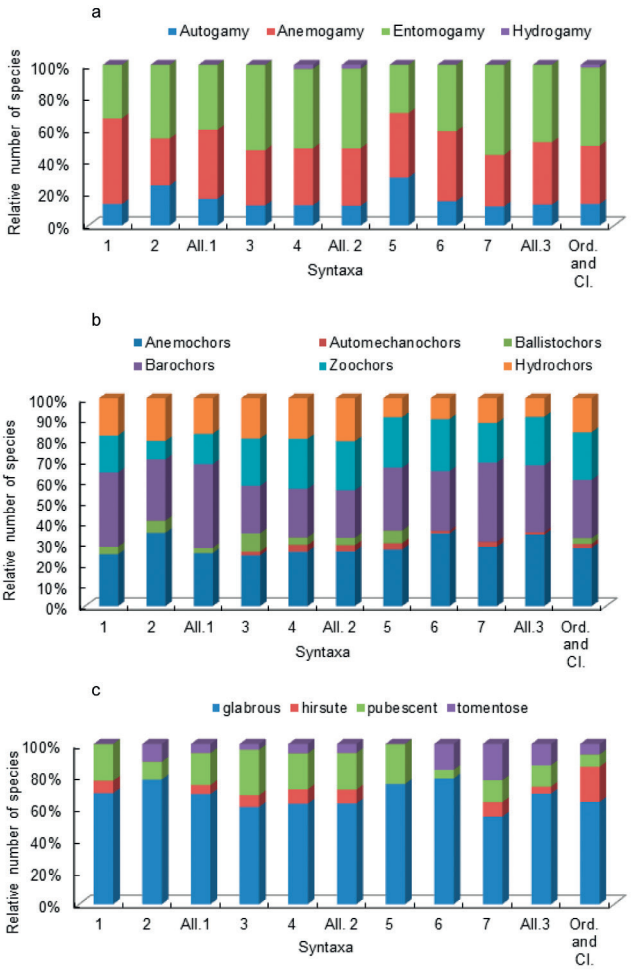

Fig. 2. The types of pollination (a), dissemination (b) and pubescence (c) of syntaxa *Isoëto-Nano-Juncetea* plants. 1 – *Cyperetum flavescentis*; 2 – *Juncetum bufonii*; 3 – *Cyperetum micheliani*; 4 – *Eleocharito acicularis–Limoselletum aquaticae*; 5 – *Psammophilielo–Juncetum nastanthi*; 6 – *Polygono recti–Juncetum juzepczukii*; 7 – *Eragrostidetum suaveolentis*; All.1 – *Nano-Cyperion*; All.2 – *Eleocharition ovatae*; All.3. – *Verbenion supinae.* Contribution of different species (%) are presented.

Soil humidity has the leading value among factors characterizing edaphic conditions (Didukh 2011). According to it, the highest range of amplitude has *Eleocharito acicularis–Limoselletum aquaticae.* Communities of these associations are common for the national park and forms in habitats with different regimes of humidity. Associations *Cyperetum flavescentis, Juncetum bufonii* and *Cyperetum micheliani* have similar values of these factors. The vegetation of the alliances *Radiolion linoides* and *Verbenion supinae* are presented on the most xeric soils. The communities of *Eragostidetum suaveolentis* are clearly different from *Polygono-Juncetum* according to their humidity regime (Fig. 3a).

The variability of moisture is very important factor for annual wetland communities. All associations excluding *Eragostidetum suaveolentis* and *Polygono-Juncetum* have a similar range of values. Dry soils in the habitats of *Verbenion supinae* are the main reason for the invasion of species with adaptation to hydrocontrastophily (irregular wetting of soil layer) in characteristic communities (Fig. 3b).

According to the relations of associations to soil acidity and total salt regime we can clearly see the differentiation of *Cyperetum flavescentis* due to existing soils with sodium sulphate salting (Figs. 3c, d). This association has a higher rank of carbonate content in the soil too (Fig. 3e). Also, *Radiolion linoides* communities grow on chernozems, enriched enough with carbonates.

Almost all associations have similar ranks of nitrogen content in soil. The most nitrophilic syntaxa are *Cyperetum flavescentis* and *Eleocharito acicularis–Limoselletum aquaticae.* On the other hand, communities of *Eragostidetum suaveolentis* include a lot of plants that grow on poor mineral-nitrogen oligotrophic soils (Fig. 3f).

Soil aeration limits the distribution of many ephemeral annual herbs. The highest ranking (9.37) is *Eleocharito acicularis–Limoselletum aquaticae,* the lowest rank (6.44) is characteristic for *Eragostidetum suaveolentis.* Other syntaxa are very similar (Fig. 4a) according to this parameter (7.33–8.67).

According to the thermal climate and humidity, all of the associations demonstrated no significant value of variation (Figs. 4b, c). Other climate parameters are the source of differentiation of *Isoëto-Nano-Juncetea* syntaxa. In *Juncetum bufonii* and associations of *Radiolion* and *Verbenion* subcontinental species prevail. In the other syntaxa, we determined the dominance of hemi-oceanic elements (Fig. 4d).

By the parameter of the cryo-climate, we identified *Cyperetum flavescentis* as the most cryophilic association due its northern area of distribution (Fig. 4e).

The regimes of light in characteristic habitats of the annual wetland vegetation are similar. Most syntaxa have strict ranges of amplitude by this parameter. Only communities of *Polygono-Juncetum* have lower value of light due their development in partly woody areas (Fig. 4f).

The canonical discriminant analysis showed a clear dispersion of the *Cyperetum flavescentis*, *Cyperetum micheliani, Eleocharito-Limoselletum* and *Eragrostidetum* associations (Fig. 5). The remaining associations from three different alliances demonstrated a significant overlap in the amplitudes of the whole set of ecological parameters studied, as already mentioned above.

The chorological core of the class in the national park is wide-ranging progressive species with Holarctic (22; 31.73%), cosmopolitan (22, 21.15%) and Palaearctic (12, 11.53%) types of areas. The proportion of geographic elements has a similarity in all syntaxa, with the exception of the *Verebenion*. In this alliance, cosmopolitan species dominate.

Anthropogenic transformation of communities of the annual wetland vegetation ephemeretum is manifested in the significant representation in the general list of flora of euhemerobes (27; 25.96%) and mesohemerobes (40; 38.46%). Euhemerobes are particularly active in the coenoses of the association *Eragrostidetum suaveolentis*, but in more humid conditions they are rare.

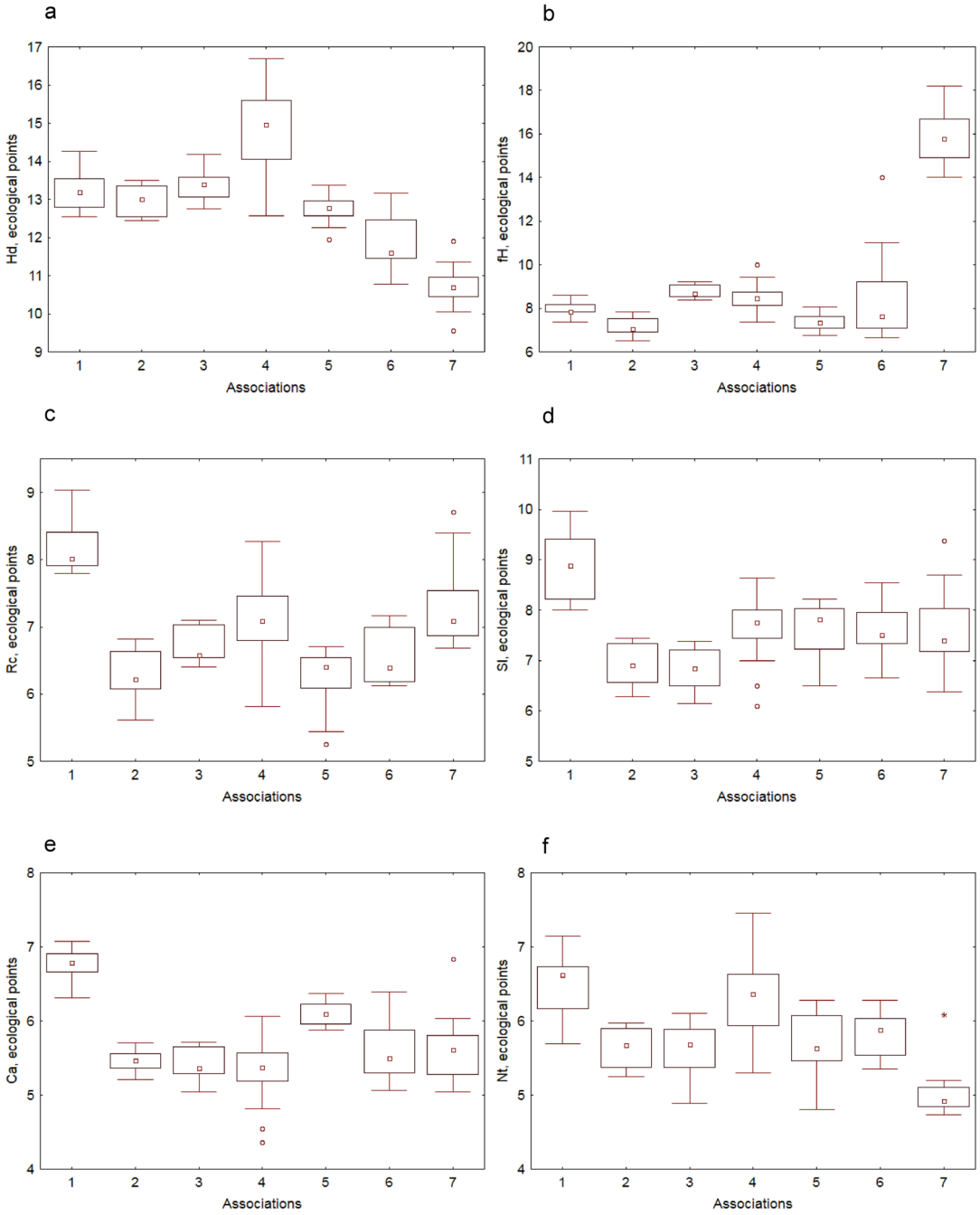

Fig. 3. Box-whisker plot for distribution of associations of the class *Isoëto-Nano-Juncetea* by: a) soil humidity (Hd); b) moisture (fH); c) acidity (Rc); d) total salt regime (Sl); e) carbonate content in soil (Ca); f) nitrogen content in soil (Nt). 1 – *Cyperetum flavescentis*; 2 – *Juncetum bufonii*; 3 – *Cyperetum micheliani*; 4 – *Eleocharito acicularis–Limoselletum aquaticae*; 5 – *Psammophiliello–Juncetum nastanthi*; 6 – *Polygono recti–Juncetum juzepczukii*; 7 -*Eragrostidetum suaveolentis*. Box-whisker plot: centre line denotes median value, the box encloses the inner two quartiles (25th and 75th percentile), and the whiskers display the 10th and 90th percentile.

The ratio of urbanophiles, urbanoneutral and urbanophobic species is correlated with the previous indicator. Among the apophytes, the prevalent hemiapophytes (29; 54.71%), euapophytes and random apophytes in all syntaxa are represented uniformly.

The lowest percentage of alien species was noted for the alliances of *Nano-Cyperion* and *Radiolion lionoidis* (5.50% and 6.25% respectively), while similar indicators for the alliances *Eleocharition ovatae* (12.86%) and *Verbenion supinae* (21.95%) are significantly higher. The absolute majority of alien species are coenophytes (10, 66.67%) predominantly of North American origin (8, 53.33%).

The factor analysis by the principal components method (Fig. 6) showed, on one hand, a significant affinity for the associations *Cyperetum micheliani* and *Juncetum bufonii*, which are discrete in floral, physiognomic and ecologi-

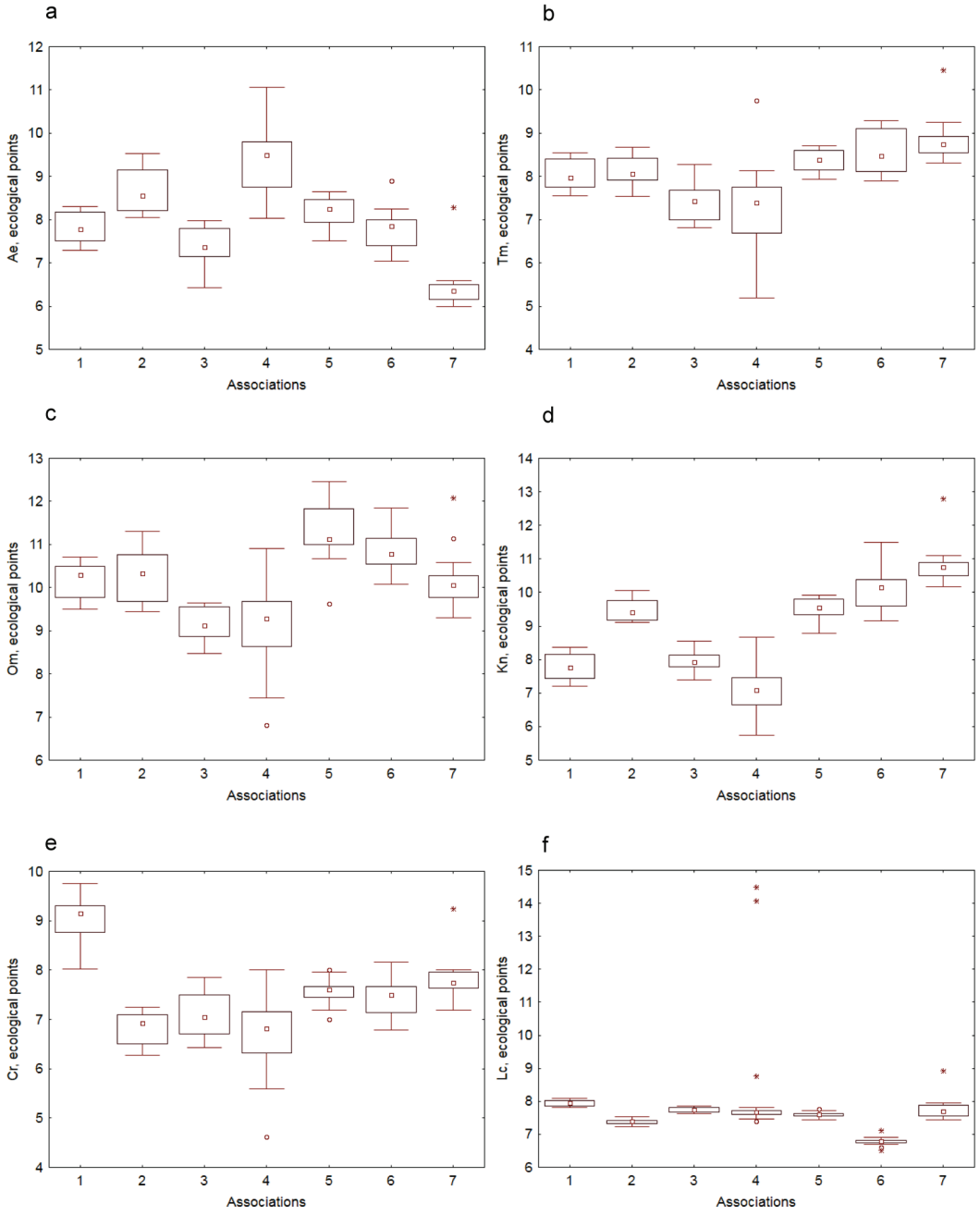

Fig. 4. Box-whisker plot for distribution of associations of the class *Isoëto-Nano-Juncetea* by: a) aeration (Ae); b) thermal climate (Tm); c) humidity (Om); d) continental climate (Kn); e) cryoclimate (Cr); f) light in community (Lc). 1 – *Cyperetum flavescentis*; 2 – *Juncetum bufonii*; 3 – *Cyperetum micheliani*; 4 – *Eleocharito acicularis–Limoselletum aquaticae*; 5 – *Psammophiliello–Juncetum nastanthi*; 6 – *Polygono recti–Juncetum juzepczukii*; 7 – *Eragrostidetum suaveolentis*. Box-whisker plot: centre line denotes median value, the box encloses the inner two quartiles (25th and 75th percentile), and the whiskers display the 10th and 90th percentile.

cal relationships while on the other hand it clearly delineated the associations of the *Verbenion supinae* association, which were close by the same criteria.

Discussion

Results of cluster analysis of syntaxa correspond strongly to the obtained scheme of classification. However, the association *Juncetum bufonii* did not unite with the *Cyperetum flavescentis*, as might be expected according to the syntaxonomic position. *Juncetum bufonii* has a high level of floristic similarity with associations of the *Eleocharition ovatae* alliance. On one hand, this result confirms the need for the recognition of the separate alliance *Juncion bufonii* Philippi 1968 or, by contrast, a wider understanding of the *Nano-Cyperion* alliance, as suggested by a number of authors (Borhidi 2003, Sanda et al. 2008), but without inclusion in its communities of *Radiolion linoidis*. In our opinion, this discrepancy between the dendrogram and the proposed syntaxonomic scheme is due to the regional difference of *Juncetum bufonii*

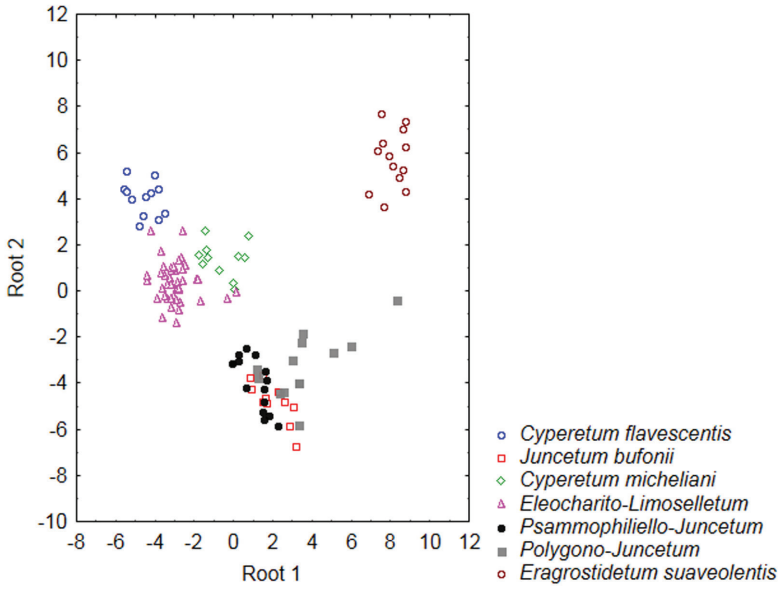

Fig. 5. Differentiation of phytocoenoses of the annual wetland herbs vegetation in the space of two discriminant functions according to the data of ecological analysis.

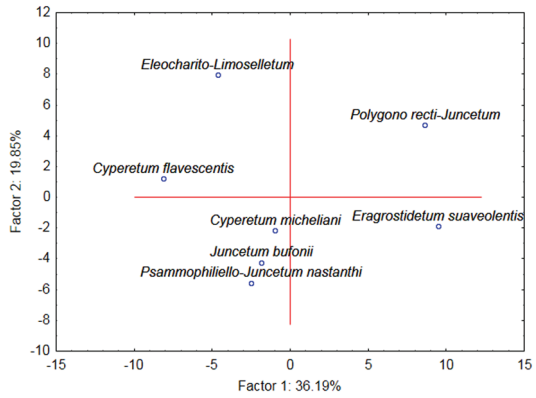

Fig. 6. Distribution the annual wetland herb vegetation associations in the multifactorial space.

communities with their main distribution area in the north, as well as their spatio-functional contacts with the phytocoenoses of the *Eleocharion ovatae* alliance. Coenofloristic proportion diagnoses a rather low overall level of species diversity, which is due to the unique ecological parameters of the characteristic communities of the class. Due to the increase of the moisture gradient, the coenotic role and representation of monocots in the communities also increase. The spectrum of the leading families of the annual wetland herb vegetation differs significantly from analogous relationships for other types of vegetation. In addition, if the dominance of the representatives of *Asteraceae* and *Poaceae* is the background for most of the coenofloras of the Holarctic temperate zone, and the increasing role of *Cyperaceae* is typical for communities of *Phragmiti-Magno-Caricetea* and *Scheuchzerio-Caricetea nigrae* classes, then the high positions of *Polygonaceae* and *Juncaceae* are a distinctive feature for *Isoëto-Nano-Juncetea*.

The ecological analysis of *Isoëto-Nano-Juncetea* vegetation showed the clearest differentiation of associations according to the soil moisture factor. The *Nano-Cyperion* alliance is traditionally considered the most hygrophytic. However, we find communities of *Cyperetum micheliani* and *Eleocharito-Limoselletum* associations in conditions with higher soil moisture. The answer to whether this is a regional specificity, or yet more evidence in favour of an expanded understanding of the *Nano-Cyperion* will be given by detailed comparative studies of the ecological amplitude of the union throughout the range. According to substrate chemistry, most associations did not show significant differences. In the general background, only the *Cyperetum flavescentis* association, genetically linked to weakly saline ecotopes, stands out. Concerning the factors of thermo-regime and continentality, the association *Eragrostidetum suaveolentis*, described from the Volga-Akatubinsk annual wetland herb vegetation, is clearly differentiated, and found its western boundary of distribution here.

The coenotic differentiation of the syntaxa of annual wetland vegetation is formed mainly due to the moisture factor against the background of the constancy of the edaphic and climatic conditions of the habitats. The communities of class *Isoëto-Nano-Juncetea* consist predominantly of species that have a wide eco-coenotic amplitude (generalists and semi-generalists according to Novosad and Krytska (2010)). The main fragments of their coenotic distribution are in the space of classes *Phragmiti-Magno-Caricetea*, *Molinio-Arrhenetheretea* and *Scorzonero-Juncetea*. It should also be noted that in communities of the annual wetland vegetation, such species are represented either by special forms or by the pregenerative age stages. The role of species with narrow coenotic amplitude (specialists and semi-specialists) increases in the spatially restricted communities of the alliances *Nano-Cyperion* and *Verbenion*. The low value of total coverage and the mo-

saic of the grass stand and the weakly expressed dominance in the studied communities contribute to the active introduction of alien species (alien species account for 14.42%), among which the most constant are *Bidens frondosa*, *Conyza canadensis* and *Iva xantiifolia*. Some of the alien species have a high coenotic value and are therefore considered as diagnostic species, for example, *Juncus tenuis* for the alliance, *Nano-Cyperion*, *Epilobium adenocaulon* and *Digitaria ischaemum* for *Verbenion supinae*. It is interesting that such a status for them is also characteristic within the primary areas (Brullo and Minisalle 1998, Šumberová 2011). This analysis confirms the vulnerability of the annual wetland communities to the factor of human pressure, as well as the abundant evidence of the radical transformation and elimination of *Isoëto-Nano-Juncetea* phytocoenoses in Western and Central Europe (Korneck 1960, Philippi 1968, Pietsch 1973, Popiella 1996, Šumberová 2011). The results of factor analysis are additionally against synonymization of *Polygono-Juncetum* with *Eragrostidetum suaveolentis* as some authors proposed (Dubyna et al. 2016). The problem of determining the ceonoses of *Nano-Cyperion, Radiolion* and *Eleocharition* is obvious, at least at the regional level. The peculiarity of the association *Eleocharito-Limoselletum* is explained by the largest representation, and as a consequence, by the diversity of its communities on the territory of Pyriatynskyi NNP.

Conclusions

Analysis of the syntaxa of the annual wetlands vegetation as multiparameter systems revealed a complex picture of their differentiation in a system of floral, ecological and geographic coordinates. The dendrogram of the floristic similarity of phytocoenes largely coincides with the early classification of vegetation of the class *Isoëto-Nano-Juncetea* developed for Pyriatynskyi NNP. The systematic and biomorphological structure of the determined syntaxa is quite original due to the ecological and phenological uniqueness of the studied communities. According to the data of the synphytoindication, the leading factors of the variety of annual wetland communities are the soil, humidity and to a lesser extent, salt regime against the background of the constancy of the remaining ecological parameters. The geographic structure of the lower-level syntaxa is quite conservative and coincides with that for the class. Anthropogenic pressure on the communities of *Isoëto-Nano-Juncetea* cases increasing role of anthropophilic elements in the composition of the vegetation cover. As a consequence, the development of special measures for the protection of this unique type of vegetation is necessary. A complex comparative study of *Isoëto-Nano-Juncetea* syntaxa analysis pointed on one hand to the critical nature of the distinction between the *Nano-Cyperion* and *Eleocharion ovatae* alliances and on the other hand confirmed the acceptability of the *Radiolion linoidis* as a separate syntaxon, and the legitimacy of distinguishing associations *Eragrostidetum suaveolentis* and *Polygono-Juncetum.*

In view of the above, we think that a large-scale study of the syntaxa of the annual wetland vegetation allows us to make a stable system of the *Isoëto-Nano-Juncetea* class and sheds light on many theoretical and practical problems in the classification of vegetation.

References

Borhidi, A., 2003: Magyarország Növénytársulásai. Akadémiai Kiadó, Budapest.

Brullo, S., Minisalle, P., 1998: Considerazioni sintassonomische sulla classe Isoëto-Nanojuncetea. Itinerra Geobotanica 11, 263–290.

Didukh, Y.P., 2011: Ecological scales for the species of Ukrainian flora and their use in synphytoindification. Phytosociocentre, Kyiv.

Didukh, Y.P., Pliuta, P.H., 1994: Phytoindication of ecological factors. Naukova dumka, Kyiv (in Ukrainian).

Dubyna, D.V., Dziuba, T.P., Iemelianova, S.M., Davydov, D.A., 2016: Contemporary state and actual tasks of protection of pioneer vegetation in Ukraine. Ukrainian Botanical Journal 73, 11–20 (in Ukrainian).

Ellenberg, H., 1982: Vegetatiom Mitte leuropas mit den Alpen in ökologischer Sicht. Stuttgart, 794–802.

Golub, V.B., Dubyna, V.B., Kuzmina, E.V., 2007: Communities *Eragrostidetum suaveolentis* ass. nova in the valley of the Lower Volga. Samara bend 16, 532–537 (in Russian).

Korneck, D., 1960: Beobachtungen an Zwergbinsengesellschaften im Jahre 1959. Beiträge zur naturkundlichen Forschung in Südwestdeutschland 19, 101–110.

Kovalenko, O.A., 2014: Syntaxonomy of flood-plain ephemerous vegetation communities (*Isoëto-Nano-Juncetea* Br.-Bl. et Tx. ex Br.-Bl. et al. 1952) of National Nature Park "Pyriatynskyi" (Poltava Oblast, Ukraine). Botanical Journal 99, 34–60 (in Russian).

Novosad, V.V., Krytska, L.I., 2010: Phyto- and flora diversity of the Middle Dniester banks vascular plants, 1. Phyton, Kyiv. (in Ukrainian).

Philippi, G., 1968: Zur Kenntnis der Zwergbingesellschaften (Ordnung der *Cyperetalia fusci*) des Oberrheingebiet. Veroff. Landestelle Natursch. u. Landschaftspfelge Baden-Württemberg 3, 68–130.

Pietsch, W., 1973: Beitrag zur Gliederung der europäischen Zwergbinsengesellschaften (*Isoëto-Nanojuncetea* Br.-Bl. et Tx. 1943). Vegetatio 28, 401–438.

Popiella, A., 1996: Occurrence of Isoeto-Nanojuncetea associations in Poland. Fragmenta Floristica et Geobotanica Polonica 3, 289–310 (in Polish).

Sanda, V., Öllerer, K., Burescu, P., 2008: Phytocoenoses in Romania: syntaxonomy, structure, dynamics and evolution. Ars Docendi, Bucharest (in Romanian).

Semkin, B.I., Komarova, T.A., 1977: Analysis of phytocoenotic descriptions using inclusion measures (using plant communities in the valley of the Amgoumi River in Chukotka). Botanical Journal 62, 54–36 (in Russian).

Senchylo, O.O., Goncharenko, I.V., 2008a: *Isoeto-Nanojuncetea* of the alluvial sand outcrops of the Forest-Steppe Dnipro. Bulletin of Donetsk National University. Series A: Natural Sciences 5, 334–343 (in Ukrainian).

Senchylo, O.O., Goncharenko, I.V., 2008b: Methodology of characterizing of the syntaxes as multiparameter systems. Bulletin of Donetsk National University. Series A: Natural Sciences 2, 344–356 (in Ukrainian).

Shapoval, V. V., 2006: On syntaxonomy of vegetation depressions of the left bank of the Lower Dnipro. Classes: *Isoëto-Nanojuncetea* Br.-Bl. et R. Tx. ex Westhoff et al. 1946, *Molinio-Arrhenateretea* R. Tx. 1937 and *Festuco-Brometea* Br.-Bl. et R. Tx. in Br.-Bl. 1949. News Biosphere Reserve "Askania Nova" 8, 15–48 (in Ukrainian).

Šumberová, K., 2011: Class *Isoëto-Nano-Juncetea*. In: Chytrý M. (ed.), Vegetation of the Czech Republic 3. Aquatic and wetland vegetation, 312–315. Academia, Praha (in Czech).

Taran, G.S., 1993: On syntaxonomy of Black Irtysh floodplain ephemerous vegetation. Siberian Journal of Biology 5, 79–84 (in Russian).

Taran, G.S., 1995: A little-known vegetation class of the former USSR-flood plain ephemeretum (*Isoëto-Nanojuncetea* Br.-Bl. et Tx. 1943). Siberian Journal of Ecology 2, 373–382 (in Russian).

Taran, G.S., 2001: Association *Cypero-Limoselletum* (Oberd. 1957) Korneck 1960 (*Isoëto-Nanojuncetea*) in the floodplain of the middle Ob River. Vegetation of Russia 1, 43–56 (in Russian).