The Vegetation of *Isoëto-Nano-Juncetea* Class
in the Sluch River Valley (Ukraine**)**

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Abstract. Vegetation of *Isoëto-Nano-Juncetea* class has been investigated in the Sluch River valley within the forest-steppe zone. We distinguished three associations belonging to *Verbenion supinae* (*Pulicario vulgaris-Menthetum pulegii* Slavnić 1951), *Eleocharition ovatae* (*Cyperetum micheliani* Horvatić 1931 and *Veronico anagalloidis-Lythretum hyssopifoliae* Wagner ex Holzner 1973) alliances. The floristic composition of these syntaxa, is rich in diagnostic species of *Bidentetea tripartitae* and *Phragmito-Magnocaricetea* classes, which could indicate a transition to more sustainable communities in the succession row. Our current work is a small portion of a large task to clarify the location of 'hot spots' across the overall diversity of *Isoëto-Nano-Juncetea*, and to identify where and how this diversity can be maintained best.

Key words: ephemeral vegetation, phytosociology, Polissia, alien species

1. Introduction

Until present, *Isoëto-Nano-Juncetea* class has remained insufficiently studied in Ukraine as there are only fragmentary researches on this issue (Senchylo & Honcharenko 2008; Kovalenko 2014). Besides, this class has never been studied on the territory of Right-Bank Polissia. There are communities of low-growing annual wetland graminoids and some dicot herbs. These species are characterized by a short life cycle and dependence on the hydrological and temperature regimes. Such biological and ecological characteristics enables their survival in the unpredictable conditions of wetlands that can periodically dry out or become flooded. The optimal zone for the communities lies in places where the water level drops down to the bottom level, and then dries out slowly (Chytrý 2011). They are widespread throughout Eurasia, including the Mediterranean region (Šumberová & Hrivnák 2013; Krawczyk *et al*. 2016; Mucina *et al*. 2016). In Ukraine they are commonly found along the banks of the Dnieper River, ponds and other water bodies (Senchylo & Honcharenko 2008). The research results of floodplain ephemerous vegetation communities in the Pyryatynsky National Nature Park are presented by Kovalenko (2014), in the Horol River and in the planned Korostyshevsky National Nature Park by Orlov & Yakushenko (2005), and for the whole territory of Ukraine by Solomakha (2008). On the neighboring territories of Russia, research was conducted on the floodplain ephemeretum (Taran 1995), the floodplain of the Ob River (Taran 2001, 2009, 2017) and in the Sudost-Desna River interfluves (Semenyshchenkov 2009). The aim of our study was to classify the dataset of *Isoëto-Nano-Juncetea* relevés from the Sluch River valley (Ukraine), to make a detailed description of species composition of plant communities.

2. Material and methods

We performed an analysis of phytosociological relevés recorded on the territory of the Sluch River valley (Ukraine) (Fig. 1). This dataset included 22 phytosociological relevés of wetland and some types of ruderal vegetation, stored in the phytosociological database format of Turboveg software package (Hennekens & Schaminée 2001). Most of these relevés (about 70%) were made on the standard 1-2 m^2 plots, or, in several cases, in the areas less than 1 m^2. These plots were selected mainly based on the presence of sand banks with
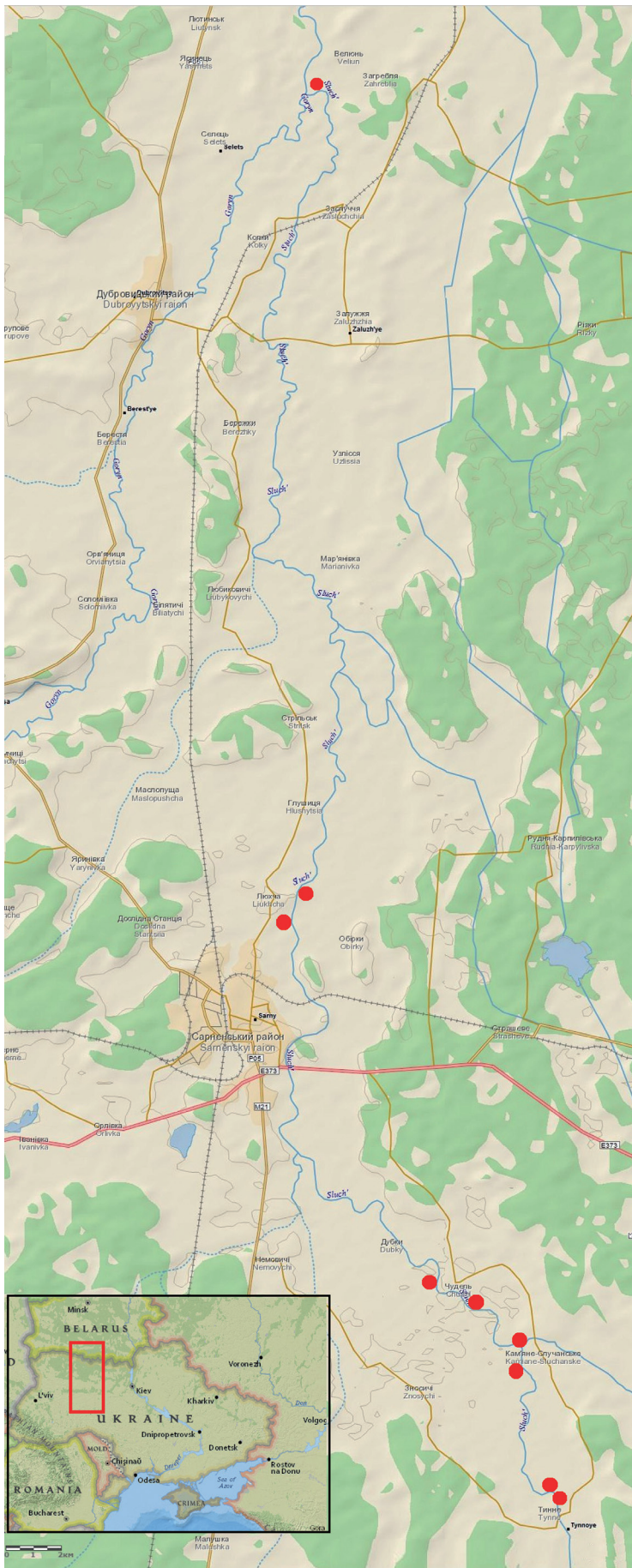
Fig. 1. An overview map of Ukraine with the research area showing the distribution of the vegetation of the *Isoëto-Nano-Juncetea* class in the Rivne region (Sluch River valley)

frequent occurrence of large and homogenous *Isoëto-Nano-Juncetea* stands. The area of research is located downstream the Sluch River in the Rivne region: on the Sarny and Dubrovitsky territories. The river valley is mostly flat and characterized by a broad floodplain, flat banks and alluvial sediments composed of sand, with a constant alluvium flow. These processes lead to the formation of *Isoëto-Nano-Juncetea* annual communities.

Our research was conducted in August-September 2015, when the riverbed of Sluch is characterized by the lowest water level due to high air temperatures and low rainfall during the summer.

Data processing and classification was carried out using the JUICe software package (Tichý 2002), which was also used for the determination of diagnostic, constant and dominant species. Diagnostic species include differential and characteristic (or indicator) species determined by measuring statistical fidelity using the phi coefficient (Chytrý *et al.* 2002). Species with phi coefficient above 0.25 were considered diagnostic for a particular association, while species with a phi coefficient above 0.50 were considered highly diagnostic. The latter are underlined in the vegetation description below. Statistical significance of association fidelity was calculated using Fisher's exact test (Chytrý *et al.* 2002) at a level of significance P<0.001. Constant or highly constant species were those with a frequency over 40% or 80%, respectively. Dominant and highly dominant species were those with a cover value exceeding 25% in at least 15% and 30% of relevés, respectively. Highly constant and highly dominant species are emphasized in the vegetation description below.

3. Results

In the investigated area, the class *Isoëto-Nano-Juncetea* is represented by two alliances and three associations (Table 1).

Isoëto-Nano-Juncetea Br.-Bl. et Tüxen ex Br.-Bl. *et al.* 1952

Eleocharition ovatae Philippi 1968

 Cyperetum micheliani Horvatić 1931

Verbenion supinae Slavnić 1951

 Pulicario vulgaris-Menthetum pulegii Slavnić 1951

 Veronico anagalloidis-Lythretum hyssopifoliae Wagner ex Holzner 1973

Vegetation of *Isoëto-Nano-Juncetea* in the studied area is formed by small therophytes. It develops in late summer and early autumn, in periodically drained areas – on muddy and sandy sediments, silted sand deposits along the rivers, drying bays, oxbow lakes, ponds and lakes (Fig. 2).

The vegetation of the alliance *Eleocharition ovatae* occurs on riparian sediments along the rivers, oxbow
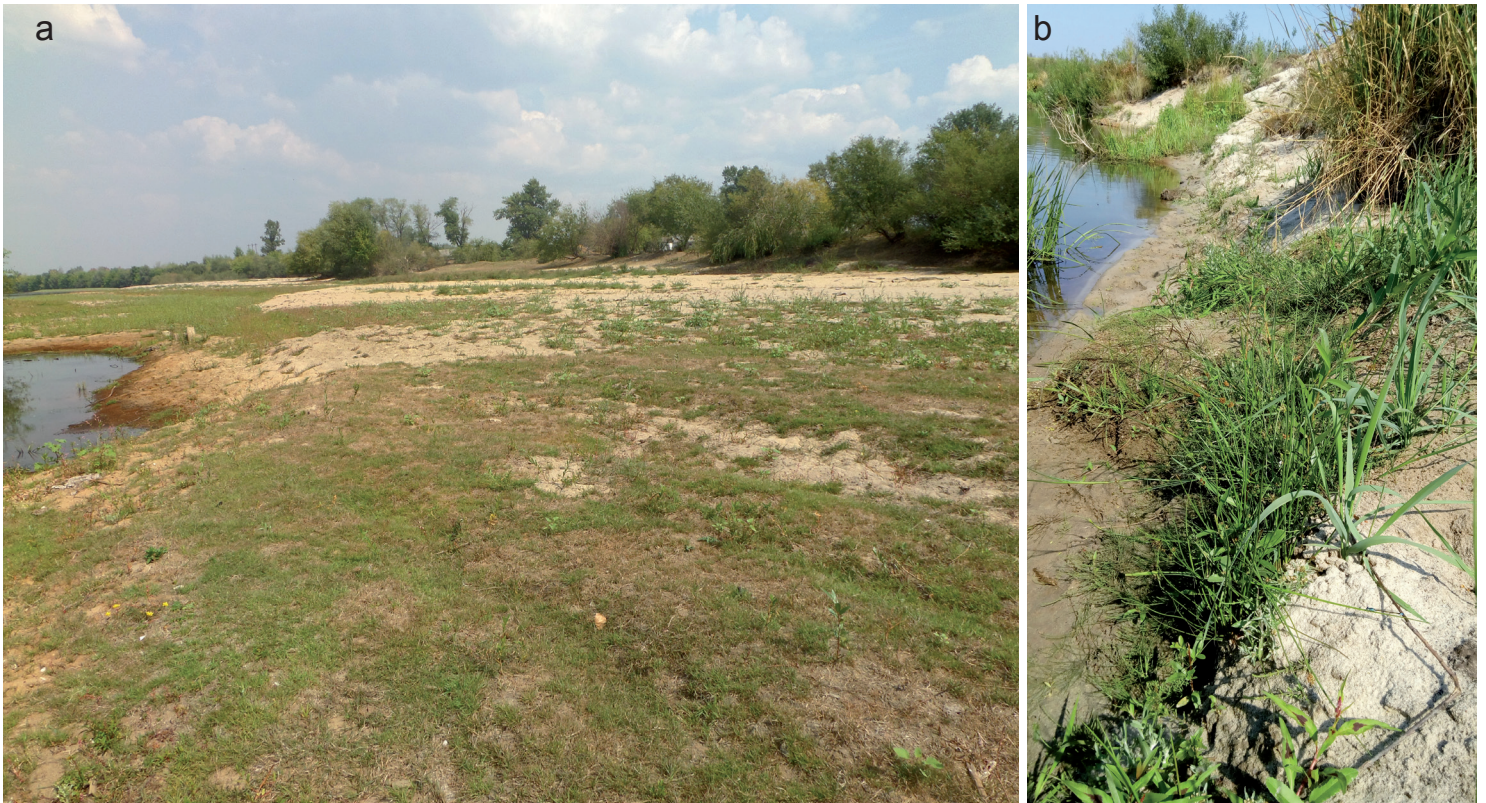
Fig. 2. Sites along the shallow banks of the Sluch River valley with the plant communities of *Isoëto-Nano-Juncetea* class (Rivne region, Sarny district near Tynne village, right bank of the Sluch River)

Explanations: a – ass. *Cyperetum micheliani*, b – *Veronico anagalloidis-Lythretum hyssopifoliae*

lakes and reservoirs on muddy terrain, often with humified substrates composed of gravel or sand. Seed germination requires significant soil moisture or slight flooding, followed by the gradual drying up.

Cyperetum micheliani association includes low-growing annual vegetation, formed mainly by *Cyperus fuscus* L. and *Juncus bufonius* L. This association includes the low-growing vegetation of summer or winter annuals, or short-lived perennial species, which are weak competitors on sand and muddy substrates. The studied communities occur on sandy riverbanks on flooded, mostly warm lowland areas at the center of the valley, Rivne region. They are rich in the diagnostic species of *Bidentetea tripartitae* R. Tx., Lohmeyer et Preising 1950 and from the *Phragmito-Magnocaricetea* Klika in Klika et Novak 1941 class, which probably indicates a transition to more sustainable communities in the succession row.

The alliance *Verbenion supinae* includes vegetation of low-growing, low-competition annual and perennial species, mainly in disturbed habitats, drained bottoms of ponds, on moist sandy or loamy calcium-rich soils or sandy loams.

The association *Pulicario vulgaris-Menthetum pulegii* occurs on the outcropping banks of the Sluch River. Patches of this association are found on sandy

loam or non-saline soils of the river sediments. Besides the main community edificators, such as: *Gnaphalium uliginosum* L., and *Juncus bufonius* L., there are also species characteristic for the eutrophic substrates (*Bidens tripartita* L., *Echinochloa crus-galli* (L.) P. Beauv.), and some species of wet meadows (*Agrostis stolonifera* L.). *Pulicario vulgaris-Menthetum pulegii* occurs in different habitats, such as: open rivers and ponds, pastures and shallow depressions in alluvial grassland complexes. These habitats are rich in nutrients due to regular flooding or anthropogenic impact (such as agriculture or grazing).

Veronico anagalloidis-Lythretum hyssopifoliae association, represented by low-growing annual vegetation, occurs in small patches in periodically flooded depressions on arable land. This association occurs in narrow strips (0.5-10 m wide) on poor sandy substrates formed by alluvial sediments along the denuded banks of the Sluch River.

In the floristic composition of investigated communities, there are complexes of annual species and the species of *Bidentetea tripartitae* R. Tx., Lohmeyer et Preising 1950 and *Phragmito-Magnocaricetea* Klika in Klika et Novak 1941 classes. *Eragrostis pilosa* (L.) P. Beauv. and *Xanthium albinum* (Widder) Scholz & Sukopp are alien species for the studied areas, which

Table 1. Phytocoenotic table of the *Isoëto-Nano-Juncetea* class syntaxa and the synoptic table of the *Isoëto-Nano-Juncetea* plant communities diagnosed within the Sluch River valley. Only species with a frequency > 20% in the whole dataset and species with a frequency > 40% in individual associations were presented. Diagnostic species of clusters are shown in bold and ordered by decreasing fidelity, expressed as Φ values multiplied by 100 (upper index)

Relevé number	1	2	3	4	(I)	5	6	7	8	9	(II)	10	11
D. s. ass. *Cyperetum micheliani* & D. s. all. *Eleocharition ovatae*													
Limosella aquatica	3	1	1	4	$100^{94.5}$	.	.	.	.	.	---	.	1
Chenopodium glaucum	+	+	.	+	$75^{81.6}$	.	.	.	.	.	---	.	.
Lythrum salicaria	1	1	.	1	$75^{56.0}$	.	.	.	.	+	20^{---}	+	.
Dichostylis micheliana	.	1	1	.	$50^{63.2}$	.	.	.	.	.	---	.	.
Eleocharis acicularis	1	.	.	+	$50^{63.2}$	.	.	.	.	.	---	.	.
D. s. ass. *Pulicario vulgaris-Menthetum pulegii*													
Mentha pulegium	.	.	.	.	---	1	2	+	1	+	$100^{94.5}$	.	.
Lycopus europaeus	.	.	.	.	---	+	1	.	1	+	$80^{63.1}$	1	.
Pulicaria vulgaris	.	.	.	.	---	1	+	.	.	+	$60^{70.7}$	.	.
D. s. ass. *Veronico anagalloidis-Lythretum hyssopifoliae*													
Juncus bufonius	+	+	.	+	$75^{30.9}$	.	.	.	.	.	---	1	1
Juncus articulatus	.	.	.	.	---	1	1	.	.	1	$60^{16.7}$	1	2
Veronica anagaloides	.	.	.	.	---	3	3	1	2	+	$100^{72.5}$	+	1
D. s. all. *Verbenion supinae* & D. s. class *Isoëto Nano-Juncetea*													
Gnaphalium uliginosum	1	1	1	+	100^{---}	1	1	+	2	+	100^{---}	3	1
Cyperus fuscus	1	1	1	1	$100^{11.5}$	2	3	1	3	1	$100^{11.5}$	1	2
Polygonum persicaria	1	+	.	+	75^{---}	3	3	4	3	2	$100^{24.7}$	3	1
Other species													
Agrostis stolonifera	+	+	.	.	50^{---}	2	2	.	2	5	$80^{16.9}$	.	2
Eragrostis pilosa	1	+	.	+	$75^{28.8}$	2	.	.	.	.	20^{---}	1	2
Rorippa amphibia	3	2	.	4	$75^{26.7}$	+	+	.	.	.	40^{---}	+	1
Plantago major	3	1	1	+	$100^{47.7}$	+	.	.	+	1	60^{---}	.	+
Xanthium albinum	.	+	1	.	$50^{12.5}$	.	.	.	.	+	20^{---}	.	.
Echinochloa crusgalli	+	+	.	.	50^{---}	+	.	.	1	+	$60^{14.9}$	.	1
Bidens frondosa	+	1	.	.	$50^{12.5}$	.	.	.	.	1	20^{---}	.	.
Bidens tripartita	.	.	.	.	---	1	1	+	.	.	$60^{36.4}$	1	.
Salix alba (juv.)	+	+	.	1	$75^{58.8}$	.	.	.	.	.	---	.	2
Myosotis palustris	+	+	2	.	$75^{60.8}$	.	.	+	.	.	20^{---}	.	.
Chenopodium acerifolium	1	+	1	.	$75^{69.2}$	.	.	.	.	.	---	.	1
Polygonum hydropiper	+	1	.	+	$75^{60.8}$	+	.	.	.	.	20^{---}	.	.
Bidens cernua	.	.	.	.	---	2	3	.	2	+	$80^{50.3}$	.	1
Erigeron canadensis	.	.	.	.	---	.	.	.	.	+	20^{---}	.	.
Digitaria sanguinalis	.	.	.	.	---	.	.	.	.	+	20^{---}	.	2
Salix acutifolia (juv.)	.	.	.	.	---	.	.	.	1	.	$20^{11.4}$	3	2
Herniaria glabra	.	.	.	.	---	.	.	.	.	.	---	.	1
Juncus tenuis	.	.	.	.	---	+	.	+	+	.	$60^{56.8}$	.	.
Chenopodium polyspermum	.	.	.	.	---	1	.	.	.	.	20^{---}	+	.
Potentilla anserina	.	.	.	.	---	+	1	1	1	.	$80^{73.2}$	.	.
Leersia oryzoides	.	.	.	.	---	.	.	.	.	.	---	+	.
Atriplex prostrata	.	.	.	.	---	1	.	+	.	.	$40^{39.3}$	.	.
Alisma plantago-aquatica	+	.	.	+	$50^{55.2}$	.	.	.	.	.	---	+	.
Bidens radiata	.	.	.	.	---	.	.	+	.	.	$20^{26.3}$	.	.
Rumex maritimus	.	.	.	.	---	.	+	.	.	.	$20^{26.3}$	.	.
Taraxacum officinale	.	.	.	.	---	.	+	.	+	1	$60^{70.7}$	.	.
Oenanthe aquatica	+	.	.	.	$25^{1.3}$	.	+	.	1	.	$40^{26.0}$	.	.
Xanthium strumarium	.	.	.	.	---	2	1	.	.	.	$40^{55.5}$	.	.
Ranunculus repens	.	.	.	.	---	+	1	.	.	.	$40^{55.5}$	.	.
Inula sabuletorum	.	.	.	.	---	1	1	.	.	.	$40^{55.5}$	.	.
Acer negundo	.	.	.	.	---	+	.	.	2	.	$40^{46.6}$	.	.

12	13	14	15	16	17	18	19	20	21	22		
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2	+	2	1	.	+	+	3	.	2	+	**85**	44.5
2	+	1	2	1	.	1	2	+	1	.	**85**	51.5
.	+	1	.	.	.	1	.	.	1	.	**46**	---
2	1	2	2	2	+	1	1	2	1	1	100	---
2	2	3	1	1	3	1	3	.	1	1	92	---
1	2	1	4	3	3	1	.	1	+	1	92	7.3
2	4	4	3	3	2	5	.	3	.	2	77	12.2
2	.	2	3	1	1	.	.	1	3	.	69	20.6
.	1	.	.	2	.	1	.	+	+	.	54	---
+	+	.	.	+	.	.	.	+	.	1	46	---
+	+	.	.	1	+	1	.	1	.	1	54	18.0
.	.	.	.	+	+	1	.	+	.	.	38	---
1	+	.	3	.	.	1	.	1	+	2	54	18.0
1	2	+	.	2	.	.	+	.	.	.	46	15.9
.	.	.	3	.	.	.	+	.	+	.	31	---
.	.	1	.	.	.	.	.	.	.	.	8	---
.	.	.	.	.	.	.	.	.	.	1	15	---
.	.	.	.	.	.	.	.	.	.	1	8	---
.	1	.	1	1	1	2	.	1	.	.	54	13.1
.	+	.	1	1	+	.	.	1	+	.	46	41.1
.	+	.	.	1	.	.	.	1	+	.	38	33.9
+	.	.	.	.	.	.	.	.	.	.	23	17.6
.	.	.	.	2	.	+	.	1	.	.	31	47.8
.	.	.	.	.	.	.	2	.	2	.	15	---
+	+	+	.	.	.	.	+	.	.	.	38	33.9
.	.	.	.	+	+	.	.	.	.	.	15	---
.	.	+	.	.	.	.	+	.	.	.	23	40.8
.	+	.	1	.	.	.	.	.	.	.	15	---
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.	.	.	.	.	.	.	.	.	.	.		---
.	.	.	.	+	.	.	.	.	.	.	8	---

Sporadic species: *Rorippa brachycarpa* (2:1), *Sedum sexangulare* (2:+), *Herniaria polygama* (2:+), *Populus nigra* (2:+), *Potentilla supina* (2:+), *Lycopus exaltatus* (1:+, 2:+), *Myosoton aquaticum* (1:+), *Crepis tectorum* (2:+), *Achyrophorus maculatus* (1:+), *Artemisia marschalliana* (1:+, 2:+), *Barbarea stricta* (1:+, 2:+), *Lycopersicon esculentum* (1:+, 2:+), *Cardamine parviflora* (4:+), *Typha angustifolia* (4:+), *Poa annua* (1:+, 2:+), *Polygonum propinquum* (2:+), *Galinsoga parviflora* (1:+), *Juncus atratus* (2:+), *Mentha arvensis* (1:+), *Carex acuta* (4:+), *Sagittaria sagittifolia* (4:+), *Batrachium trichophyllum* (4:+), *Spergularia rubra* (16:+), *Betula obscura* (11:+), *Lotus corniculatus* (11:+), *Senecio vernalis* (11:+), *Trifolium fragiferum* (9:1), *Trifolium hybridum* (9:+), *Ranunculus sceleratus* (9:+), *Erysimum canescens* (12:+), *Salix purpurea* (12:+), *Arrhenatherum elatius* (12:+), *Deschampsia caespitosa* (17:+), *Leontodon autumnalis* (21:+), *Lysimachia nummularia* (18:+), *Lolium perenne* (18:+), *Artemisia vulgaris* (10: +), *Epilobium hirsutum* (10: +), *Cardamine amara* (10: +), *Scleranthus annuus* (10: +), *Rorippa palustris* (10: +), *Artemisia campestre* (19:+), *Eragrostis minor* (19:+), *Pimpinella major* (15:+), *Polygonum bellardii* (6:1), *Eleocharis palustris* (8:1), *Elytrigia repens* (17:+), *Equisetum pratense* (17:+), *Stenactis annua* (11:+,1:+), *Potentilla reptans* (9:+,13:+), *Equisetum arvense* (13:+,21:+), *Galium palustre* (20:1), *Cerastium arvense* (16:+,11:+), *Carex hirta* (8:1,16:1), *Setaria viridis* (17:+,21:1), *Bolboschoenus maritimus* (4:+), *Eleocharis acicularis* (20:+, 21:1), *Chenopodium glaucum* (20:+,21:+,22:+) *Eleocharis ovata* (2:+), *Salix cinerea* (17:2,11:2), *Rumex confertus* (6:+,17:+), *Medicago lupulina* (16:+,12:+,19:+), *Polygonum aviculare* (16:+,19:+), *Plantago lanceolata* (16:+,15:1), *Artemisia absinthium* (16:+,1:+,2:+), *Setaria glauca* (15:+,21:+), *Mentha aquatica* (6:+,13:1), *Portulaca oleracea* (6:+,1:+,2:+), *Gratiola officinalis* (16:+,11:1), *Achillea submillefolium* (16:+,15:+,19:+), *Inula salicina* (16:+,13:2,3:1), *Rumex crispus* (8:+), *Hieracium pilosella* (5:+,11:1,10:+), *Equisetum palustre* (20:1,22:1,15:2), *Calamagrostis epigeios* (19:+,21:+), *Cerastium holosteoides* (14:+,19:1), *Veronica anagallis-aquatica* (3:2). *Juncus conglomeratus* (16:1, 18:+,21:+), *Trifolium repens* (9:+,13:+,11:+), *Crypsis alopecuroides* (22:1).? *Sagina procumbens* (16: 1; 20: +), *Psammophiliella muralis* (21: +; 10: +).

Location of relevés

Relevé number, Locality, Slope (°), Cover total (%), Latitude (°), Longitude (°), Date (year/month/day), Author abbreviations: NP: Nataliia Pashkevych, IK: Inna Korotka, NA – data not available.
1 – Chudel, Rivne region, Ukraine, 40%, 51°15'08.2", N 26°42'57.0"E, 22.08.2015, NP
2 – Kaminno-Sluchanske, Rivne region, Ukraine, 20%, 51°12'45.6", N 26°45'56.0"E, 22.08.2015, NP
3 – Lyuhcha, Rivne region, Ukraine, 30%, 51°22'47.7", N 26°38'49.5"E, 21.08.2015, NP
4 – Lyuhcha, Rivne region, Ukraine, 40%, 51°22'47.7", N 26°38'49.5"E, 21.08.2015, NP

5 – Liubykovychy, Rivne region, Ukraine, 60%, 51°29'46.9"N 26°37'34.7"E, NP
6 – Kolky, Rivne region, Ukraine, 70%, 51°35'49.8"N 26°38'22.8"E, NP
7 – Kolky, Rivne region, Ukraine, 50%, 51°35'49.8"N 26°38'22.8"E, NP
8 – Kolky, Rivne region, Ukraine, 55%, 51°35'49.8"N 26°38'22.8"E, NP
9 – Kaminno-Sluchanske, Rivne region, Ukraine, 60%, 51°12'45.6", N 26°45'56.0"E, 22.08.2015, NP
10 – Lyuhcha, Rivne region, Ukraine, 60%, 51°22'19.8", N 26°38'20.7"E, 21.08.2015, IK
11 – Tynne, Rivne region, Ukraine, 50%, 51°10'25.4", N 26°46'41.0"E, 22.08.2015, NP
12 – Lyuhcha, Rivne region, Ukraine, 60%, 51°23'03.7", N 26°39'06.0"E, 21.08.2015, IK
13 – Kaminno-Sluchanske, Rivne region, Ukraine, 5° SSW, 60%, 51°12'55.9", N 26°45'57.1"E, 22.08.2015, NP
14 – Wielun, Rivne region, Ukraine, 65%, 51°37'59.4", N 26°39'17.4"E, 21.08.2015, IK
15 – Chudel, Rivne region, Ukraine, 60%, 51°15'08.2", N 26°42'57.0"E, 22.08.2015, NP
16 – Tynne, Rivne region, Ukraine, 35%, 51°10'24.9"N, 26°46'41.3"E, 22.08.2015, NP
17 – Lyuhcha, Rivne region, Ukraine, 40%, 51°22'47.7", N 26°38'49.5"E, 21.08.2015, NP
18 – Tynne, Rivne region, Ukraine, 80%, 51°10'23.9", N 26°46'39.9"E, 22.08.2015, IK
19 – Lyuhcha, Rivne region, Ukraine, 65%, 51°23'04.4", N 26°39'06.3"E, 21.08.2015, IK
20 – Tynne, Rivne region, Ukraine, 40%, 51°10'25.4", N 26°46'41.0"E, 22.08.2015, NP
21 – Wielun, Rivne region, Ukraine, 30%, 51°37'59.4", N 26°39'17.4"E, 21.08.2015, IK
22 – Tynne, Rivne region, Ukraine, 30%, 51°10'25.4", N 26°46'41.0"E, 22.08.2015, IK

have recently spread and naturalized in different phyto-coenoses, including the communities of *Isoëto-Nano-Juncetea* class.

4. Discussion

Analysis of data on the *Isoëto-Nano-Juncetea* class communities currently available in Ukrainian (Senchylo & Honcharenko, 2008) and other literature sources (Holub *et al*. 2007; Kovalenko 2014) showed that the series of relevés done by us in the Sluch River valley differs from already existing syntaxa associations, both in floristic composition and in habitat conditions (Table 2). Also, for the comparison of associations, we have also used literature sources dealing with studies outside the territory of research and adjacent territories (Brullo & Minissale 1998; Popiela *et al*. 2009).

The aquatic environment is a corridor for the transfer of seeds, including those of alien species. Therefore, it is necessary to pay more attention to the assessment of the alien species influence on vegetation formation, especially, on ephemeral vegetation.

In the floristic composition of the investigated communities, many of such species, belonging to different families, were recorded. However, the most common are neophytes characterized by the C_4 carbon fixation. As known, the total number of C_4 plants represents about 3% of all land plants (Simpson 2010) and the majority of these plant species in Europe (Pyankov *et al*. 2010) belong to four families: Amaranthaceae, Chenopodiaceae, Cyperaceae and Poaceae. The analysis of systematic structure of the studied vegetation class has shown this trend as well. Among the species of *Isoëto-Nano-Juncetea* class characterized by the C_4 carbon fixation are: *Atriplex prostrata* R. Br., *Chenopodium acerifolium* Andrz., *Ch. polyspermum* L., (Chenopodiaceae), *Agrostis stolonifera* L., *Digitaria sanguinalis* (L.)

Scop., *Echinochloa crus-galli* (L.) Scop., *Eragrostis minor* Host, *E. pilosa* (L.) P. Beauv., *Leersia oryzoides* (L.) Sw., *Setaria glauca* (L.) P. Beauv., *S. viridis* (L.) P. Beauv. (Poaceae) etc. A favorable factor for the invasion of these species into the community of ephemeretum may be an increase in drought and environmental degradation in the study region.

In the Sudost-Desnyanskiy interfluves, Semenyschenkov (2009) observed one association belonging to the class (*Cypero fusci-Limoselletum*) that includes three communities, one of which is *Juncus bufonius* community.

On the flood plain of the River Ob, Taran (2017) reported the presence of annual shoots of *Salix alba* and *S. triandra* in the *Cypero fusci-Limoselletum* association. In the plant communities occurring on the River Sluch banks, the juvenile individuals of willow species of *Salix alba* and *S. acutifolia* have been discovered.

Šumberová & Hrivnak (2013) has pointed out that the *Isoëto-Nano-Juncetea* class represents a very interesting mix of different communities, 'which include dozens of associations described from different parts of Europe and the transitions between them across relatively small regions of Europe'. Our work is only a small portion of an in-depth investigation to clarify the location of 'hot spots' across the whole diversity of *Isoëto-Nano-Juncetea*, and to understand where and how this diversity can be best maintained.

The flood-plain ephemeretum of the River Sluch is represented by three associations of two alliances of the *Nanocyperetalia* Klika 1935 order, *Isoëto-Nano-Juncetea* Br.-Bl. et Tx. in Br.-Bl. *et al*. 1952 class. Thus, for the class of ephemeral vegetation, there is a significant threat of the alien species introduction, which over time and during structural transformations can be on a significant scale and even result in new syntaxa formation. In the shallows, *Cyperetum micheliani* ass.

Table 2. Synoptic table of the *Isoëto-Nano-Juncetea* plant communities diagnosed in Ukraine. Only species with a frequency > 10% in the whole dataset and species with a frequency > 20% in individual associations were presented. Diagnostic species of clusters are in bold and ordered by decreasing fidelity, expressed as Φ values multiplied by 100 (upper index). The relevés of plant communities in this table were made by O. Kovalenko (2014) (Group No. 1-5) and the authors (Group No. 6-8)

Group No.	1	2	3	4	5	6	7	8
No. of relevé	8	5	8	12	11	7	12	5
Eragrostis suaveolens	**100**$^{100.0}$	.	.	.	.	.	.	.
Crypsis alopecuroides	**100**$^{95.5}$	.	.	.	.	.	8	.
Convolvulus cantabrica	**88**$^{92.7}$	.	.	.	.	.	.	.
Polygonum aviculare	**62**$^{57.5}$	20$^{8.7}$	.	.	.	.	17$^{4.9}$	.
Spergularia rubra	**38**$^{27.1}$	60$^{52.2}$	.	.	.	.	8	.
Psammophiliella muralis	100$^{59.7}$	**100**$^{59.7}$	12	.	.	.	17	.
Radiola linoides	.	**80**$^{88.2}$	.	.	.	.	.	.
Veronica scutellata	.	**60**$^{75.3}$	.	.	.	.	.	.
Myosurus minimus	.	**80**$^{88.2}$	.	.	.	.	.	.
Gnaphalium rossicum	38$^{15.8}$	.	**100**$^{74.2}$	.	7$^{6.2}$	.	.	.
Lythrum hyssopifolia	12$^{4.1}$	.	**62**$^{68.9}$	.	.	.	.	.
Elatine alsinastrum	.	.	**50**$^{58.3}$	.	.	14$^{8.7}$	.	.
Rumex maritimus	.	.	**25**$^{27.8}$	.	.	.	8$^{2.5}$	20$^{20.2}$
Potentilla supina	.	.	**62**$^{60.8}$	.	.	29$^{20.5}$	.	.
Bolboschoenus maritimus	.	.	**38**$^{26.6}$	42$^{31.2}$	.	29$^{16.7}$	.	.
Dichostylis micheliana	.	.	**75**$^{64.3}$	.	.	43$^{30.0}$	.	.
Pycreus flavescens	.	.	.	**100**$^{100.0}$	.	.	.	.
Juncus gerardii	.	60$^{50.8}$	.	**50**$^{39.8}$	.	.	.	.
Carex distans	.	.	.	**75**$^{85.1}$	.	.	.	.
Trifolium fragiferum	.	.	.	**92**$^{84.8}$	.	.	.	20$^{6.6}$
Schoenoplectus elanospermus	.	.	25$^{9.4}$	**75**$^{61.1}$	27$^{11.7}$	.	.	.
Puccinelia distans	.	.	.	**50**$^{68.3}$	.	.	.	.
Sagina nodosa	.	.	.	**58**$^{54.4}$	36$^{28.7}$	.	.	.
Juncus bufonius	75$^{19.7}$	40	25	42	**100**$^{38.6}$	43	67$^{13.4}$	.
Sagina procumbens	.	20	.	83$^{52.4}$	**73**$^{43.0}$	.	17	.
Juncus tenuis	.	.	.	42$^{18.4}$	**55**$^{30.2}$	.	17	60$^{35.3}$
Juncus compressus	.	.	.	.	**36**$^{57.7}$	.	.	.
Limosella aquatica	.	.	50$^{22.5}$	.	45$^{18.5}$	**100**$^{66.5}$	.	.
Lythrum salicaria	.	.	.	.	.	**43**$^{41.6}$	7$^{8.5}$	20$^{12.7}$
Chenopodium glaucum	.	.	.	.	.	**43**$^{62.9}$	.	.
Myosotis palustris	.	.	.	.	.	**57**$^{56.8}$	8	20$^{11.4}$
Eleocharis acicularis	.	.	38$^{25.6}$	8	9	**57**$^{47.0}$	.	.
Chenopodium acerifolium	.	.	38$^{24.4}$	.	.	**71**$^{60.7}$	8	.
Juncus articulatus	.	.	.	.	.	14	**83**$^{60.5}$	60$^{38.3}$
Digitaria sanguinalis	.	.	.	.	.	.	**33**$^{40.4}$	20$^{20.2}$
Chenopodium polyspermum	.	.	.	.	.	.	**42**$^{48.1}$	20$^{17.4}$
Veronica anagaloides	.	.	.	.	.	.	**42**$^{23.7}$	100$^{81.5}$
Lycopus europaeus	.	.	12	.	.	.	33$^{18.3}$	**80**$^{66.7}$
Pulicaria vulgaris	12	.	25$^{13.0}$	.	9	.	.	**60**$^{51.9}$
Potentilla anserina	.	40$^{21.5}$	.	8	.	.	17	**80**$^{60.7}$
Mentha pulegium	.	.	.	.	.	.	8	**100**$^{95.5}$
Eragrostis pilosa	.	.	.	.	.	43$^{27.4}$	67$^{51.8}$	20$^{3.9}$
Bidens cernua	.	.	.	8	.	.	50$^{32.7}$	80$^{62.7}$
Rorippa amphibia	.	.	.	.	.	43$^{26.7}$	50$^{33.9}$	40$^{23.8}$
Polygonum persicaria	.	.	.	.	18	43$^{9.2}$	2$^{48.8}$	100$^{55.6}$
Gnaphalium uliginosum	.	.	.	.	.	71$^{29.9}$	10$^{52.7}$	100$^{52.7}$
Agrostis stolonifera	.	.	.	17	.	29$^{3.1}$	75$^{43.6}$	80$^{48.0}$
Bidens frondosa	.	60$^{27.4}$	25	75$^{10.5}$	.	57$^{25.0}$	58$^{6.0}$	20
Cyperus fuscus	38	.	88$^{20.2}$	75$^{10.5}$	.	100$^{29.9}$	92$^{23.5}$	100$^{29.9}$
Plantago major	.	80$^{14.9}$	100$^{30.3}$	33	100$^{30.3}$	71$^{8.2}$	42	60
Centaurium pulchellum	.	100$^{51.9}$	75$^{32.0}$	75$^{32.0}$	27	.	.	.
Chenopodium rubrum	12	.	38$^{28.6}$	50$^{42.9}$	.	.	.	.
Atriplex prostrata	.	.	.	.	.	.	17$^{9.1}$	60$^{64.7}$
Erigeron canadensis	.	.	.	.	.	.	50$^{55.2}$	20$^{15.0}$
Echinochloa crusgalli	12	.	.	.	.	29$^{11.9}$	33$^{16.7}$	60$^{43.7}$
Xanthium albinum	.	.	.	.	.	43$^{29.2}$	58$^{45.5}$	20$^{5.1}$
Bidens tripartita	.	.	.	42	36$^{17.7}$	.	50$^{31.0}$	60$^{40.8}$
Polygonum hydropiper	.	.	25$^{11.7}$	8	9	43$^{31.0}$	8	20$^{6.3}$
Alisma plantago-aquatica	.	.	.	.	9$^{5.4}$	29$^{37.1}$	8$^{4.2}$	.
Inula salicina	.	.	.	.	.	29$^{37.5}$	17$^{18.0}$	.
Oenanthe aquatica	.	.	.	17$^{8.5}$	.	14$^{5.5}$	8	40$^{38.1}$
Polygonum scabrum	50$^{68.3}$	.	.	.	.	.	.	.

Explanations: 1 – *Eragrostidetum suaveolentis*, 2 – *Psammophilello-Juncetum nastant*, 3 – *Eleochario acicularis-Limiselletum aquaticae*, 4 – *Cyperetum flavescentis*, 5 – *Juncetum bufonii*, 6 – *Cyperetum micheliani*, 7 – *Veronico anagalloidis-Lythretum hyssopifoliae*, 8 – *Pulicario vulgaris-Menthetum pulegii*

dominates, while the associations of *Verbenion supinae* Slavnić 1951 alliance often dominate in disturbed habitats, such as, wet places in pastures and on the river banks.

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