

# JUNCUS SQUARROSUS (JUNCACEAE) IN ROMANIA: ITS FIRST CERTAIN OCCURRENCE AND A NEW PLANT ASSOCIATION FOR THE ROMANIAN VEGETATION

JÓZSEF PÁL FRINK<sup>1</sup>, GHEORGHE COLDEA, ANDREA SASS-GYARMATI,  
 TAMÁS PÓCS & GUSZTÁV JAKAB

**Abstract.** This study confirms the first certain occurrence of *Juncus squarrosus* L., an Atlantic species, in the Romanian native flora. Characteristic plant communities with *J. squarrosus* occur in the Apuseni Mts (Western Romanian Carpathians). At these sites *J. squarrosus* has the southeastern limit of its European distribution. The identified plant communities with *J. squarrosus* in Romania are devoid of some Atlantic species present in Western and Central European communities and therefore are assigned to the *Nardo-Juncetum squarrosi* (Nordh. 1920) Bük. 1942 association. This plant community is a new syntaxon for the Romanian vegetation.

**Key words:** Atlantic species, Apuseni Mountains, distribution, heath, *Nardo-Juncetum squarrosi* association, phytosociology

József Pál Frink, National Institute for Research and Development in Forestry 'Marin Drăcea', Horea St. No. 65, 400275-Cluj-Napoca, Romania; e-mail: jpfrink@gmail.com

Gheorghe Coldea, Institute of Biological Research, National Institute of Research and Development for Biological Sciences, Republicii St., No. 48, 400015-Cluj-Napoca, Romania; e-mail: office@icbcluj.ro

Andrea Sass-Gyarmati & Tamás Pócs, Institute of Biology, Eszterházy Károly University, Pf. 43, 3301-Eger, Hungary; e-mails: sassgyarmati@gmail.com, colura@upcmail.hu

Gusztáv Jakab, Szent István University, Tessedik Campus, Szabadság St., No. 1-3, 5540-Szarvas, Hungary; e-mail: cembra@freemail.hu

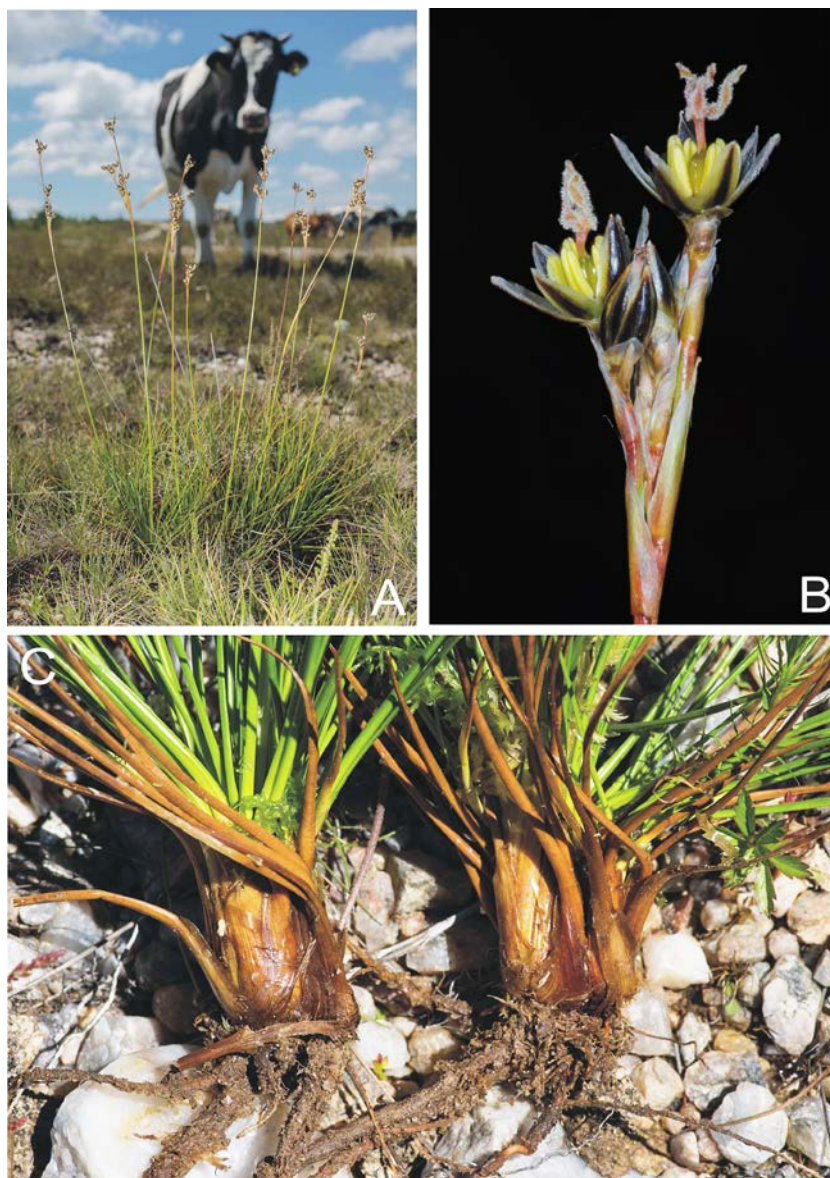
## INTRODUCTION

*Juncus squarrosus* L. (syn. *Juncus ellmanii* C. E. Hubb., Sandwith & Turrill, *J. sprengelii* Willd., *J. strictus* Lucé) is a perennial caespitose plant with rigid stems 15–50 cm long and many basal subcoriaceous leaves forming dense tufts (Fig. 1). This species is widespread in the British Isles and in oceanic parts of Europe; it is considered an Atlantic floristic element (Welch 1966a; Ellenberg 1979). Its distribution area also extends to the south of Spain and Central and Eastern Europe to the Dnieper River, being present in scattered localities (Meusel *et al.* 1965; Welch 1966a; Snogerup 1980; Andrienko 1983). It is also found in southern Greenland as well as in Iceland, Svalbard and Scandinavia, especially in the western oceanic areas (Meusel *et al.* 1965; Welch 1966a; Anonymous

2006–2017). It occurs abundantly on siliceous bedrock in oligotrophic grasslands, heaths, moors and bogs, where it is the dominant and characteristic species in some communities of *Oxycocco-Sphagnetum* Br.-Bl. & Tx. 1943 (*Ericion tetralicis* Schwickerath 1933), *Calluno-Ulicetum* Br.-Bl. & R. Tx. ex Klika & Hadač 1944 (*Juncion squarrosi* Oberd. 1956; Rodwell *et al.* 2002) and *Nardo-Callunetum* Prsq. 1949 (*Nardo-Juncion squarrosi* (Oberd. 1957) Passarge 1964; Oberdorfer 1978). According to Welch (1964, 1966a, b), *J. squarrosus* has strong reproductive capability due to its large production of viable seeds and good vegetative development. It is unpalatable in summer, but the inflorescences are grazed (Welch 1964, 1966b).

In Romania the presence of *J. squarrosus* has been considered uncertain until now. Although it has been mentioned since the 19<sup>th</sup> century, its

<sup>1</sup> Corresponding author



**Fig. 1.** *Juncus squarrosus* L. A – habit, B – inflorescence, C – tufts. Photo G. Jakab.

occurrence has always been contested because of the lack of herbarium material. The earliest mention of this species in Transylvania is found in Baumgarten's study (1816, En. 3: 335) under the name *Juncus squarrosus* Wild. Later this species was mentioned by Steffek (1864), who found it 'common' in the surroundings of Oradea (Hungarian: Nagyvárad; German: Grosswardein).

Neilreich (1866) discussed the species mentioned by Steffek but cast doubt on the accuracy of the taxon identification. Since Baumgarten did not attribute the description of this species to Linné, Simonkai (1886) reconsidered Baumgarten's taxon and related it with *Juncus compressus* Jacq. (*Juncus squarrosus* non L., Baumg. En. 3: 335. 1816). Moreover, in his study from 1890, Simonkai

eliminated *J. squarrosus* from the list of plants to be found around Oradea.

At the beginning of the 20<sup>th</sup> century, Prodan (1939), based only on bibliographic data, mentioned this species in the northwestern part of Romania (Oradea) as well as in Moldova and the Ciuc Basin (Eastern Carpathians). Because there was no herbarium material in the botanists' early 20<sup>th</sup> century studies, the occurrence of *J. squarrosus* in the Transylvanian and Romanian flora was considered questionable (Jávorka 1925; Soó 1940; Borza 1947; Grințescu 1966). That is why *J. squarrosus* is not mentioned in *Flora Europaea* (Snogerup 1980) as occurring in Romania. Nor is the species reported from Romania in floristic monographs recently published by Romanian botanists (Ciocârlan 2000, 2009; Oprea 2005; Chifu et al. 2006; Sârbu et al. 2013).

This paper reports the first certain occurrence of *J. squarrosus* in the Romanian native flora, and analyzes the floristic composition of plant communities in which the species occurs.

#### STUDY AREA, MATERIAL AND METHODS

During vegetation studies in 2013 in the Apuseni Mountains, *J. squarrosus* was identified close to Beliș and Dealu Negru villages (Frink et al. 2014). This area is part of a larger erosional mountain plateau (ca 1100 m a.s.l.), formed on crystallized deposits which date to the Paleozoic, covered by paleogene sediments (Pop 1962) and having a slight inclination (5°–15°). The geographic, geologic and topoclimatic features of this tableland facilitate the development of bogs. Oligotrophic bogs occur to various extents in the whole area (Pop 1947, 1960).

Herbarium vouchers with *J. squarrosus* are deposited in the Herbarium of Babeş-Bolyai University, Cluj-Napoca (CL, inventory no. 664521, leg. Frink J.P., Jakab G., Sass-Gyarmati A.) and in the Herbarium of Eszterházy Károly University, Eger (EGR, inventory nos 8152, 8153, leg. Frink J.P., Jakab G., Sass-Gyarmati A. and no. 14110/C, leg. Höhn M., Pócs T., Tóth E.).

Between 2014 and 2016, additional field surveys were made in order to investigate the local ecological conditions of *J. squarrosus* and its phytosociological characteristics. Also, the neighboring areas of its occurrence (Mărișel area, Stâna de Vale area and Beiuș Depression in the western part of the Apuseni Mts) were

thoroughly surveyed in order to discover new localities of it.

The field survey concerning the floristic structure of plant communities with *J. squarrosus* followed the Braun-Blanquet method (1928, 1964), with modifications proposed by Borza (1934). These modifications entail using the local frequency of each species in the sample plot (phytosociological relevé), instead of considering their sociability. This substitution readily reveals the local spread of each species within the sample plot. The species registered in the relevés were entered in a synthetic table and grouped, according to their ecological and phytosociological characteristics, in diagnostic species for alliances, orders and vegetation classes. This floristical-ecological criterion was used to establish more accurately the position of plant communities with *J. squarrosus* from Romania in the Central European syntaxonomical system (Passarge 1964; Oberdorfer 1978; Krahulec et al. 2007; Matuszkiewicz 2008). Nomenclature of vascular plants follows *Flora Europaea* (Tutin et al. 1964–1980), and that of bryophytes follows Hill et al. (2006).

#### RESULTS AND DISCUSSION

The *Juncus squarrosus* populations are found in the Molhașul de la Rîșca (Mohușul de la Dealul Negru – Lágys), Dîmbul Negru – La Pod and Dîmbul Negru – Platou oligotrophic bogs (local toponymy according to Pop 1947, 1960). At these sites *J. squarrosus* has the southeastern limit of its European distribution. During the field research between 2014 and 2016 in the neighboring areas of its occurrence, no other new localities with *J. squarrosus* were identified.

The plant communities with *J. squarrosus* are patchily distributed on small surfaces (20–30 m<sup>2</sup>), mainly on the edge of flat bogs (blanket bogs). They come into contact with hygrophilous coenoses of the *Epilobio-Juncetum effusi* Oberd. 1957 association and with oligotrophic coenoses of the *Vaccinio-Callunetum* Bük. 1942 community. The soil on which the phytocoenoses with *J. squarrosus* occur is reddish brown peaty gley with excess moisture most of the year, and has an acid reaction (according to our field measurement, pH 4.9–5.5). This species is considered by Ellenberg (1979) to be an oceanic, heliophilous, hygrophilous and

**Table 1.** Floristic composition of *Nardo-Juncetum squarrosi* (Nordh. 1920) Bük. 1942 association in Romania.

Relevé no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Elevation (× 10 m a.s.l.)	106	106	108	108	108	109	110	110	110	109	106	108	110	109	110	
Aspect	N	NW	W	W	W	NW	W	–	–	W	S	–	–	–	–	
Slope (°)	2	2	2	2	1	3	3	–	–	3	3	–	–	–	–	F%
Sample plot size (m <sup>2</sup> )	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	
Grass cover (%)	55	50	90	100	95	100	100	95	95	80	90	80	70	85	90	
Moss cover (%)	10	7	40	50	1	60	45	15	2	18	5	10	10	5	15	
CHAR. ASS.																
<i>Juncus squarrosus</i>	2.4	2.2	3.5	3.5	3.5	2.5	3.5	3.5	2.3	2.5	1.3	3.5	2.5	3.5	2.5	100
<i>Nardus stricta</i>	1.2	2.3	3.4	3.5	1.3	3.5	3.5	3.5	3.5	3.5	3.5	2.5	2.5	3.5	3.5	100
<i>Nardetalia</i>																
<i>Antennaria dioica</i>	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
<i>Arnica montana</i>	.	.	.	.	.	+1	.	+1	.	+1	.	.	.	.	.	20
<i>Carex ovalis</i>	+1	.	.	.	.	.	.	+1	+1	.	.	.	.	1.3	+1	33
<i>Carex pallescens</i>	+1	+1	.	.	.	.	+1	1.1	+1	+1	1.3	+	.	+	+1	67
<i>Chamaespartium sagittale</i>	.	.	.	.	.	.	.	.	.	.	1.5	.	.	.	.	7
<i>Nardo-Callunetea</i>																
<i>Calluna vulgaris</i>	3.5	2.2	3.5	3.5	1.1	3.5	2.5	3.5	1.3	3.5	1.3	2.5	1.3	2.3	2.4	100
<i>Danthonia decumbens</i>	.	+1	.	.	+1	.	.	+1	+1	+1	1.3	1.2	1.3	1.2	1.3	67
<i>Deschampsia flexuosa</i>	.	.	.	.	.	1.1	.	.	.	.	.	.	.	+	.	13
<i>Hieracium pilosella</i>	+1	.	.	.	+1	.	.	+1	+1	+1	+	1.3	.	.	+1	53
<i>Hypericum maculatum</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+1	13
<i>Hypochoeris radicata</i>	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	.	7
<i>Luzula campestris</i>	+1	.	.	.	.	.	+1	.	+1	.	+	.	.	.	+1	27
<i>Potentilla erecta</i>	1.1	1.2	2.3	1.5	1.2	1.5	2.5	1.4	1.3	1.3	1.3	1.5	1.5	1.5	2.5	100
<i>Vaccinium myrtillus</i>	.	.	.	.	.	.	.	.	+1	.	+1	.	.	.	.	13
<i>Vaccinium vitis-idaea</i>	+1	.	.	1.1	.	+1	+1	+1	.	+1	.	.	.	.	.	40
<i>Veronica officinalis</i>	.	.	.	+1	+1	.	.	.	+1	.	+	.	.	.	+1	33
<i>Viola canina</i>	.	.	.	.	+1	.	.	.	.	.	.	.	.	+	+1	20
<i>Caricetalia fuscae</i> s.l.																
<i>Agrostis canina</i>	.	+1	1.2	1.1	2.5	.	.	.	.	.	+	.	.	.	.	33
<i>Carex canescens</i>	+1	+1	+1	.	.	+1	+1	+1	.	.	.	.	.	.	.	40
<i>Carex echinata</i>	.	.	.	.	.	+1	+1	+1	.	.	.	+	+	+	.	40
<i>Carex flava</i>	.	.	.	.	.	.	+1	.	.	.	.	.	.	.	.	7
<i>Carex nigra</i>	.	.	.	.	.	+1	.	.	.	.	.	+	.	.	.	13
<i>Carex oederi</i>	+1	+1	.	.	+1	.	.	+1	+1	.	+	+	+	+	.	60
<i>Carex panicea</i>	+1	+1	.	.	.	.	.	.	.	+1	.	.	.	.	.	20
<i>Molinietales</i> s.l.																
<i>Deschampsia caespitosa</i>	.	.	.	.	1.2	.	.	.	2.3	1.1	.	1.1	+	+	.	40
<i>Galium palustre</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	7
<i>Juncus articulatus</i>	.	.	.	.	+1	.	.	.	.	.	.	+	.	.	.	13
<i>Juncus conglomeratus</i>	.	.	+1	+1	1.2	+1	.	+1	+1	.	1.2	+2	1.3	+3	1.3	73
<i>Juncus dudleyi</i>	.	.	.	.	.	.	.	.	.	.	2.4	.	1.1	.	.	13
<i>Juncus effusus</i>	+1	+1	+1	.	+1	.	.	+1	+1	+1	.	1.2	.	.	1.5	60
<i>Juncus thomasi</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+1	13
<i>Succisa pratensis</i>	.	.	.	.	.	+1	+1	.	.	.	.	.	.	+	.	20
<i>Valeriana simplicifolia</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	7
<i>Molinio-Arrhenatheretea</i>																
<i>Agrostis capillaris</i>	.	.	.	.	.	1.1	.	.	1.2	1.2	.	+	2.5	1.5	1.3	47

Table 1. Continued.

Relevé no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	F%
<i>Anthoxanthum odoratum</i>	.	+1	+1	.	2.5	1.1	1.3	1.1	1.2	.	2.5	+2	+	1.3	1.3	80
<i>Cerastium holosteoides</i>	.	.	.	.	.	.	.	.	.	+1	+	.	+	.	+1	27
<i>Cynosurus cristatus</i>	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	13
<i>Festuca rubra</i>	+1	+1	1.3	2.3	2.5	2.5	2.5	2.5	3.5	2.4	1.4	.	+	+	+3	93
<i>Holcus lanatus</i>	.	+1	.	.	+1	.	.	.	.	.	+	.	+	+	1.2	40
<i>Leontodon autumnalis</i>	+1	+1	.	.	+1	.	.	+1	+1	.	+	.	.	.	+1	47
<i>Leucanthemum vulgare</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	7
<i>Lotus corniculatus</i>	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	13
<i>Plantago lanceolata</i>	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	+1	13
<i>Poa pratensis</i>	+1	+1	.	.	.	.	.	.	+1	.	.	.	.	.	.	20
<i>Prunella vulgaris</i>	.	.	.	.	1.1	.	.	.	.	.	+	.	+	.	.	20
<i>Ranunculus acris</i>	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	27
<i>Stellaria graminea</i>	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	+1	13
<i>Trifolium patens</i>	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	13
<i>Trifolium pratense</i>	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	.	7
<i>Trifolium repens</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1.3	13
OTHERS																
<i>Betula pendula</i> juv.	+1	.	.	1.1	.	.	+1	+1	.	+1	.	+	.	+	.	47
<i>Genista tinctoria</i>	.	.	.	.	.	.	.	.	1.1	.	.	.	.	.	.	7
<i>Homogyne alpina</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	7
<i>Juncus bufonius</i>	.	+1	.	.	+1	.	.	.	+1	.	.	+	.	+	.	33
<i>Peplis portula</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	7
<i>Picea abies</i> juv.	+1	.	.	.	.	+1	.	.	.	.	.	.	.	+	.	20
<i>Pinus sylvestris</i> juv.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
<i>Populus tremula</i> juv.	+1	.	.	+1	.	.	.	+1	.	+1	.	.	.	.	.	27
<i>Rumex acetosella</i>	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	.	7
<i>Salix aurita</i> juv.	.	.	.	+1	+1	.	+1	.	.	.	.	.	.	.	.	20
<i>Salix cinerea</i> juv.	+1	.	.	1.2	+1	.	+1	+1	.	+1	+	.	.	+	+1	60
<i>Sorbus aucuparia</i> juv.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
BRYOPHYTES																
<i>Ceratodon purpureus</i>	+1	.	.	.	+1	.	.	.	+1	.	.	.	1.1	.	.	27
<i>Leucobryum juniperoides</i>	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	7
<i>Pleurochaete squarrosa</i>	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	7
<i>Pleurozium schreberi</i>	+1	.	.	.	.	.	.	+1	.	.	.	.	.	1.2	.	20
<i>Polytrichum formosum</i>	+1	+1	1.3	+1	+1	1.1	.	1.1	.	.	1.5	1.2	1.1	.	1.1	73
<i>Polytrichum juniperinum</i>	.	.	.	.	.	.	.	.	1.1	+1	.	.	.	.	1.1	20
<i>Sphagnum capillifolium</i>	.	.	.	.	.	2.3	.	1.1	.	1.3	.	.	.	.	.	20
<i>Sphagnum compactum</i>	1.1	1.1	2.5	1.2	.	1.2	2.5	1.2	.	1.2	.	1.2	.	.	1.1	67
<i>Sphagnum contortum</i>	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	7
<i>Sphagnum fallax</i>	.	.	.	1.1	.	.	1.2	.	.	.	.	.	.	.	.	13
<i>Sphagnum palustre</i>	.	.	+1	3.5	.	2.5	2.5	.	.	.	.	.	.	.	.	27
<i>Sphagnum rubellum</i>	1.1	+1	2.2	.	.	2.3	1.1	.	.	1.3	.	.	.	.	.	40
LICHENS																
	+	+	+	.	.	.	.	+	+	+	.	.	.	.	.	40

LOCATION OF RELEVÉS

1–7 – Dealu Negru: at edge of Molhaşul de la Rîşca – Lágyas flat bog, 04 July 2014; 8 – Dealu Negru: on right side of DJ103K road, near Râşca Transilvană Monastery, 04 July 2014; 9 – Dealu Negru: east of Râşca Transilvană Monastery, 04 July 2014; 10 – Dealu Negru: northeast of Râşca Transilvană Monastery, 04 July 2014; 11 – Beliş: Dîmbul Negru – la Pod oligotrophic bog, 22 July 2016; 12–13 – Dealu Negru, Molhaşul de la Rîşca – Lágyas flat bog, 22 July 2016; 14–15 – Dealu Negru, Molhaşul de la Rîşca – Lágyas flat bog, 10 Aug. 2016

strongly acidophilic flora element which grows on moist soils poor in nitrogen.

In Romania the plant communities with *J. squarrosus* (Table 1) have a different floristic composition, lacking the sub-Atlantic and Atlantic species characteristic of the communities described in Central Europe (Passarge 1964; Oberdorfer 1978) and Western Europe (McVean & Ratcliffe 1962; Rodwell, 1991, 1992; Sýkora *et al.* 1993). However, one typical Atlantic bryophyte should be mentioned as present: *Sphagnum compactum*. This is a highly constant species (67% frequency; Table 1) in the studied phytocoenoses. Its presence could be considered strong evidence for the indigenous origin of *J. squarrosus* in these communities. The dominant and diagnostic species for these plant communities are *Juncus squarrosus*, *Nardus stricta* and *Calluna vulgaris* (Table 1), covering 50–80% of the ground in the sampling plots. Besides these, there is a group of acidophilic and oligotrophic species characteristic for and indicators of nutrient-poor soils, such as *Danthonia decumbens*, *Potentilla erecta*, *Carex pallescens*, *Carex ovalis*, *Arnica montana*, *Luzula campestris*, *Hypericum maculatum*, *Antennaria dioica* and *Chamaespartium sagittale* (Table 1). These species, together with the dominant ones, emphasize the syntaxonomical position of phytocoenoses with *J. squarrosus* from Romania in the Central European syntaxonomical system (Oberdorfer 1978; Matuszkiewicz 2008): the *Nardo-Callunetea* Prsq. 1949 class and *Nardetalia* Oberd. 1949 order. We consider it more appropriate to include these phytocoenoses in *Nardo-Juncion squarrosi* (Oberd. 1957) Passarge 1964 alliance, together with the phytocoenoses from Central Europe (Oberdorfer 1957, 1978; Passarge 1964), although they lack some sub-Atlantic species (e.g., *Polygala serpyllifolia*, *Pedicularis sylvatica*), rather than to place them into the *Violion caninae* Schwickerath 1944 alliance (Matuszkiewicz 2008) which integrates hilly and mountainous grasslands with *Nardus stricta* (Coldea 2012).

The plant association to which the communities with heath rush from Romania were assigned is *Nardo-Juncetum squarrosi* (Nordh. 1920) Bük. 1942 (Table 1), which together with the

*Nardo-Juncion squarrosi* (Oberd. 1957) Passarge 1964 alliance are new syntaxa for the Romanian vegetation.

The floristic composition of the phytocoenoses with *J. squarrosus* in Europe varies, mainly depending on the region where they grow and on the climate. In this respect the Western and Central European communities have in their structure some Atlantic species (*Erica tetralix*, *Narthecium ossifragum*, *Carex binervis*, *Trichophorum caespitosum* subsp. *germanicum*) that are not present in the floristic composition of the Eastern European communities. Therefore the phytocoenoses with *J. squarrosus* are published in scientific studies not only as a distinct plant community, *Juncus squarrosus-Festuca ovina* (Rodwell 1992), but also as plant associations named *Juncetum squarrosi sub-alpinum* (McVean & Ratcliffe 1962), *Lycopodio-Rhynchosporium* (Sýkora *et al.* 1993) and *Juncetum squarrosi* (Oberdorfer 1978; Krahulec *et al.* 2007). The names of these syntaxa lack relevant persuasive phytogeographical arguments, and for this reason Passarge (1964) considered the syntaxon *Juncetum squarrosi* Nordh. 1923 to be a group of three associations: (i) the boreo-Atlantic association *Genisto anglicae-Juncetum squarrosi* Passarge 1964; (ii) the mountain-Atlantic association *Polygalacto serpyllifolii-Juncetum squarrosi* (Oberd. 1934) Bük. 1942, where he separated several geographical races; and (iii) the north-western association *Rhytidiadelpho-Juncetum squarrosi* Br.-Bl. & Tx. 1952, specific to Ireland.

Because the phytocoenoses with *J. squarrosus* described in Central Europe (Zarzycki 1958; Passarge 1964: tab. 88, col. d–g; Krahulec *et al.* 2007) and those from Romania presented in this study have a similar floristic composition, they should be included in a unique association. The association name *Nardo-Juncetum squarrosi* (Nordh. 1920) Bük. 1942, used by Matuszkiewicz (2008) for the phytocoenoses from Poland, is considered appropriate from the floristic point of view for all the communities with *J. squarrosus* in Central and Eastern Europe.

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