

Stipa ucrainica (Poaceae): a recently recognized native species of the Bulgarian flora

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Abstract. *Stipa ucrainica* of the *S. dasyphylla* group is reported here as a recently recognized species of the Bulgarian flora, found in three sites in Northeast Bulgaria and in the Black Sea Coast floristic regions. Its occurrence in a fragment of a lowland steppe community confirms that West Pontic grass steppes represent the natural vegetation of some parts of Northeast Bulgaria.

Key words: Bulgaria, feather grass, steppes, *Stipa dasyphylla* group, *Stipa ucrainica*-*Festucetum valesiacae*

Introduction

Northeast Bulgaria is strongly influenced by agricultural practices, with the remaining natural and semi-natural habitats confined to small patches of landscape, usually with shallow soils. Nevertheless, that part of the country still harbours valuable fragments of steppe vegetation (Jordanoff 1936; Tzonev & al. 2005; Apostolova & Meshinev 2006). In the process of identification of Important Plant Areas in Bulgaria, a fragment of a steppe community with feather-grasses (*Stipa* spp.) near the village of Tyulenovo (Dobrich district) was visited and studied by I. Apostolova, A. Petrova and T. Meshinev in May 2007. The unknown dominant *Stipa* species with hairy leaves, rather large lemma with seven lines of hairs, an awn divided into a bigeniculate, glabrous column and a hairy seta, was clearly referable to *Stipa* L. sect. *Stipa*, as circum-

scribed by Cvelev (1976: 586–592) and Martinovský (1977: 100–109). Following Morariu (1972) and Martinovský (1980), it was finally identified as *S. ucrainica* P.A. Smirn. (Smirnow 1926), a member of the *S. dasyphylla* group (Martinovský 1980).

Without knowing this, J. Danihelka, identifying *Stipa* specimens collected during the 9th OPTIMA expedition to Bulgaria in 1999 (acquired in exchange with W), arrived to the same conclusion. Later on, another specimen of *S. ucrainica* from Bulgaria was found at BRNU. A search in the relevant literature has shown that these are the first records of *S. ucrainica* from Bulgaria.

The purpose of this paper is (1) to provide a description of this species, together with some taxonomical information, and (2) to consider the phytosociological and phytogeographical aspects of this find.

Materials and methods

The site was first visited in late August 2005, when the vegetation had absolutely withered, so determination of the dominant *Stipa* species has failed. The field work for this paper was done in May 2007. Vegetation sampling followed the Braun-Blanquet approach (Westhoff & van der Maarel 1980). The vegetation was recorded from two relevés, each on a sampling plot of 16 m². The geographical coordinates were measured by a Garmin-Etrex GPS (WGS84 system).

The taxonomy and nomenclature of the species follow Kozuharov (1992), the classification of floristic elements follows Assyov & Petrova (2006), with some minor modifications.

Results and discussion

Morphology and taxonomy

The most important diagnostic characters of the plants collected in Northeast Bulgaria and identified as *Stipa ucrainica* are as follows (based on our own observations and literature cited below):

Plants caespitose, forming dense tussocks with numerous leaves; basal sheaths yellow-brown, glabrous or less frequently puberulent. Leaves almost flat to conduplicate in the field and convolute or conduplicate when dry, 0.3–0.5 mm in cross section (20 measurements); on the abaxial surface densely aculeolate and with sparse to

moderately dense, up to 0.5 mm long stiff hairs, subappressed when dry (Fig. 1A); on the adaxial surface shortly hairy (with no hairs protruding between the margins of the leaf), with acuminate (not setaceous) apex. Ligules of basal leaves in vegetative tillers 1–2 mm long (16 measurements), acute or tridentate. Sheaths of stem leaves glabrous, usually not purplish when live. Lemma 17.0–18.5 mm long (six measurements), with the ventral lines of hairs ending 2.5–5.5(–6.5) mm below the base of the awn (nine measurements).

The leaves of *S. ucrainica* may resemble those of *S. lessingiana* Trin. & Rupr. and *S. tirsia* Steven in the field, but both species differ by the very short, only 0.1–0.3 mm long ligules of the leaves of vegetative tillers, developed as a fimbriate collar, and in abaxial leaf surface covered by very short, up to 0.2 mm long, stiff, subappressed hairs (but not aculeolate! Fig. 1 B, C). *Stipa tirsia* differs also by conspicuously long leaves with a setaceous apex.

According to the description given above, the plants considered here clearly belong to the *S. dasyphylla* group, whose taxonomy is based mainly on the studies by Smirnov (Smirnow 1926, 1929; Smirnov 1928) and Martinovský (e.g., Martinovský 1975), both applying a rather splitting attitude. In Eastern

and Central Europe, this species group includes *S. dasyphylla* (Lindem.) Trautv., *S. smirnovii* Martinovský, *S. glabrata* P.A. Smirn., *S. zalesskii* Wilensky s.str. (syn. *S. rubentiformis* P.A. Smirn.), *S. pontica* P.A. Smirn., and *S. ucrainica* (Smirnov

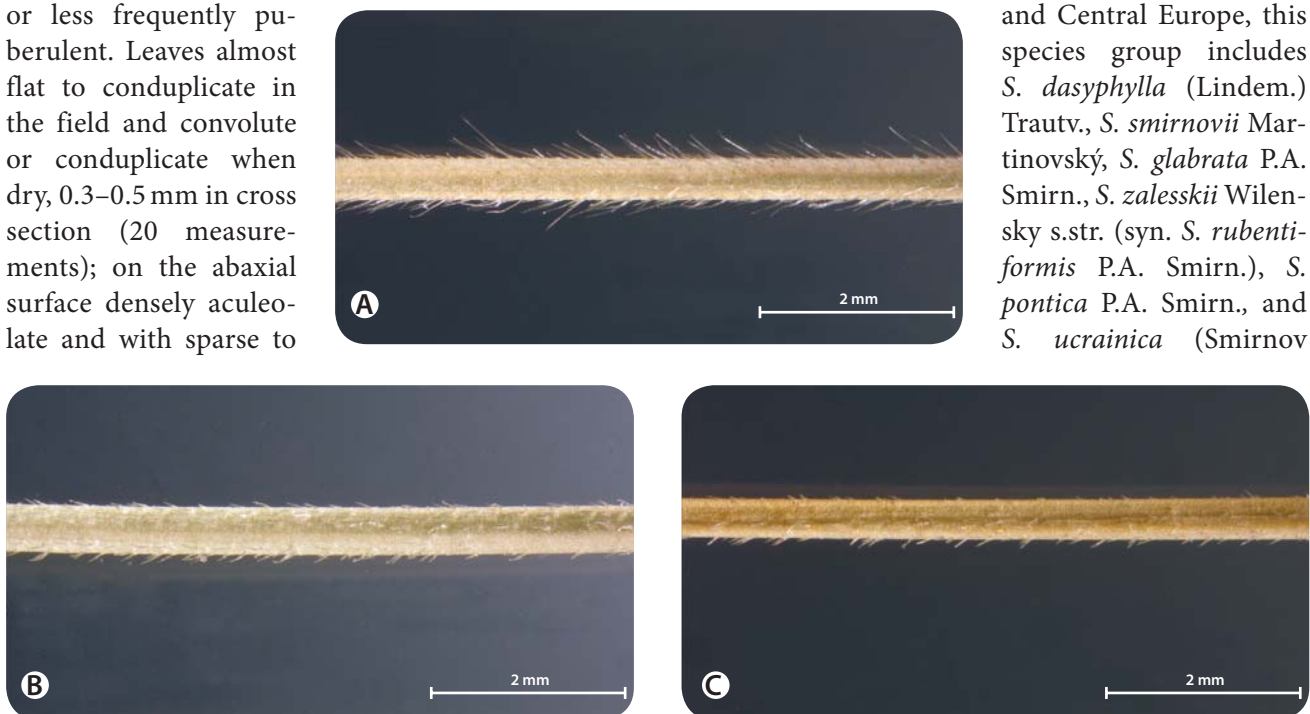


Fig. 1. Leaves of vegetative tillers (photo P. Pařil).

A – *S. ucrainica*: Bulgaria, Vidno village (BRNU 590 906); **B** – *S. lessingiana*: Kirgystan, Talas Valey (BRNU 590 911); **C** – *S. tirsia*: Czech Republic, southern Moravia, White Carpathians, Radějov village (BRNU 189 184).

1928; Martinovský 1975, 1980). Apart from *S. ucrainica*, they all have lemmas with ventral (or marginal) lines of hairs usually reaching the base of the awn, or ending 1(-2) mm below the base, and most of them also have thicker leaves and puberulent sheaths of the stem leaves. Thus the plants collected in North-east Bulgaria are clearly referable to *S. ucrainica*.

Despite the conflicting opinions about the taxonomy of the *S. dasyphylla* group (see also Cvelev 1976; Freitag 1985), *S. ucrainica* is easily recognisable and therefore generally accepted on species level in all recent floras covering parts of its distribution range (Morariu 1972; Cvelev 1974; Prokudin & al. 1977), while only Cvelev (1976) preferred treating it as one of the five subspecies of *S. zalesskii*. However, a taxonomic revision of the *S. dasyphylla* group in its entire distribution range, including also molecular methods, seems to be necessary.

Stipa ucrainica is not the first species of the *S. dasyphylla* group reported to grow in Bulgaria. Recognizing six species of *Stipa*, Vulev (1963) includes *S. pontica* as native to Bulgaria. As far as we know, it has not been well recognized and identified by Bulgarian botanists, and the specimens in Bulgarian herbaria (SO, SOM, SOA) need a critical reassessment. Field observations would also be helpful, as Smirnow (1929) emphasises also the ecological differences between *S. ucrainica* and *S. pontica* as important.

Distribution, habitats, and phytosociology

Stipa ucrainica is endemic to the Pontic floristic region (Meusel & al. 1965; Moiseenko & al. 2002). It takes part in the recent steppe vegetation in East Romania, Moldova, South Ukraine (including Crimea), the southern part of European Russia (including the foothills of North Caucasus) (Dihoru & Doniță 1970; Tomescu 2000; Moiseenko & al. 2002; Shabanova 2006).

So far three localities of *S. ucrainica* have been discovered in Bulgaria (Fig. 2) and documented by herbarium specimens:

Black Sea Coast (Northern): between the villages of Tyulenovo and Goroun, 50 m, 43°17'40" N, 27°18'31" E (described in detail below), coll. *I. Apostolova, A. Petrova & T. Meshinev*, 11.05.2007 (SOM 164 023); the northern coastal area of the Black Sea, 10 km NW of Shabla, 5 km NE of Vidno village, Gioren place, 75 m., 43°34'38" N, 28°24'29" E, coll. *Th. Raus & F. Pina Gata* 44-1-1 (OPTIMA Iter Mediterraneum IX to Bulgaria), 06.06.1999 (BRNU 590 906).

Black Sea Coast (Southern): Bourgas district, in declivi stepposo-nemoroso infra viam Varna versus supra Slunchev Bryag, ca 150 m, coll. *A. Hrabětová*, 04.06.1960 (BRNU 434 864).

The Bulgarian sites are situated along the southwestern edge of the species range and represent its remarkable extension along the Western Black Sea Coast to the southwest.

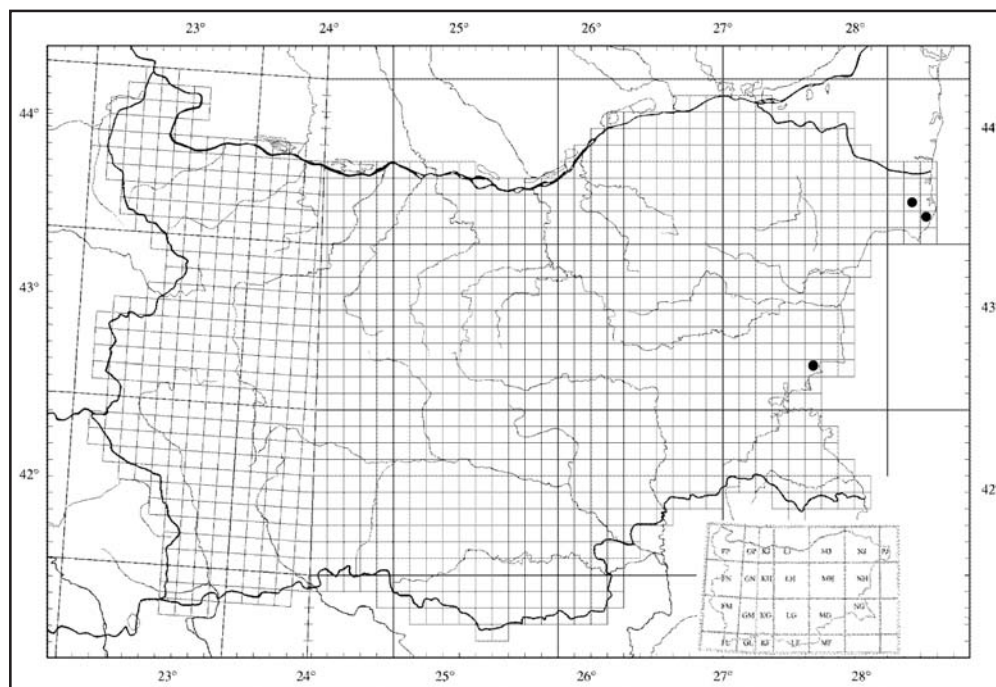


Fig. 2. UTM-based map with records of *S. ucrainica* in Bulgaria.

The Tyulenovo site is situated close to the road between Tyulenovo and Goroun villages. On May 11, 2007, the plants were in full blossom (Fig. 3). The flowering and fruiting period lasted until mid-June. The site represents an extensive pasture, with about remaining 3 ha of natural vegetation surrounded by vast arable land. It is situated in a slight depression with relatively shallow soils, and this may be the reason for not being ploughed up yet. The locality is found on a narrow strip of Neogen carbonate deposits surrounded by Quaternary eolian formations (Cheshitev & Kanchev 1989). Presumably, geological peculiarities support the existence of the feather-grass community in this site. The position in a shallow depression enhances the soil moisture: *S. ucrainica* is considered less xerophilous (together with *S. tirsia*) and at the same time more tolerant of soil salinity than the other Ukrainian feather-grasses (Prokudin & al. 1977; Romashchenko 2006). The proximity of the sea coast also corresponds to the ecological requirements of *S. ucrainica*.

The vegetation was documented from two sample plots (Table 1). Both relevés were made on level terrain, at 50 m altitude. The total projection cover of the vegetation was 90%. The cover of stones and pebbles on the soil surface was under 5%. With more than 50 species (70 species were identified altogether) found per relevé, the community had remarkable floristic diversity. All species found were herbs, with strong prevalence of perennials (66%).



Fig. 3. *S. ucrainica* dominated the vegetation in May 2007 (photo I. Apostolova).

The floristic composition of the steppe community corresponds well to the association *Stipo ucrainicae-Festucetum valesiaca* Dihoru 1970, described from the Babadag Plateau in the Romanian Dobroudzha, about 100 km northwards (Dihoru & Doniță 1970). However, some of the species listed as diagnostic for the association in Romania, namely *Amygdalus nana* L., *Centaurea orientalis* L., *C. rutifolia* subsp. *juri-neifolia* (Boiss.) Nyman, *Dianthus pallens* Sm., *Stipa pulcherrima* Koch and *Veronica austriaca* subsp. *jaquinii* (Baumg.) Malý, were not present in our sample plots, but all have been found in similar habitats in the neighbouring territories. The site in the Babadag Plateau was surrounded mostly by oak forests of the *Quercetea pubescenti-petraeae* class, while in Bulgaria, to the contrary, the surrounding landscape has been intensively used for centuries, mainly as arable land. This might have caused local extinction of some species and thus the species diversity has been somewhat lower than in similar stands in the Romanian locality.

With regard to floristic elements, the relation of the Tyulenovo steppe stands to the Pontic floristic province was manifested by the large share (35.2%) of species with Pontic distribution (Pontic, Ponto-Pannonic, Ponto-Siberian, Ponto-E-Mediterranean, etc.). Another 29.5% of the plants represent some widely distributed species (Euro-Asiatic, Circumboreal, Subcosmopolitan, etc.). The Mediterranean influence was also strong, as 27.2% of the species present in the relevés have been related to this floristic region, including the East Mediterranean, Mediterranean-Oriental or Mediterranean-Turanian species. With regard to floristic elements, the Bulgarian stands were very similar to the *Stipo ucrainicae-Festucetum valesiaca* in the Romanian Dobroudzha. A higher proportion of Mediterranean elements in the Bulgarian site may be explained by its position farther to the south and lower altitude.

The Romanian and the Bulgarian sites have also similar abiotic conditions: they are both situated close to the Black Sea, on cretaceous deposits and have similar climate characterized by a pronounced summer drought period (cf. Dihoru & Doniță 1970).

For these reasons, we consider the Tyulenovo steppe community as a fragment of a large true lowland and colline West Pontic grass steppes, with *Stipa lessingiana* and *S. ucrainica* as dominant species (Jordanoff 1936; Bohn & al. 2003), reaching also North-east Bulgaria, i.e. South Dobroudzha.

Table 1. *Stipa ucrainicae-Festucetum valesiacae* Dihoru 1970.

Floristic element	Species	rel. 1	rel. 2	Constancy in Dihoru & Doniță (1970)
1	2	3	4	5
Diagnostic for the association				
Pont	<i>Stipa ucrainica</i>	3	3	II
Pont-Med	<i>Convolvulus cantabrica</i>	+	+	III
Euro-Sib	<i>Salvia nutans</i>	+	+	II
Pont-Pan-Bal	<i>Iris pumila</i>	+	+	I
Med-subMed	<i>Teucrium polium</i>	+	+	III
Euro-Orient	<i>Vinca herbacea</i>		+	III
Bal	<i>Achillea clypeolata</i>		+	II
E. Med	<i>Scorzonera mollis</i>		+	I
Festucion valesiacae, Festuco-Brometea				
Euro-Sib	<i>Festuca valesiaca</i>	+	+	V
Pont-Med	<i>Eryngium campestre</i>	+	+	IV
Euro-As	<i>Stipa capillata</i>	+	1	II
Euro-As	<i>Falcaria vulgaris</i>	+	+	II
Euro-As	<i>Medicago minima</i>	+	+	I
Med-subMed	<i>Teucrium chamaedrys</i>	+		IV
Euro-As	<i>Phleum phleoides</i>	+		III
Euro-As	<i>Thlaspi perfoliatum</i>	+		I
Euro-As	<i>Bromus squarrosus</i>		+	I
Other species				
Med-Orient	<i>Adonis flammea</i>	+	+	I
Euro-Pont	<i>Agropyron cristatum</i> subsp. <i>pectinatum</i>	+	+	I
Euro-Orient	<i>Alyssum hirsutum</i>	+	+	
Euro-As	<i>Arenaria leptoclados</i>	+	+	
Pont-Bal	<i>Carduus thoermeri</i>	+	+	I
Kos	<i>Cerastium glomeratum</i>	1	+	
subMed	<i>Euphorbia agraria</i>	+	+	I
Euro-As	<i>Euphorbia helioscopia</i>	+	+	
Pont-CAs	<i>Galium octonarium</i>	1	+	
Euro-As	<i>Geranium rotundifolium</i>	+	+	
Med-subMed	<i>Legousia speculum-veneris</i>	1	+	
Pont-Pan-Bal	<i>Marrubium peregrinum</i>	+	+	II
subMed	<i>Ornithogalum kochii</i>	+	+	
Med	<i>Scandix australis</i>	+	+	
Euro-As	<i>Senecio vernalis</i>	+	+	

Conclusions

The presence of *Stipa ucrainica* in Northeast Bulgaria in the remains of a remarkable steppe community confirms that true steppes have extended to North-east Bulgaria (Jordanoff 1936; Bohn & al. 2003). The small remaining patches of this vegetation deserve strict conservation. The studied locality and the site close to the Vidno village are situated within a proposed Natura 2000 pSCI zone (BG0000130 Kraimorska Dobroudzha).

1	2	3	4	5
subCosmop	<i>Erodium cicutarium</i>	+	+	
Euro-As	<i>Sherardia arvensis</i>	+	1	
Pont	<i>Tanacetum millefolium</i>	+	+	
Med-subMed	<i>Trifolium scabrum</i>	+	+	
Med	<i>Trigonella gladiata</i>	+	+	
Pont-CAs	<i>Elymus hispidus</i>		+	
Pont-Med	<i>Ajuga chamaepytis</i>	+		
Euro-OT	<i>Allium rotundum</i>	r		I
E. Med	<i>Alyssum strigosum</i>	+		
Euro-As	<i>Arabis auriculata</i>		+	
Pont-Sib	<i>Aster oleifolius</i>		+	
Euro-As	<i>Bromus arvensis</i>	+		
Med-OT	<i>Calepina irregularis</i>	+		
Euro-Med	<i>Centaurea solstitialis</i>	+		
Med	<i>Coronilla scorpioides</i>		+	
Med-subMed	<i>Crepis sancta</i>	+	+	
Pont-Sib	<i>Dianthus roseoluteus</i>		+	
Circumbor.	<i>Erophila verna</i>	+		
Pont	<i>Erysimum bulgaricum</i>		+	
Pont-CAs	<i>Galium tenuissimum</i>		+	
Med-As	<i>Galium verticillatum</i>		+	
subMed	<i>Helianthemum salicifolium</i>	1	+	
Euro-Med	<i>Inula oculus-christi</i>	+		
Euro-As	<i>Lamium ampexicaule</i>		+	
Pont-Med	<i>Lathyrus setifolius</i>	+		
Pont-Sib	<i>Linaria genistifolia</i>		+	I
Med-subMed	<i>Linum austriacum</i>	+		
Pont-E. Med	<i>Potentilla mollicrinis</i>		+	
Pont-Pan	<i>Salvia austriaca</i>	+		I
Pont-Med	<i>Seseli tortuosum</i>		r	
Euro-As	<i>Silene conica</i>		+	
SE-Europ.–Southsiber	<i>Thymus glabrescens</i>		+	
Med-subMed	<i>Trigonella monspeliaca</i>		+	
Med-Orient	<i>Valerianella costata</i>	1		
Med-CAs	<i>Valerianella muricata</i>		+	
Pont-Med	<i>Valerianella pumila</i>	+	+	
Med-subMed	<i>Verbascum sinuatum</i>	+		
Med-OT	<i>Vicia peregrina</i>	+	+	

Due to its assumed rarity and confinement to endangered habitats in Bulgaria, *S. ucrainica* should also be included in the National Red List of Vascular Plants and Fungi and in the new edition of the *Bulgarian Red Data Book*. The national status evaluation based on *IUCN Red List Criteria* (IUCN 2001) resulted in **CR [B1ab(iii)+2ab(iii)]**.

Stipa ucrainica is included in the *Ukrainian Red Data Book* (Tkachenko 1996) and the *Romanian Red List* (Dihoru & Dihoru 1994) as Vulnerable, because its populations have strongly decreased outside the nature reserves. In Moldova, the feather-grass steppes and *S. ucrainica* in particular are considered rare, threatened and are also subject to conservation measures (Shabanova 2006).

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References

- Apostolova, I. & Meshinev, T. 2006. Classification of semi-natural grasslands in Northeast Bulgaria – *Ann. Bot. (Rome)*, nuova serie, **6**: 29-52.
- Assyov, B. & Petrova, A. (eds) 2006. *Conspectus of the Bulgarian Vascular Flora. Distribution Maps and Floristic Elements*. Ed. 3. BBF, Sofia.
- Bohn, U., Gollub, G., Hettwer, Ch., Neuhauslová, Z., Schlüter, H. & Weber, H. 2003. *Karte der natürlichen Vegetation Europas*. Maßstab 1 : 2 500 000. Erläuterungstext. Bundesamt für Naturschutz, Bonn.
- Cvelev, N.N. 1974. *Stipa* L. – In: Fedorov, A.A. (ed.), *Flora of the European Part of the USSR*. Vol. 1, pp. 323-332. Nauka, Leningrad (in Russian).
- Cvelev, N.N. 1976. *Grasses of the USSR*. Nauka, Leningrad (in Russian).
- Cheshitev, G. & Kanchev, I. (eds). 1989. *Geological Map of Bulgaria*, scale 1: 500 000. Geol. Committee, Sofia (in Bulgarian).
- Dihoru, G. & Dihoru, A. 1994. Rare, threatened and endemic plant species of Romania. A Red List. – *Lucr. Grăd. Bot.*, **1993-1994**: 173-199 (in Romanian).
- Dihoru, G. & Doniță, N. 1970. *Flora and Vegetation of Babadag Plateau*. Edit. Acad. Rep. Soc. România, Bucharest (in Romanian).
- Freitag, H. 1985. The genus *Stipa* (*Graminae*) in Western Asia. – *Notes Roy. Bot. Gard. Edinburgh*, **42**(3): 355-489.
- IUCN. 2001. *IUCN Red List Categories and Criteria*. Version 3.1. IUCN Species Survival Commission. IUCN, Gland & Cambridge.
- Jordanoff, D. 1936. Über die Verbreitung der Steppenvegetation in Bulgarien. – *Sborn. Bălg. Akad. Nauk., Klon Prir.-Mat.*, **32**: 1-105 (in Bulgarian).
- Kozhuharov, S. (ed.). 1992. *Field Guide to the Vascular Plants in Bulgaria*. Nauka & Izkoustvo, Sofia (in Bulgarian).
- Martinovský, J.O. 1975. Taxonomische Studie über die *Stipa*-Serie *Dasyphyllae*. XXV. Beitrag zur Kenntnis der Gattung *Stipa*. – *Preslia*, **47**(3): 249-261.
- Martinovský, J.O. 1977. *Clavis analytica nec non descriptiones breves taxorum generis Stipa in Europa centrali provenientium*. – *Preslia*, **49**(2): 97-113.
- Martinovský, J.O. 1980. *Stipa* L. – In: Tutin, T.G. & al. (eds), *Flora Europaea*. Vol. 5, pp. 247-252. Cambridge Univ. Press, Cambridge.
- Meusel, H., Jäger, E. & Weinert, E. (eds). 1965. *Vergleichende Chorologie der zentraleuropäischen Flora*. Vol. 1. Text. Gustav Fischer, Jena.
- Moiseenko, I., Górski, P. & Boiko, P. 2002. Contributions to the flora of steppes of the Black Sea region (Ukraine). – *Roczn. Akad. Roln. Poznaniu*, **347**, Bot. 5: 123-134.
- Morariu, I. 1972. *Stipa* L. – In: Săvulescu, T. (ed.), *Fl. Reipubl. Popularis Romanicae*. Vol. 12, pp. 190-207. Editio Acad. Reipubl. Popularis Romanicae, Bucharest (in Romanian).
- Prokudin, Yu.N., Vovk, A.G., Petrova, O.A., Ermolenko, E.D. & Vernichenko, Ju.V. 1977. *Grasses of Ukraine*. Naukova Dumka, Kiev (in Russian).
- Romashchenko, K. 2006. Ecological niches of Ukrainian feather-grasses: differentiation, structure, limiting factors. – *Ukrayins'k. Bot. Zhurn.*, **63**(4): 480-494 (in Ukrainian).
- Shabanova, G. 2006. Steppic communities of forest-steppe territories in Moldova, their state and protection. – In: Academician Leo Berg-130: collection of scientific articles. Pp. 28-37. Bendery, Eco-TIRAS (in Russian).
- Smirnov, P.A. 1928. *Stipa* L.. – In: Fedchenko B.A. (ed.), *Flora of the Southeast of the European part of the USSR*. Vol. 2, pp. 1-20 (ed. separate). Leningrad (in Russian).
- Smirnov, P. 1926. Zwei neue russische Stipen. – *Feddes Repert.*, **22**: 374-375.
- Smirnov, P. 1929. Neue Stipen. – *Feddes Repert.*, **26**: 264-271.
- Tkachenko, V. 1996. The Ukrainian feathergrass – *Stipa ucrainica* P. Smirn. – In: Shelyag-Sosonko, Y. (ed.), *Red Data Book of Ukraine*. Vol. 2. Flora, Kiiv (in Ukrainian).
- Tomescu, A. 2000. Evaluation of Holocene pollen records from the Romanian Plain. – *Rev. Paleobot. & Palynol.*, **109**: 219-233.
- Tzonev, R., Roussakova, V. & Dimitrov, M. 2005. The Western-Pontic steppe vegetation in Bulgaria. – *Hacquetia*, **5**(1): 5-23.
- Vulev, S. 1963. *Stipa* L. – In: Jordanov, D. (ed.), *Fl. Reipubl. Popularis Bulgariae*. Vol. 1, pp. 265-272. In *Aedibus Acad. Sci. Bulgariae, Serdicae* (in Bulgarian).
- Westhoff, V. & van der Maarel, E. 1980. The Braun-Blanquet approach. – In: Whittaker, R.H. (ed.), *Classification of Plant Communities*. Ed. 2, pp. 289-399. Dr. W. Junk Publishers, The Hague, Boston & London.