

**Taxonomic revision of the genus *Psathyrostachys* Nevski (Poaceae: Triticeae) in Turkey**Evren Cabi<sup>1\*</sup>, Musa Doğan<sup>2</sup>, Ersin Karabacak<sup>3</sup><sup>1</sup>Atatürk University, Faculty of Science, Department of Biology, 25240, Erzurum, TURKEY<sup>2</sup>Middle East Technical University, Faculty of Arts and Sciences, Department of Biological Sciences, 06531, Ankara, TURKEY<sup>3</sup>Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences, Department of Biology, 17020, Çanakkale, TURKEY

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**Abstract**

In this study, the genus *Psathyrostachys* Nevski is revised in Turkey. Furthermore multivariate analysis have been carried out in order to understand the delimitation of the taxa of *Psathyrostachys*. For this reason, 20 quantitative, qualitative and multi-state morphological characters were scored for the accessions representing 10 populations of the genus. The data were subjected to numerical taxonomic analysis. The results showed that the genus is represented by 3 species one of which is new species and the other one is a new record for Turkey. An account of 3 species and 4 subspecies recognized in the genus is given including the genus description, a key for the species as well as the subspecies, species descriptions, flowering times, habitats, altitudes, type citations, distributions, phytogeography and their conservation status. However, three new taxa, namely *P. narmanica* sp. nov., *P. fragilis* subsp. *artvinense* subsp. nov. and *P. daghestanica* subsp. *erzurumica* subsp. nov. are described and illustrated for the first time.

**Keywords:** Poaceae, *Psathyrostachys*, revision, Turkey.**Introduction**

The genus *Psathyrostachys* Nevski (Poaceae; Triticeae) is a small, well-defined, perennial genus comprising only eight species (Baden 1991). This genus is characterized by having very brittle rachis and consists of the species with the same basic genome, N, or modified forms of this genome (Löve 1984; Dewey 1982, 1984; Barkworth and Dewey 1989; Hsiao et al. 1986; Bothmer et al. 1987; Wang 1987, 1990; Lu et al. 1989; Baden et al. 1990; and Baden 1991; Laursen and Baden, 1994; Petersen et al. 2004). In Turkey, the genus *Psathyrostachys* was first revised by Melderis (1985) in Flora of Turkey and the East Aegean Islands, in which he recognized only one species *P. fragilis* (Boiss.) Nevski. This species was further divided into two more subspecies, namely subsp. *secaliformis* Tzelev and subsp. *villosus* by Baden (1991). According to this account, subsp. *villosus* was confined to Erzincan province, while the subsp. *secaliformis* was found in the eastern and the northern part of Turkey (Davis et al. 1988). Bor (1968), in Flora of Iraq Vol.9, and Humphries (1980) in Flora Europaea Vol. 5, recognized only one species. In this genus Nevski (1934) recognized six species in Flora of USSR. He also made the first sectional delimitation and divided the genus into three sections: Sect. *Hordella*, Sect. *Eupsathyrostachys* and Sect. *Camptolepis* based on mainly the number of perfect florets in the spikelets. Baden (1991) did not recognize any sections in his study. As the diagnostic characters the most authors have used length of glumes and lemmas, number of spikelets per node, number of florets per spikelet, and pubescence of glumes and lemmas (Nevski 1934; Keng 1965; Bor 1970; Tzelev 1983; Baden 1991). After the publication of the Flora of Turkey and its supplements, the new grass taxa were compiled in the supplements (Davis et al., 1988; Güner et al., 2000). Therefore, additional taxonomical, palynological and

anatomical studies have also been done on certain grass genera (Doğan, 1988, 1991, 1992, 1997; Cabi and Doğan, 2009, 2010; Cabi et al., 2009, 2010a, b, c). The primary goal of the present paper is to clarify the systematics of the genus *Psathyrostachys* in Turkey. We present a revision of the genus based on the examination of the material collected from Turkey within either in the past three years period or stored as herbarium samples.

**Results and Discussion**

During the field studies conducted in Erzurum in East Anatolia, a few interesting specimens were collected from three localities. After a close examination of the specimens and cross-checking with the *Psathyrostachys* accounts given in various floras (Bor 1968, Bor 1970, Humphries 1980, Tzelev 1976) and Baden's revisional study (1991), we have recognized a new species and two new subspecies for *Psathyrostachys* for Turkey. The new material was also compared with the type accessions of the related species. *P. fragilis* densely caespitose perennial characterized by its spikes with very long lemmas and glumes. Glumes and lemmas (including awn) are longer than 30 mm. Baden (1991) divided this species into three subspecies namely subsp. *secaliformis*, subsp. *villosus* and subsp. *fragilis*. Former two are found naturally in Turkey. The altitudinal distribution range of these subspecies was given as between 1300 and 3500 m. During one of the excursions conducted in Artvin in N. E. Anatolia. We collected a specimen identified as *P. fragilis* at an altitude of 560 m. The specimen looked like subsp. *secaliformis* at first glance because of its scabrous glumes. After a closer examination of the specimen and cross-checking it with the type specimens of subsp.

*secaliformis* and subsp. *villosus* it was realized that the specimen were quite different from subsp. *secaliformis* by having densely pilose lemmas. This specimen is also found in a very narrow area in Artvin, at the altitude of 560 m. Because of the above facts we proposed this specimen as a new subspecies which occurs in a very restricted area in the Artvin province N.E. part of Turkey. The proposed new species *P. narmanica* has thought to be close to *P. lanuginosa* at first glance because of its extremely brittle spikes with distinct patent pilose hairs giving a plumose appearance to the spike. After a close examination of the specimens and cross-checking of them with the descriptions given in Baden's account, we realized that the two taxa are strictly different from each other. Then we determined that closest species of our specimen is *P. daghestanica*. Our new specimen differs from the *P. daghestanica* by having usually two spikelets per node and indumentum of glume and lemma features. *P. daghestanica* subsp. *erzurumica* is characterized by obtuse paleas contrary to *P. daghestanica*. Löve (1984) in his genomically based study, transferred *P. daghestanica* into *P. rupestris* as a subspecies. Later, Baden (1991), followed the same treatment of Löve, he also treated *P. daghestanica* as a subspecies of *P. rupestris* contrary to Nevski (1934), Grossheim (1939) and Tzvelev (1983). Both taxa are confined to rather small geographical areas in Daghestan. The main differences between the taxa are as follows: The spikelets number at each node, palea apex and indumentum of glumes and lemmas, leaf shape characteristics, length of lemma awn. The spikelet numbers at each node as diagnostic character is useful not only for the species delimitation but also the generic delimitation as well. Because of the above facts, we treated *P. daghestanica* as separate species. The populations collected from two different localities in Erzurum province, morphologically fits the description of *P. daghestanica*. The only morphological difference between the taxa is related the apex of paleas. Apex of paleas is obtuse in our collection contrary to *P. daghestanica*. Baden (1991) indicated that *P. daghestanica* grows at low altitudes between 400-600 m. Our specimens were also gathered from 1400-1800 m. Considering the ecological differences such as altitude difference and morphological differences of palea apex, we proposed a new subspecies *P. daghestanica* subsp. *erzurumica* Cabi & Dogan subsp. nov. The phenogram (Fig 1) resulted from the cluster analysis shows that two major groups are recognizable. The characters that distinguish these two groups are length of glume and lemmas and their awns. The first group includes the populations of *P. daghestanica* subsp. *erzurumica* subsp. nov and *P. narmanica* sp. nov. populations. The second main group includes the *P. fragilis* populations. It consists three subgroups representing the subspecies of *P. fragilis* in Turkey. The indumentum types of the glumes and the lemmas helped the separation of the subgroups. The species cut of line drawn at c. 0.72 similarity level proves that the genus *Psathyrostachys* should be represented with three species in Turkey.

***Psathyrostachys Nevski*** in Fl. URSS 2:716 (1934).- Nevski, Act. Inst. Bot. Acad. Sci. U.R.S.S., ser. 1, 1: 27 (1933), nom. nud.

Type: *P. lanuginosa* (Trin.) Nevski. Ic: Baden (1991). Caespitose perennials, forming with short creeping rhizomes. Inflorescence an erect, dense spike with fragile rachis. Spikelets with 1 or 2-3 florets, arranged in group of 2-3 at each rachis node, falling with next lower rachis segment; rachilla tough. Glumes subulate, erect or recurved, scabrid or pilose. Lemma coriaceous, lanceolate, glabrous or ± pilose, with scabrid or pilose awn.

#### A revised key to Species and Subspecies

1. Awn of lemma and glumes more than 30 mm long.....**1. *P. fragilis***
2. Glumes densely pilose; hairs patent. 0.5-1 mm.....**1a. *P. fragilis* subsp. villosus**
2. Glumes scabrous to puberulent; hairs not patent, up to 0,4 mm; lemmas glabrous to pilose
3. Lemmas scabrous to puberulent.....**1b. *P. fragilis* subsp. secaliformis**
3. Lemmas densely pilose.....**1c. *P. fragilis* subsp. artvinense**
1. Awn of lemma and glumes up to 15 mm long,
4. Spikelets usually two at each node, each spikelet contain one floret, glumes and lemmas densely pilose with patent hairs up to 1.2 mm long, giving plumose appearance.....**2. *P. narmanica***
4. Spikelets usually three at each node, contain two florets; glumes pilose at lower half, scabrous towards apex; lemmas scabrous to pilose; awn of lemmas scabrous.....**3. *P. daghestanica* subsp. erzurumica**

**1. *P. fragilis* (Boiss.) Nevski** in Kom., Fl. URSS 2: 716 (1934).

Syn: *Hordeum fragile* Boiss., Diagn. Ser. 1(7):128 (1846)! *Elymus fragilis* (Boiss.) Griseb. apud Ledeb., Fl. Ross. 4: 330 (1852)!. Ic: Fl. Iraq 9: t. 89, Baden (1991).

Densely caespitose; with a curved base; older basal sheaths glabrous. Nonflowering shoots 7,5-35 cm, convolute, scabrid at abaxial side. Stem 32-60 cm long, glaucous, glabrous, pubescent below spike or throughout; nodes 2-3, glabrous..... Type: [S. Iran] in monte Sabst- Buschom prope Schiraz, Kotschy 375 (holo G iso BM!, CAL, G, GOET, HEL, JE, KI, LE, M, MO, S, W)

**1.a. subsp. villosus Baden** in Nordic J. Bot. 11: 10 (1991). Ic: Baden op. Cit.: f. 2K-S (1991).

Type: [Turkey A7 Gümüşhane] Gümüşhane, Argyridagh, 20 vi 1894, Sintenis 5947 (holo. K, iso. B!). Fl. 6-7. Calcareous and gypsum slopes, at altitudes between 1450- 2100 m.

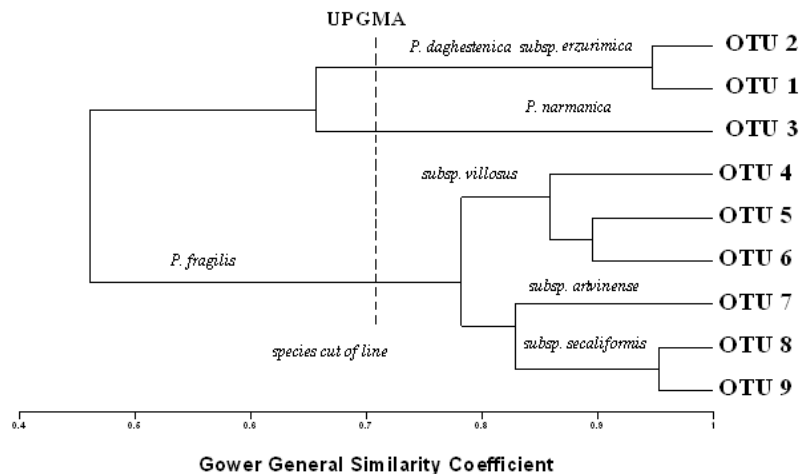
**Endemic.** Only known from localities distributed in B6 and B7 squares.

#### Examined specimens

East Anatolia B6 Sivas, 18 km from Kangal to Gürün, near crossroad of Kuşyakası village, open slopes of hills, sandy calcerous soils 1564 m [39° 07' 45.1" N 37° 14' 32.8" E]; *E. Cabi* 2424 Sivas: Kangal to Zara 5 km before Karabel pass, gypsum slopes. 1700 m [39° 37' 00.8" N 37° 43' 19.5" E]. *E. Cabi* 2454 B7 Erzincan Keşiş Dağı above Cimin, 1900-2100 m D 31769!; Erzincan: Erzincan to Sivas, before 29 km from Refahiye, 2023m [39° 52' 180" N 39° 04' 209" E] *E. Cabi* 1510-1511.; Erzincan: Sivas to Refahiye, 49 km before Refahiye, 1522 m. [39° 51' 848" N 39° 16' 809" E] *E. Cabi* 1508; Erzincan: Refahiye to Erzincan, near Sakalsultan pass, gypsum rocks, slopes, elev 1932 m., [39° 52' 19,1" N 39° 04' 57.8" E] *E. Cabi* 2462. Erzincan: Refahiye to Erzincan, 24 km before Erzincan, 1592 m., scree, [39° 52' 31.2" N, 39° 14' 54.7" E] *E. Cabi* 3407, Erzincan. 2 km from Erzincan to Spikör Mount, calcareous slopes. 1465m., [39° 47' 34.9" N 39° 28' 25.8" E] *E. Cabi* 2469 .

**Table 1.** List of characters scored for clustering analysis

1.	Habit; caespitose forming dense tufts (0), forming loose tufts (1)
2.	Stem length (cm)
3.	Nodes number on stem
4.	Length of upper internodes
5.	Stem indumentum: glabrous throughout (0), pilose just below the spike (1)
6.	Length of basal leaves (cm)
7.	Leaf shape of basal leaves: involute (0), flat (1)
8.	Leaf indumentum of basal leaves: glabrous (0), scabrid (1), pilose (2)
9.	Length of uppermost leaf on stem (cm)
10.	Stem leaves indumentum: glabrous 0, scabrid 1, pilose 2
11.	Spike length (cm)
12.	Spike width (mm)
13.	Number of spikelets per node
14.	Florets number per spikelet
15.	Glume length: more than 30 mm (0); not more than 20 mm (1)
16.	Lemma length (inc awn); more than 31 mm (0); not more than 29 mm (1)
17.	Awn of lemma: more than 20 mm (0); not more than 10 mm (1)
18.	Palea length of central spikelet (mm)
19.	Glume indumentum: scabrid or puberulent (0); pilose (1)
20.	Lemma indumentum: glabrous (0), scabrid (1), pilose in lower half scabrid in upper half (2), pilose densely throughout



**Fig 1.** Phenogram constructed by means of UPGMA algorithm and Gower General Similarity Coefficient OTUs: OTU 1,2 *P. daghestanica*; OTU 3 *P. narmanica*; OTU 4-6 *P. fragilis* subsp. *villosus* OTU 7 *P. fragilis* subsp. *artvinense* OTU 8-9 *P. fragilis* subsp. *secaliformis*

**1.b subsp. secaliformis Tzelev** in Novosti Sist. Vyssh. Rast. 9:58 (1972). Ic. Baden in Nordic J. Bot. 11: f. 3A-J (1991).  
 Syn: *Elymus secaliformis* Trin. ex Steud., Nomencl., ed. 2, 1: 551(1841) nom. nud. Fl. 6-9. Stony or rocky slopes or scree at altitudes between 1300-3100 m.  
 Type: [Iran] Prov. Azerbaijan, distr. Khoi, in promotoris ad Seidkodzi locis lapidosis subhumidis, Szowitz 197 (LE designated by Baden in Nordic J. Bot. 11: 10, 1991).

#### Examined specimens

N and S. East Anatolia A8 Erzurum: Tortum to Narman, near İncedere, slopes, 1946 m. [40°21.579' N. 41°37.259' E.] *E. Cabi 1481* (with *P. daghestanica* subsp. *erzurumica* *E. Cabi 1480*); Erzurum: Erzurum to Pazaryolu-İspir, 3 km before Toprakkale, 2152 m, rocky slopes and scree, [40°13.084' N, 40°57.616' E], *E Cabi 3449* Erzurum: Erzurum to Pazaryolu-İspir, junction of Elmalı village, 1981 m [40°08.948' N,

**Table 2.** Comparison of diagnostic characters in *Psathyrostachys narmanica* and the related species of *P. lanuginosa* and *P. daghestanica*

<i>P. narmanica</i>	<i>P. daghestanica</i> subsp. <i>erzurumica</i>	<i>P. lanuginosa</i>
Stem 50-70 cm long densely caespitose Stem glabrous throughout	Stem 40-65 cm long loosely caespitose Stem glabrous or hairy just below the spike	Stem 15-40 cm long Caespitose Stem glabrous or hairy just below the spike
Spikes 60-85 x 6-9 mm Spike with often 2 rarely 3 spikelets Each spikelet with 1 flowered,	Spikes 40-70 x 6-12 mm Spike usually with 3 spikelets Each spikelet with 2 flowered,	Spikes 10-30 x 4-9 mm Spike usually 3 spikelets at each node Each spikelet with 1 flowered or rarely 2 flowered,
Glumes of central spikelets unequal 12.5-15.5 mm long Glumes densely pilose with patent hairs throughout Lemma including awn 15.5 mm long, densely pilose, 0.7-1 mm long,	Glumes of central spikelets unequal 10.5-13.5 mm Glumes pilose at lower half, scabrous towards apex Lemma including awn 13-15 mm long, scabrous to pilose, Awn of lemmas 4.0-5.0 mm long, scabrid	Glumes of central spikelets unequal 6.2-8.0 mm Glumes densely pilose throughout Lemma including awn 7.5-8.9 mm long, densely pilose, mostly so at the apex of the body Awn of lemma 1.4-2 mm long, pilose
Awn of lemmas 4.0-5.0 mm, pilose with patent hairs		



**Fig 2.** *P. fragilis* subsp. *artvinense* Cabi & Dogan subsp. nov. A. Spike B. Spikelet C. Indumentum of glume

41°01.866' E], slopes and scree, *E. Cabi* 3432 Gümüüşhane: Aşkale to Bayburt Kop Geçidi, 2415-2450 m [40°01.569' N 40°31.339' E] *E. Cabi* 3758; Erzurum Aşkale to Bayburt Kop Mount, calcareous scree, 2039 m [40°00'12,2" N 40°32'06" E] *E. Cabi* 2543; Erzurum Aşkale to Bayburt, Kop Mount, Kop pass calcareous slopes, 2401 m [40°01'38,0"N 40°31'20,4"] *E. Cabi* 2548; B8 Muş, Varto to Erzurum, 80 km to Erzurum, 1 km before Kirişli pass, rocky mountains, slopes, scree, 2202 m [39°28.190' N 41°03.202' E] *E. Cabi* 3714; B9 Bitlis/Van: mt. 10 km S. E. of Pelli, 2250 m *D. 22521!*; Van İspiriz Da., 2600 m *D. 23630!*; Van: 17 km from Özalp to Van 2100 m N slopes in steppe *D. 44357*; C9 Hakkari: Elkiyayla Da., above pass between Marunis and Beytuşşebap, CENTO road 2400-2550 m *D. 45297!*; Hakkari: Mor Da., 3100 m, Watson 3600. Turkey, Caucasia, Iraq, Iran Afghanistan.

### 1.c. subsp. *artvinense* subsp. nov. (Fig. 2)

Type: [Turkey] A9 Artvin: Ardanuç to Arevet (Torbalı village), near Ekşiler village, slopes 560 m [41°06.142' N, 42°03.316' E], 25.vi.2008 *E. Cabi* 3529 (holotype GAZI) A9 Artvin: İspir to Yusufeli, Alanbaşı village, 764 m. rocks [40°43.251' N, 41°25.813' E], 21.vi.2008 *E. Cabi* 3478 (syntype GAZI)

*Diagnosis:* Subsp. *secaliformis* smilis, ab ea diversa: lemnae patenter pilosae, pili 0.7-1.0 mm. longis.

Closely allied to subsp. *secaliformis*, from which it can be distinguished by having pilose lemmas. It also closely allied to subsp. *villosus*, from which it can be distinguished by having scabrid glumes.



**Fig 3.** Illustration of *P. narmanica* Cabi&Dogan sp. nov.(A) habit (B) spike(C)

**Distribution.** Subsp *artvinense* is endemic to Artvin and only known from two localities at lower altitudes than subsp. *secaliformis* and *villosus* occurred. Fl. 6. Stony and rocky slopes or scree, at altitudes between 560- 765 m.

***P. narmanica* sp. nov. (Fig. 3)**

**Type:** Turkey A8 Erzurum: Narman to Pasinler, Fairy chimneys place, [40°18.050' N, 41°52.608' E], 1608 m, red soil slopes, 22.vi.2008, *E.Cabi* 3498 [holotype GAZI];

**Diagnosis:** *P. daghestanica* similis, ab ea diversa: plerumque 2 spiculati et nodis, glumae and lemnae patenter pilosae confertim omnino, spica plumosus habitus.

*P. narmanica* is closely allied to *P. daghestanica*, from which, it can be distinguished by its 2 spikelets at each node and densely pilose glumes and lemmas all over, giving the plumose appearance, the latter having usually three spikelets at each node and its glumes are covered in the lower half with patent hairs and towards the apex scabrous hairs and its body of lemmas scabrous to pilose.

Caespitose, with a curved base; older basal sheaths yellowish brown, glabrous. Culms 50-70 cm long, glabrous; culm nodes 2, glabrous; leaf sheaths covering 3/4 of the culm; uppermost internode 20-25 cm long; uppermost leaf sheath 9-12,5 cm long; uppermost leaf 10-30 cm x 1-2 mm; basal leaves up to 20 cm long pale green, involute, culm leaves scarce two or three, flat to involute; leaf surface scabrous, with prominent veins, Spikes 60-85 x 6-9 mm; rachis brittle, rachis margin pilose; 2-3 spikelets per node, spikelets 1 flowered, central spikelets narrowly elliptic, glumes unequal 12,5-15,5 mm long both erect, densely hirsute, hairs patently divergent 0,5-1,0 mm long; lemma including awn 15,5 mm long, densely

pilose, 0,7-1 mm long, lemma awns 4,5 mm long; palea and body of lemma 9,5 mm; palea acute at apex; pilose; lateral spikelets narrowly elliptic, glumes 15-16,5 mm long; densely pilose, hairs patently divergent, 0,8-1 mm long; lemma including awn 18,5 mm long; lemma awns up to 7 mm long, densely pilose, palea and body of lemma 11 mm long, pilose, anther 4,5-6 mm long. Fl. 6-7

**Habitat and Ecology.** *Psathyrostachys narmanica* grows in dry mountain slopes, iron rich soils, and rocks. It was collected from 1690 m. Other species growing in the area are as follows *Ajuga chamaepitys* (L.) Schreb., *Convolvulus lineatus* L., *Dactylis glomerata* L., *Eremopyrum distans* (K.Koch) Nevski, *Euphrasia pectinata* Ten., *Galium verum* L. subsp. *verum*, *Hedysarum elegans* Boiss. & Huet, *Juniperus oxycedrus* L. subsp. *oxycedrus*, *Melica persica* Kunth, *Elymus sosnowskyi ilis* (Boiss.) Nevski, *Pseudorosularia sempervivoides* (Fisch.) M.Z.Gurgenidze, *Rumex acetosella* L., *Salvia huberi* Hedge, *Scutellaria orientalis* L. subsp. *sosnowskyi* (Takht.) Fed., *Teucrium polium* L., *Zingiber biebersteiniana* (Claus) P.A.Smirn., *Ziziphora clinopodioides* Lam., *Onobrychis*, *Potentilla*, *Veronica*, *Artemisia*, *Alchemilla*, *Euphorbia*, *Thymus*, *Alhagi*, *Iris*, *Stipa*, *Centaurea*, *Rubiaceae*, *Silene*, *Alopecurus*, *Anthemis*, *Areneria*.

**Distribution.** East Anatolia (A8 Erzurum) Endemic. Ir-Tur. Element (Fig. 4). It is known only from the type locality.

**Etymology:** This endemic species is named after Narman, a town in Erzurum, from where it was collected by the authors.

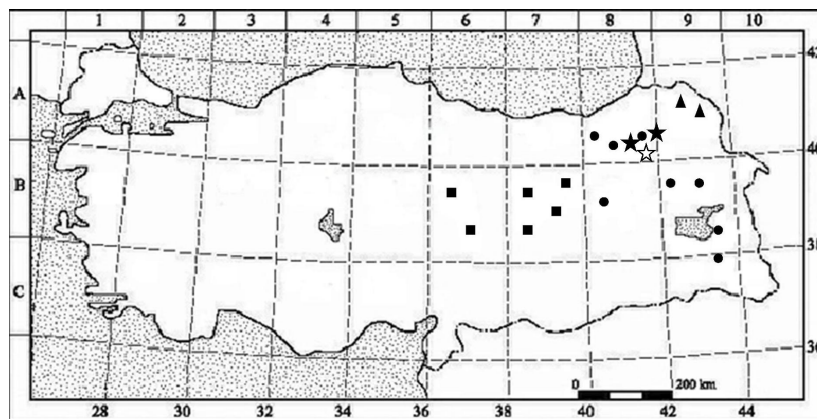
***P. daghestanica* (Alex.) Nevski subsp. *erzurumica* subsp.nov.**

**Type:** A8 Erzurum: Oltu, Çamlidere (Borahan), [40°31.037' N, 41°59.603' E], 1401 m, slopes, 22.vi.2008, *E.Cabi* 3486 (GAZI); A8 Erzurum from Tortum to Narman, calcerous soils and slopes, 1804 m [40°20.263' N 41°35.031' E] 05.07.2006 *E. Cabi* 1480 (GAZI)

**Diagnosis:** Subsp *daghestanica* similis, ab ea diversa: palea obtusus et apex

Caespitose perennial. Older basal sheaths brown, glabrous. Culms 40-65 cm long, sparsely hairy just below the spike, remaining part is glabrous; nodes 2, glabrous; leaf sheaths covering 3/4 of the culm, uppermost internode 13-20 cm long; uppermost leaf sheath up to 15 cm long; uppermost leaf 6-8x 0.2-0.5 cm, basal leaves up to 25 cm long pale green, involute, culm leaves scarce one or two, flat to involute; leaf surface glabrous, with prominent veins, Spikes 40-70x 6-12 mm; rachis brittle, rachis margins pilose; three spikelet per node, spikelets usually with 2 flowered, one fertile, the other one is rudimentary or sterile with a 3 mm long pedicel; central spikelets narrowly elliptic, glumes unequal 10.5-13.5 mm, long both erect; or recurved, densely hirsute, hairs patently divergent 0,5-1,0 mm long; lemma including awn 13-15 mm long, pilose, mostly so at the apex of the body, lemma awns 4.0-5.0 mm long; palea and body of lemma 10 mm; palea obtuse at apex; sparsely pilose on keels; lateral spikelets narrowly elliptic, glumes 11-18 mm long; densely hirsute, hairs patently divergent, 0,8-1 mm long; lemma including awn 15-20 mm long; lemma awns 4.0-8.5 mm long, scabrid, palea and body of lemma 10-11 mm long, sparsely pilose. Caryopsis 6-7 mm long, anthers yellow 5.5-6 mm long.





**Fig 4.** Distribution of *Psathyrostachys* in Turkey. *P. fragilis* subsp. *villosus* (■), *P. fragilis* subsp. *secaliformis* (●), *P. fragilis* subsp. *artvinense* (▲), *P. narmanica* (☆), *P. daghestanica* (Alex.) Nevski subsp. *erzurumica* (★)

### Materials and methods

This study is based on morphological characters of fresh and mounted material of the genus *Psathyrostachys*. Most of the material was collected from different localities of Turkey during the field surveys carried out as a part of a research project sponsored by the Turkish Scientific and Technical Research Council (TUBITAK) for a three year period starting from 2006. During the investigation, material from the herbaria namely herbaria E, K, BM, ANK, GAZI, ISTE, VANF (herbarium abbreviations were given according to Holmgren, Holmgren and Barnet 1990) were barrowed and studied. The descriptions of the taxa are based on the measurements of as many specimens as possible. Sterile parts were measured directly on herbarium material; spikelets and florets on material boiled in a tap water. Measurements have been made with the use of Leica L2 Stereomicroscope and Leica Application Suite software package. A cluster analysis was made so as to show the clear-cut morphological differences among the taxa. Voucher specimens (Appendix 1) scored for cluster analyses are currently housed in Plant Systematic and Biodiversity Laboratory in Middle East Technical University (METU). Operational Taxonomic Units (OTU's) used for constructing the cluster analysis were chosen from the complete specimens. A set of 20 diagnostic characters (Table1) was chosen and scored for the OTU's (Sneath & Sokal 1973). The morphometric analysis was carried out with the use Gower (1971) general similarity index with the help of software package of the MVSP version 3.13p (Kovach, 1999). Gower's (1971) General Similarity Index was chosen to generate a distance matrix. This matrix was used for cluster analysis with the help of UPGMA algorithm. Gower's formula has a range of [0,1] irrespective of the number of variables, so that the tree length is unaffected by the number of traits, which is considered an advantage by Mason et al. (2005).

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### References

- Baden C, Linde-Laursen I, Dewey DR (1990). A new Chinese species of *Psathyrostachys* (Poaceae) with notes on its karyotype. *Nord J Bot.* 9:449-460
- Baden C (1991). A taxonomic revision of *Psathyrostachys* (Poaceae). *Nord J Bot.* 11:3-26
- Barkworth ME, Dewey DR (1985). Genomically based genera in the perennial Triticeae of North America: Identification and membership. *Am J Bot.* 72:767-776
- Bor NL (1968). *Psathyrostachys*. -In: Townsend, C. C., Guest, E. & Al-Rawi, A. (eds), *Flora of Iraq* 9. Baghdad, pp 257-258
- Bor NL (1970). *Psathyrostachys*. -In: Rechinger, K. H. (Ed.), *Flora Iranica*. Graz, Austria: Akademische Druk-Und Verlasantald, Wiена, 70:229.
- Bothmer R. Von, Kotimaki M, Linde-Laursen I. (1987). Genome relationships between *Psathyrostachys huashanica* and *P. fragilis* (Poaceae). *Pi Syst Evol.* 156: 183-188
- Cabi E, Doğan M (2009). A first vouchered wild record for the flora of Turkey: *Aegilops juvenalis* (Thell.) Eig (Poaceae). *Turk J Bot.* 33: 447-452.
- Cabi E, Doğan M, Başer B, Us E, Pehlivan S (2009). Morphological and Palynological features of the *Dasyphyrum* (Poaceae) in Turkey. *Phytol Balcanica.* 15(3): 393-400.
- Cabi E, Doğan M, Mavi Ö, Karabacak E, Başer B. (2010a). *Elymus sosnowskyi* (Hackel) Melderis (Poaceae), a rare endemic species in Turkey. *Turk J Bot.* 34: 105-114.
- Cabi E, Doğan M, Mavi Ö (2010b). Morphological and anatomical properties of the genus *Crithopsis* (Poaceae) in Turkey. *Biodicon* 3/2: 42-48
- Cabi E, Doğan M. (2010). Taxonomic study on the genus *Eremopyrum* (Ledeb.) Jaub. et Spach (Poaceae) in Turkey. *Plant Sys Bot.* 287(3-4): 129-140.
- Cabi E, Doğan M, Özler H, Akaydın G & Karagöz A (2010c). Taxonomy, Morphology and Palynology of *Aegilops vavilovii* (Zhuk.) Chennav. (Poaceae:Triticeae). *Afr J Agri Res.* 5(20): 2841-2849.
- Davis PH, Mill RR, Tan K (1988). *Flora of Turkey and The East Aegean Islands*. Vol. 10 (supplement) Edinburgh: Edinburgh University Press.

- Dewey DR (1982). Genomic and Phylogenetic relationships among North American Triticeae.-In: Estes, J. R., Tyrl, R.J. & Brunken, J. N. (eds), Grasses and grasslands. Systematics and ecology. Norman:University of Oklohama, pp 51-88.
- Dewey DR (1984). The genomic system as a guide to intergeneric hybridization with the perennial Triticeae-In Gustafson, J. P.(ed.), Gene manipulation in plant improvement. Plenum Publishing Corp., pp 209-279.
- Doğan M. (1988). A Scanning Electron Microscope Survey of Lemma in *Phleum*, *Pseudophleum* and *Rhizocephalus* (Gramineae) Notes RGB Edinburgh. 45(1): 117-124.
- Doğan M (1991). Taxonomic significance of vegetative and floral morphologies in the genus *Alopecurus* L. (Gramineae). Turk J Bot. 15: 124-132
- Doğan M (1992). Assessment of the morphological variation by means of numerical taxonomy in *Alopecurus* (Gramineae), Flora et Vegetatio Mundi, 9:75-81.
- Doğan M (1997). Numerical taxonomic study on the genus *Alopecurus* L. Gramineae), The Herb J Systematic Bot. 4(2):71-76.
- Holmgren PK, Holmgren NH, Barnett LC (1990). Index herbariorum part I. Herbaria of the world. 8th edn. Regnum Vegetabile 120. New York Botanical Garden, New York. (<http://www.nybg.org/bsci/ih/>)
- Hsiao C, Wang RRC, Dewey DR (1986). Karyotype analysis and genome relationships of 22 diploid species in the tribe Triticeae. Can J Genet Cytol. 28: 109-120
- Güner A, Özhatay N, Ekim T, Baser KHC (2000). Flora of Turkey and the East Aegean Islands. Vol. 11 (supplement) Edinburgh: Edinburgh Univ. Press.
- Löve A (1984). Conspectus of the Triticeae. Feddes Repert. 95:425-521
- Linde-Laursen I, Baden C (1994). Giemsa C-Banded karyotypes of two cytotypes (2x, 4x) of *P. lanuginosa* (Poaceae; Triticeae). Hereditas. 120:113-120
- Lu BR, Yen C, Yanc JL, Flink J (1989). Cytogenetic studies of the hybrid between *Psathyrostachys juncea* and *P.huashanica* (Poaceae). Nord J Bot. 9: 11-14
- Melderis A (1985). *Psathyrostachys* (Gaertner) -In Flora of Turkey and the East Aegean Islands, Vol. 9 (P.H. Davis, ed.). Edinburgh, pp 261-262.
- Nevski SA (1934). Tribe XIV. Hordeae Benth. 590-722. In V. L. Komorov Flora of the U.S.S.R. The Botanical Institute of the Academy of Sciences of the USSR. Leningrad USSR.
- Petersen G, Seberg O, Baden C (2004). A phylogenetic analysis and morphology of the genus *Psathyrostachys* (Poaceae) based on nuclear gene, three plastid genes and morphology. Plant Syst Evol. 249: 99-110
- Tzelev NN (1976). Poaceae URSS. Tribe 3. Triticeae Dumort. Genus 17. *Agropyron* Pages 143-150. USSR Academy of Science Press, Leningrad.
- Wang RRC (1987). Synthetic and natural hybrids of *Psathyrostachys huashanica*. Genome 29: 811-816
- Wang RRC (1990). Intergeneric hybrids between *Thinopyrum* and *Psathyrostachys* (Triticeae). Genome 33: 845-849