TAXONOMICAL STUDIES ON ENDEMIC SCORZONERA PYGMAEA VAR. PYGMAEA AND VAR. NUTANS STAT. NOV. (ASTERACEAE) FROM TURKEY

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Abstract

The taxonomic status of Scorzonera pygmaea var. pygmaea and var. nutans belonging to the tribe cichoreae (Asteraceae) S. pygmaea samples were collected from Arayit mountain. We suggest that these two subspecies should be classified as varieties because of their morphological and anatomical characteristics, ecological and geographical similarities. Moreover being together in the same localities of these under species taxa supports our opinion, i.e. S. pygmaea Sibth. & Sm. var. pygmaea stat. nov. and S. pygmaea Sibth. & Sm. var. nutans (Czeczott) O. Koyuncu & Yaylaci, stat. nov.

Introduction

Genus Scorzonera L. (Tribe cichoreae -Asteraceae) has approximately 180 species in the world (Bremer, 1994; Makbul et al., 2011a). Although it originates from ancient Mediterranean, it distributes from arid regions of Eurasia to Northern Africa. This genus is fairly intricate (Bremer, 1994; Nazarova, 1997; Lack, 2007; Makbul et al., 2011a,b). The most significant taxonomical problem of this genus is having too much morphological variation (Bremer, 1994; Makbul et al., 2011b). Taxonomic problems of this genus are not investigated sufficiently and there are still many controversial issues (Nazarova, 1997; Türkmen et al., 2010).

A complete classification of genus Scorzonera was made by De Candolle (1805). Then, the genus was revised again by Boissier (1875) and Lipschitz (1935, 1939). Among these revisions, the work of Lipschitz (1939) was the most comprehensive. Scorzonera is represented by 28 species in Europe (Chater, 1976). Chamberlain (1975) reported 39 taxa from Turkey. After Chamberlain a few new taxa were added (Davis et al., 1988; Güner et al., 2000; Duran, 2002a,b; Kilian & Parolly, 2002; Parolly & Kilian, 2003; Duran & Hamzaoglu, 2004; Duran & Hamzaoglu, 2004; Dinç & Bağc, 2009; Özhatay et al., 2009; Doğan & Duran, 2010; Hamzaoglu et al., 2010; Doğan et al., 2011; Özhatay et al., 2011; Coşkunçelebi et al., 2012; Makbul et al., 2012). Currently, Scorzonera is represented by 47 species, 7 subspecies and 4 varieties in Turkey; 26 of these taxa are endemic. Anatolia is a diversity centre for the genus Scorzonera with more than 50 taxa.

Some studies have been performed on anatomical, morphological, palynological, genetic, pharmacological, ethnobotanical, distribution and conservational status in genus Scorzonera (Metcalfe & Chalk, 1950; D’amato, 2000; Mço & Khan, 2004; Makbul, 2006; Karac & Cepel, 2007; Qureshi et al., 2008a,b; Dinç et al., 2008; Dinç & Bağc, 2009; Makbul et al., 2010, 2011a,b; 2012; Türkmen et al., 2010; Martin et al., 2012; Coşkunçelebi et al., 2012; Yildirim & Senol, 2012).

Anatomical characters are quite important in systematics of Scorzonera. Although classification of Scorzonera seems easy, showing too much variation of the genus makes its identification harder (Makbul et al., 2011a, b).

In addition, Chamberlain (1975) while revising the genus Scorzonera for Flora of Turkey observed some taxonomic problems in S. pygmaea. “The Kastamonu and Zonguldak plants of S. pygmaea consistently differ in being generally larger than those from Bursa and Isparta but may only represent peripheral variant populations. Czeczott described the capitula of S. nutans as nodding. This is surely an artifact; the specimens from Ilgaz Dağı do not show this feature” (Chamberlain, 1975).

The first specimens belonging to S. pygmaea were collected by Sibthorpinium from A2(A) Bursa, Turkey in the Olympus (Uludağ) and described as a new species by Sibthorpinium and Sm. in 1806 (Chamberlain, 1975). The first specimens belonging to S. nutans were collected by Czeczott from A4 Çankıri, Turkey in the Ilgaz Mountain in 1925 and was described as a new species in 1939. Later this species was reduced as S. pygmaea subsp. nutans by Chamberlain (1975).

In order to ascertain the taxonomic status of both the endemic taxa anatomic, morphologic, palynologic, distribution and conservation status was investigated.

Material and Methods

Specimen samples: We collected some Scorzonera pygmaea specimens in the Arayit Mountain (Eskişehir), Uludağ Mountain (Bursa) and Ilgaz Mountain (Çankıri) in 2009-2011.

Morphological studies: Fresh plant samples were identified with the help of relevant literature on Lipzicht (1935, 1939), Czeczott (1939), Chamberlain (1975) and Chater (1976). Morphological studies were conducted with stereo microscope Olympus CH 50. In addition, photos of various parts were taken by Nikon SZ120. The morphological characters were compared with that of Chamberlain (1975).

Anatomical studies: The samples were kept in 70% alcohol until the sections were prepared. We obtained some cross-sections of roots, stems and leaves manually. We also obtained lower and upper cross-sections from the fresh leaves. The sections were photographed by the Kameram™ digital camera and an Nikon 80i type microscope in our Department.
Palyngological studies: For palyngological studies pollen material was obtained from fresh flower specimens. The pollen morphology was investigated through Light Microscope (LM) and Scanning Electron Microscope (SEM). Faegri and Iversen’s terminology were used for the naming of the exine layers (Faegri & Iversen 1975). Under light microscope the pollen acquired from the samples was investigated by Wodehouse (1935) and Erdtmann (1952) methods. Pollen identifications were obtained by Prior binocular microscope. The materials were prepared according to Wodehouse’s and Erdtmann’s methods; the exine and intine thickness pertaining to taxa are measured a minimum 20 and a maximum 50 times. From these obtained measurements, a natural mathematical mean is calculated. Microphotographs were taken at the Eskişehir Osmangazi University Science and Art Faculty, Department of Biology by Kameram™ digital camera and a Nikon 80i microscope.


Result and Discussion

Morphological characteristics: Some morphological characters of *S. pygmaea* were examined and compared with the description of Chamberlain, (1975). Some specific characters in the type description were corrected (flowering stem 1.5-11 cm, leaves 1.2-7 x 0.2-03 cm, capitula straight or nodding and pappus lower part sparsely plumose) and some characters which were not mentioned in type description were mentioned for the first time with this study (achene length, fruiting) (Figs. 1-3, Table 1).

Table 1. Comparative morphology of *Scorzonera pygmaea* Sibth. & Sm. var. *pygmaea* and var. *nutans* (Czeczott) O. Koyuncu & Yaylaci

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>S. pygmaea</em> var. <em>pygmaea</em></th>
<th><em>S. pygmaea</em> var. <em>nutans</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitus</td>
<td>cushion-forming, with numerous scapiform stems</td>
<td>cushion-forming, with numerous scapiform stems</td>
</tr>
<tr>
<td>Stem</td>
<td>all leaves basal, 1.5-5 (7)</td>
<td>all leaves basal, (3)-5-11</td>
</tr>
<tr>
<td>Leaf</td>
<td>Leaves entire, 1.2-1.9 x 0, 2-0.3 cm Linear to linear lanceolate, sparsely lanat, ± amplexicaule</td>
<td>Leaves entire, 1-8-7 x 0, 2.0-3 cm Linear to linear lanceolate, sparsely lanat, ± amplexicaule</td>
</tr>
<tr>
<td>Capitula</td>
<td>1 per stem, straight</td>
<td>1 per stem, Nodding</td>
</tr>
<tr>
<td>Outer phyllary</td>
<td>pubescent, 3-5 mm long, ovat to lanceolat</td>
<td>pubescent, 3-5 mm long, ovat to lanceolat</td>
</tr>
<tr>
<td>Inner phyllary</td>
<td>pubescent, acute</td>
<td>pubescent, acute</td>
</tr>
<tr>
<td>Lobes of ligule</td>
<td>0.5-1.5 long</td>
<td>0.5-1.5 long</td>
</tr>
<tr>
<td>Branches of style</td>
<td>c. 5 mm long</td>
<td>c. 5 mm long</td>
</tr>
<tr>
<td>Pappus</td>
<td>pink tinged</td>
<td>pink tinged</td>
</tr>
<tr>
<td>Hairs of pappus</td>
<td>plumose below, barbellate above</td>
<td>sparsely plumose below, barbellate above</td>
</tr>
<tr>
<td>Achene length</td>
<td>6-7mm</td>
<td>7-8mm</td>
</tr>
<tr>
<td>Flowering</td>
<td>6-7(8)</td>
<td>6-7(8)</td>
</tr>
<tr>
<td>Fruiting</td>
<td>7-8(9)</td>
<td>7-8(9)</td>
</tr>
</tbody>
</table>

Fig. 1. General appearance. (a) *Scorzonera pygmaea* Sibth. & Sm. var. *pygmaea* (habit, in Uludağ-Bursa), (b) *Scorzonera pygmaea* Sibth. & Sm. var. *nutans* (Czeczott) O. Koyuncu & Yaylaci (habit, in Ilgaz Mountain-Çankırı).
Fig. 2. LM micrographs. *Scorzonera pygmaea* Sibth. & Sm. var. *pygmaea*: a- capitulum, b- achene; *Scorzonera pygmaea* Sibth. & Sm. var. *nutans* (Czeczott) O. Koyuncu & Yaylaci: c- capitulum, d- achene.

Fig. 3. LM micrographs of phyllaries. *Scorzonera pygmaea* Sibth. & Sm. var. *pygmaea*: a- outer phyllaries, b- inner phyllaries; *Scorzonera pygmaea* Sibth. & Sm. var. *nutans* (Czeczott) O. Koyuncu & Yaylaci: c- outer phyllaries, d- inner phyllaries.
Taxonomic treatment

A detailed morphological examinations of two taxa, revealed that both were similar in terms of many characters (habit, outer phyllary, inner phyllary, lobes of ligule, branches of style, flowering and fruiting). On the other hand, some differences were found in terms of some characters: subsp. pygmaea; stem; 1,5-5 (7) cm, leaf; 1,2-1,9 x 0,2-0,3 cm, capitula; straight, hairs of pappus; plumose below, barbellate above, achene length; 6-7mm, subsp. nutans; stem; (3-5) 5-11 cm, Leaf; 1,8-7 x 0,2-0,3 cm, capitula; noding, hairs of pappus; sparsely plumose below, barbellate above, achene length; 7-8mm (Figs. 1-3; Table I).

In view of morphological similarity of both the taxa and sym pathetic distribution (Fig. 7) Scorzoner a pygmaea Sibth. & Sm. subsp. nutans.

Scorzonera pygmaea Sibth.&Sm. var. pygmaea

Synonyms: Scorzonera pygmaea Sibth. & Sm. Prodr., Fl. Graec. 2:122 (1806)
=Scorzonera pygmaea Sibth. & Sm. subsp. pygmaea, Ic: Sibth. & Sm., Fl. Graeca 8. t. 783 (1833).

Type: Turkey A2(A) Bursa: Olympos Bithyno (Ulu Da.), cacumine, Sibthop.

Flowering stems 1,5-5 (7) cm, straight; leaves 12-19 mm; pappus lower part plumose .................................................. ....... var. pygmaea

Flowering stems (3-) 5-11 cm, nodding; leaves (18-) 30-70 mm; pappus lower part sparsely plumose ........................................ ...... var. nutans

Anatomical characteristics

Scorzonera pygmaea var. Pygmaea: leaf: It is ecificafial type and mesophyll consists of 2-3 layers of palisade inside of upper epidermis, 2 layers of palisade beneath the lower epidermis and 2-3 layers of sponge (Fig. 4a).

Stem: The epidermal tissue consists of a single row of rectangular or orbicular cells. Some of the epidermal cells are covered with dense simple or branched hairs, the others are generally smooth. The collenchyma is generally located very close to the epidermis, with two or three to four rows. The cortex consists of usually parenchymatic oval cells, with seven or eight to ten rows. The vascular bundles, interconnected with an intravascular sclerenchyma, formed one or two to three continuous rings in the stem. Secretory cells are located very close to the phloem tissue. Scleranchymatous cells are present in the phloem and xylem. There is also large pith in the stem centre (Fig. 4d).

Scorzonera pygmaea var. nutans

Leaf: It is ecificafial type and mesophyll consists of 2-3 layers of palisade inside of upper epidermis, 2 layers of palisade beneath the lower epidermis and 2-3 layers of sponge (Fig. 4b).

Stem: The epidermal tissue consists of a single row of rectangular or orbicular cells. Some of the epidermal cells are covered with dense simple or branched hairs, the others are generally smooth. The collenchyma is generally located very close to the epidermis, with two or three to four rows. The cortex consists of usually parenchymatic oval cells, with seven or eight to ten rows. The vascular bundles, interconnected with an intravascular sclerenchyma, formed one or two to three continuous rings in the stem. Secretory cells are located very close to the phloem tissue. Scleranchymatous cells are present in the phloem and xylem. There is also large pith in the stem centre (Fig. 4d).

Palynological characteristics

Scorzonera pygmaea var. pygmaea: Pollen grains are radially symmetrical, isopolar, oblate-spheroidal. The size (polar axis x equatorial diameter, excluding spines) ranges from 39.28 (42-38) x 42.57 (48-39) µm in Wodhouse and 40.28 (42-38) x 41.57 (45-39) µm in Erdtman. It has echinolophate, trizonocolporate pollen with 15 lacune (6 abporal, 3 poral and 6 paraporal). The spines are convex-conic with a broadened base and a tapered apical portion. The length of the spine is 3.9 (3.2–4.3) µm and its width at the base is 3.0 (2.8–3.3) µm. The base of the spines has irregularly 1–2 seriate perforations with small holes (0.3 µm) and µm2 3–4 perforates. Exine 4.6 (4.3–5.2) µm. Sexine is much thicker than nexine. Intine 1.25 (1.0–2.0) µm (Figs. 5a,b; 6a,b; Tables 2; 3).
Fig. 4. Cross sections of leaf: (a) *Scorzonera pygmaea* var. *pygmaea* (b) *Scorzonera pygmaea* var. *nutans*. Cross sections of stem: (c) *Scorzonera pygmaea* var. *pygmaea* (d) *Scorzonera pygmaea* var. *nutans*. Abbreviations: (c) cortex, (cu) cuticle, (cl) collenchyma, (e) epidermis, (le) lower epidermis, (p) parenchyma, (ph) phloem, (phs) phloem sclerenchyma, (pp) palisade parenchyma, (s) sclerenchyma, (sp) sponge parenchyma, (ue) upper epidermis, (xl) xylem.

Fig. 5. Light micrographs of pollen grains. *Scorzonera pygmaea* var. *pygmaea*: (a) polar view, (b) equatorial view, *Scorzonera pygmaea* var. *nutans*: (c) polar view, (d) equatorial view.
**Scorzonera pygmaea var. pygmaea**

Pollen grains radially symmetrical, isopolar, oblate-spheroidal. The size (polar axis x equatorial diameter, excluding spines) ranges from 40.30 (45–38) × 43 (46–39) µm in Wodhouse and 39.25 (43–33) × 44.70 (48–41) µm in Erdtman. It has echinolophate, trizonocolporate pollen with 15 lacunae (6 abporal, 3 poral and 6 paraporal). The spines are convex-conic with a broadened base and a tapered apical portion. The length of the spine is 2.9 (2.5–3.4) µm and its width at the base is 3.0 (2.8–3.3) µm. The base of the spines has irregularly 1–2 seriate perforations with small holes (0.3 µm) and µm3–4 perforates. Exine 3.6 (3.1–4.2) µm. Sexine is much thicker than nexine. (Figs. S5c,d; 6c,d; Table 2; 3).

**Distribution:**

**Scorzonera pygmaea var. pygmaea**

It is endemic to N.W. & S.W. Anatolia. A2(A) Bursa: Uludağ, 2400-2500 m a.s.l., 28.vii.2001, Y. Menemen 512 & E. Hamzaşıtyu; Bursa: Uludağ, zirve yolu, N 40° 05' 52"-E 29° 11' 18", 2280 m, 01 vii 2009, OUF E; A4 Ankara: Çubuk, Karagöl, ca. 1700 m a.s.l., 5.v.1974, S. Erikk 531; C3 Isparta: Dedegöl Da., 1600-2400m, Sorger 70-46-24; Çankırı: Ilgaz Daği, RTK vericisi civarı, N 41° 07' 46"-E 33° 40' 24", 2010 m, 12 vii 2009, OUF E 16465; B3 Eskişehir: Arayit Dağı (Sivrihisar), zirve civarı, N 39° 18' 07"-E 31° 44' 57", 1817 m, 09 vii 2009, OUF E 16466; C5 Konya: Ereğli, Aydos Dağı, Kayasaray, Sayntaş mevkii, 2500 m a.s.l., 15.vii.1977, S. Erik 2602, (Chamberlain, 1975; Duran & Hamzaşıtyu, 2004) (Fig. 3).

**Scorzonera pygmaea var. nutans**


We observed together in at least three different localities (Fig. 7).
Table 2. Palynological comparison of *Scorzonera pygmaea* var. *pygmaea* and var. *nutans*.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>S. pygmaea</em> var. <em>pygmaea</em></th>
<th><em>S. pygmaea</em> var. <em>nutans</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape in polar view</td>
<td>Semiangular</td>
<td>Semiangular</td>
</tr>
<tr>
<td>Spine shape</td>
<td>Convex-conic</td>
<td>Convex-conic</td>
</tr>
<tr>
<td>Pollen shape</td>
<td>Oblate-spheroidal</td>
<td>Oblate-spheroidal</td>
</tr>
<tr>
<td>Lachiniae number</td>
<td>15 (6 3 6)</td>
<td>15 (6 3 6)</td>
</tr>
<tr>
<td>Aperture type</td>
<td>Nonlacunate</td>
<td>Nonlacunate</td>
</tr>
<tr>
<td>Pollen Class</td>
<td>Trizonocolporate</td>
<td>Trizonocolporate</td>
</tr>
<tr>
<td>Sculpture type</td>
<td>Echinolophate</td>
<td>Echinolophate</td>
</tr>
<tr>
<td>Ornamentation</td>
<td>Spinate-microperforate-rugulate</td>
<td>Spinate-microperforate-rugulate</td>
</tr>
</tbody>
</table>

Table 3. Measurements of pollen grains of *Scorzonera pygmaea* var. *pygmaea* and var. *nutans*.

<table>
<thead>
<tr>
<th></th>
<th>P</th>
<th>E</th>
<th>P/E</th>
<th>L</th>
<th>t</th>
<th>Plg</th>
</tr>
</thead>
<tbody>
<tr>
<td>var. <em>pygmaea</em> (W)</td>
<td>39.28</td>
<td>1.6</td>
<td>42-38</td>
<td>42.57</td>
<td>2.76</td>
<td>48-39</td>
</tr>
<tr>
<td>var. <em>pygmaea</em> (E)</td>
<td>40.28</td>
<td>1.38</td>
<td>42-38</td>
<td>41.57</td>
<td>1.99</td>
<td>45-39</td>
</tr>
<tr>
<td>var. <em>nutans</em> (W)</td>
<td>40.3</td>
<td>2</td>
<td>45-38</td>
<td>43</td>
<td>1.76</td>
<td>46-39</td>
</tr>
<tr>
<td>var. <em>nutans</em> (E)</td>
<td>39.25</td>
<td>2.27</td>
<td>43-33</td>
<td>44.7</td>
<td>2.35</td>
<td>48-41</td>
</tr>
</tbody>
</table>


Fig. 7. Distribution map of *Scorzonera pygmaea* var. *pygmaea* (▲) and var. *nutans* (★) in Turkey.
Conservation status: S. pygmaea var. pygmaea and var. nutans are known at least from 5 localities and its populations are in good condition. However, its can be threatened within the next 10 years. Therefore be considered taxa Near Threatened ‘NT’ category (Anon., 2001).

Acknowledgements

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