CROSSING EXPERIMENTS IN ELYMUS TRANSHYR·
CANUS GROUP, A NEW SUBSPECIES AND A NEW SPECIES

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Elymus transhyrcanus is a variable species in Iran. Tufted and not tufted populations of this species occur in Alborz mountain chains. A disjunct locality of the species was found in W. Iran. Crossing experiments were made between different morphological and geographical variants. In spite of habit difference between the accessions from N. Iran, tufted or not tufted, they gave hybrids with high pollen fertility and high chiasmata frequency in meiotic metaphase I. Hybrids between the accessions from N. and W. Iran, showed low pollen fertility and relatively low chiasmata frequency. Based on morphological differences and crossing experiments data, E. transhyrcanus subsp. lorestanicus is described as a new subspecies for W. Iranian material. Elymus zagricus is described as a new species from W. Iran. The new species is related to E. transhyrcanus and E. libanoticus. It differs from both of them by having ciliate glumes and lemma.

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دوره گیری درون گونهای در گونه Elymus transhyrcanus یک زیر گونه و یک گونه جدید معرفی شده است.

مصطلحی از "Elymus transhyrcanus" گونه متنوع در ایران است. جمعیت‌های بالشتنکی و ریزوم دارای گونه‌ای از سلسله جبال البرز واقع شده است. روش‌های مشابه یافت می‌گردد. روش‌های داشته باشند که از گسترشگاه‌های شناخته شده این گونه در غرب ایران تشخیص داده می‌شود. آزمون‌های دوره‌گیری بین اشکال مختلف از نقطه نظر ریختی و جغرافیایی به عمل آمده. علی‌رغم وجود اختلاف در ریخت‌زمانی جمعیت‌های شمال شارعت بالشتنکی بی‌بی‌بیالشتنکی، دوره‌گیری های بین آن‌ها بازیابی با باروری در حد بالا و درای بازیابی بالا یکی‌سانی در مرحله مانند قسمت می‌وزند. دوره‌گیری حاصل بین جمعیت‌های شمال و غرب ایران دارای دارایی گرده با باروری کم و درای بازیابی بالا یکی‌سانی می‌باشد. براساس اختلافات ریختی و آزمون‌های دو ریختی زیر گونه Elymus transhyrcanus subsp. lorestanicus به عنوان زیر گونه E. zagricus جدیدی از غرب ایران شرح داده می‌شود. گونه E. transhyrcanus, E. libanoticus, E. gentryi مقایسه می‌گردد و با داشتن پوششینه (گلوی‌های) و پوششینه (لما) مزد، از آن‌ها تشخیص داده می‌شود.
Table 1. List of *Elymus transhyrcanus* seeds used in crossing experiments.

<table>
<thead>
<tr>
<th>Habit</th>
<th>Accession</th>
<th>2n</th>
<th>Origin of material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tufted</td>
<td>3786 &amp; 3788</td>
<td>42</td>
<td>Mazandaran: 45 Km from Baladeh towards Kandavan pass, 2900 m, Assadi 70893 &amp; Aghabeigi s.n.</td>
</tr>
<tr>
<td>Tufted</td>
<td>3776</td>
<td>42</td>
<td>Tehran: Gachsar, mountains W. of Azadbar on the road to Taleghan, 2800 m, Assadi s.n.</td>
</tr>
<tr>
<td>Not tufted</td>
<td>3763</td>
<td>43</td>
<td>Tehran: Between Dizin and Shemshak, 1930 m, Assadi 70882.</td>
</tr>
<tr>
<td>Tufted</td>
<td>3756</td>
<td>42</td>
<td>Tehran: Between Gachsar and Dizin, near Velayatrud, 2270 m, Assadi 70874.</td>
</tr>
<tr>
<td>Not tufted</td>
<td>3774</td>
<td>42</td>
<td>Lorestan: Doroud, Oshtorankuh, 2400 m, Assadi 70738 b.</td>
</tr>
</tbody>
</table>

**INTRODUCTION**

*Elymus transhyrcanus* (Nevski) Tzvelev has been known from Middle Asia, Caucasus, Turkey and N. Iran (Bor 1970, Tzvelev 1976, Melderis 1985). This species varies morphologically in Alborz mountains, N. Iran. Plants from higher altitudes form dense tufts, while in lower altitudes less dense plants with no tufts were observed. Also, a collection from W. Iran in a locality outside the distribution of the species were collected. This collection was morphologically distinct from the normal *Elymus transhyrcanus* of N. Iran. Crossing experiments were performed between different accessions. On the base of morphological characters, hybrid fertility and chromosome behaviour at meiotic metaphase I, two subspecies are recognized in *E. transhyrcanus*.

**MATERIAL AND METHODS**

Herbarium specimens were studied. Seeds were collected in the field and germinated in Lund and Svalöv, Sweden. Crossing experiments, mitotic studies, meiotic analysis and pollen fertility were done according to Assadi & Renemark 1994. Table 1 shows list of seeds used in crossing experiments.
RESULTS

Crossing programme, number of crossed florets, number of hybrid seeds and number of hybrid plants are shown in table 2.

Table 2. Crossing programme between different populations of *Elymus transhyrcanus*.

<table>
<thead>
<tr>
<th>Combination</th>
<th>hybrid</th>
<th>no. of florets</th>
<th>seed set</th>
<th>no. of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>3776x3768</td>
<td>8562</td>
<td>14</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3774x3778</td>
<td>8550</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3774x3756</td>
<td>8570</td>
<td>20</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>3768x3774</td>
<td>8565</td>
<td>20</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>3786x3763</td>
<td>8756</td>
<td>17</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>3756x3786</td>
<td>8575</td>
<td>30</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3 shows mean and range of chromosome association, chiasmata per cell and pollen fertility of the hybrid plants between different populations of *Elymus transhyrcanus* (Fig. 1). In the hybrid accessions 8550, 8565 and 8570 lagging univalents 2-6 and a bridge were observed.

DISCUSSION

Low seed set and plant production is due to the unfavourable condition of experiments. *Elymus* species are often easily crossed (Lu & Bothmer 1993, Assadi & Runemark 1994), therefore, the results of crossing programme do not show relationship of the populations.

Parents of hybrid accessions 8562, 8550, 8570 and 8565 are from disjunct localities in N. and W. Iran. They show relatively irregular chromosome configuration and low pollen fertility. Means of chromosome association in these combinations varies from 1.00-2.04 I, 19.62-19.96 II, 0.00-0.10 III, 0.08-0.24 IV and 0.00-0.02 V. Means of chiasmata frequencies are comparatively low and varies between 35.22-37.06.

There are certain morphological differences between the accessions from W. Iran comparing to the accessions from N. Iran. Comparing to the parents (Assadi 1994), irregular chromosome association, low chiasmata frequency, and low pollen fertility of the hybrid plants indicate that the populations from N. and W. Iran have to a considerable extent differentiated. However, as hybrids between different *Elymus* species are totally sterile or with pollen fertility less than %5 (Salomon & Lu 1992, Assadi & Runemark 1994), range of pollen fertility between 26 and 47 indicate that differentiation is not in specific level.

The hybrid accession 8756 with the parents tufted and not tufted shows mean
In accession 8562 one hexavalent and one octavalent were observed.

| Pollen | % | Total | Rings | Rods | V | I | Ia | II | III | O-6 | (21) | (15-21) | (1-0) | (0-0) | (0-5) | (2-5) | (0-2) | (1-8-21) | (0-5) | (0-2) |
| 68 | 40.60 | 0.00 | 0.00 | 0.00 | 109.10 | 1.00 | 21.00 | 17.92 | 0.70 | 2.01 | 0.70 | 2.01 | 18.18 | 2.01 | 0.70 | 2.01 | 0.70 | 2.01 | 18.18 | 2.01 | 0.70 |
| 64 | 37-49 (21-0) | 0.40 | 4.00 | 0.00 | 13.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 64 | 43-00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 47 | 32-22 | 20.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 47 | 33-40 | 20.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | 55-88 | 0.00 | 10.00 | 0.00 | 0.00 | 16.00 | 0.00 | 3.00 | 19.96 | 0.00 | 3.00 | 19.96 | 0.00 | 3.00 | 19.96 | 0.00 | 3.00 | 19.96 | 0.00 | 3.00 |
| 45 | 37-06 | 0.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 3. Meiotic metaphase I contribution of the hybrids between different populations of *GymnosFUNGUS HANSHIBANUM*.
Fig. 1. Meiotic metaphase I configuration of the hybrids between different morphological variations (A), populations (B) and subspecies (C-D) of *Elymus transhyrcanus*. -A: tufted x not tufted with 2 univalents indicated by arrow, one rod bivalent, 18 ring bivalents and one trivalent indicated by double arrow (2n=43). -B: tufted x tufted with 1 rod bivalent and 20 ring bivalents. -C-D: subsp. *transhyrcanus* x subsp. *lorestanicus* with 2 univalents indicated by arrow, 3 rod bivalents, 15 ring bivalents, one tetravalent indicated by double arrow in C and four univalents indicated by arrows, three rod bivalents, 16 ring bivalents in D. Bar=10 μm.

Chiasmata frequency 39.42 and relatively high pollen fertility, %68, indicating both parents are conspecific.

Univalents and chromatid bridges in anaphase I indicate chromosome rearrangements in different populations.

**TAXONOMIC CONCLUSION**

Population of *Elymus transhyrcanus* from W. Iran is recognized as a new subspecies different from N. Iranian populations. Two subspecies are geographically isolated.

During the studies of herbarium specimens, a new species from W. Iran was recognized. The new species is morphologically similar to *E. transhyrcanus*. A key to the taxa and nomenclature of *E. transhyrcanus* is given and the new taxa are described.

1. Glumes and lemma distinctly ciliate, leaf sheath ciliate

   **1. E. zagricus** Assadi, sp. nov.

   1. Glumes and lemma eciliate, leaf sheath never ciliate (*E. transhyrcanus*)

2. Stems glabrous, spike rachis glabrate, peduncles, glumes, and lemma glabrous

   2a. subsp. *transhyrcanus*

   2. Spike rachis and spikelet base covered with dense hairs, glumes and lemma sparsely hairy

   2b. subsp. *lorestanicus* Assadi, subsp. nov.

**1. Elymus zagricus** Assadi, sp. nov. (Fig. 2). Gramen perenne, dense caespitosum. Culmi 50-80 cm alti, viridi-flavi glabri. Foliorum vaginae glabrae, margine parte ciliatae, ligulae minimae, ca. 0.2 mm
Fig. 2. *Elymus zagricus* (x0.6). - A. Leaf (x3). - B. Upper glume (x3.5). - C. Lower glume (x3.6). - D. Lemma (x4.6). - E. Palea (x6).
longae, membranaceae, ad margine ciliatae; laminae 10 mm longae et usque ad 3 mm latae, planae vel involutae, subtus glabrae, supra pilosae. Spicae 5-15 cm longae, angustae; rachidibus planis, marginibus scabris; spiculae 6-12, sessiles, 2-3 florae; glumae inaequales, inferior 6-9 mm superior 7-10.5 mm longae, obliquae, acutae vel obtusae, mucronatae, margine membranaceae et ciliatae, lemma 9-10 mm longum, dorso glabrum, marginibus distincte ciliatum, superne obscure 5-nervis, apice in aristam usque ad 3 mm longam productum; palea lemmate vix breviora, carinis ciliatis. Antherae ca.4 mm longae.

**Typus.** Kohgilouye-Boirahamad (Fars on label): Kuh-e Dena, Gardaneh Bijan, 2400-2600 m, 4.8.1978, rocky stony scrub forest of *Juniperus*, Assadi & Mozaffarian 31286 (holotypus TARI); *Paratypus. Kohgilouye-h-Boirahamd*: Sisakht, Gardaneh Bijan, 2600 m, 8.8.1994, Assadi 72437 & Assadi 72448; Chaharmahale Bakhtiari: Darreh Bazoft, Chebed, N. slope of Kuh-e Taraz, 1700-2300 m, 12.7.1986, Mozaffarian 57817.

Perennial, densely caespitose with short rhizomes, ca. 50-80 cm high, greenish yellow. Culms thin, ca. 1-2 mm indiameter, glabrous. Leaf sheath glabrous, partly ciliate at the margin; ligules very short, ca. 0.2 mm long, membranous, ciliate at the margin; leaf lamina flat or convolute, up to 10 mm long and 3 mm broad, lower side glabrous, upper side hairy, distinctly auriculate at the base. Spike narrow, 5-15 cm long; rachis broadened, scabrous along the angles; spikelets sessile, 6-12, 2-3 flowered, ca. twice as long as rachis internodes. Lower glumes oblique (middle vein in one side), 6-9 mm long, 3-5 veined, acute or obtuse with a short mucron at the apex, membranous and ciliate at the margin; upper glumes 7-10.5 mm long, similar to the lower glume. Rachilla glabrous or minutely puberulent; lemma 9-10 mm long, glabrous but distinctly ciliate at the margin, obscurely 5-veined near the tip, awned; awn up to 3 mm long; palea somewhat shorter than lemma, 7-8 mm long, rounded at the apex, totally ciliate on the keels. Anthers ca. 4 mm long.

The new species is characterized by having caespitose habit and ciliate glumues and lemma. It is related to *E. transhyrcanus* (Nevski) Tzvelev. Main differences of the new species from *E. transhyrcanus* lies in the presence of cilia along the margin of glumes and lemma. In appearance *E. zagricus* is similar to *E. libanoticus* but differs from it in ciliate glumes and lemma.
Moreover anther length in the new species is 4 mm long (most probably inbreed) and leaf sheath ciliate. In *E. libaeanoticus* glumes and lemma eciliate, anthers longer (outcross), leaf sheath smooth and lemma not awned. *E. zagricus* differs from *E. gentryi* (Melderis) Melderis by having ciliate glumes, lemma and leaf sheath.


2a. *E. transhyrcanus* subsp. *transhyrcanus*

*Syny.: Roegneria transhyrcana* Nevski, Acta Univ. Asiae Med. ser. 8b (Bot.) 17: 70 (1934); *R. leptora* Nevski in Fl. USSR 2: 623 (1934); *Agropyron lepton* (Nevski) Grossh., Fl. Kavk. 1: 331 (1939). -Typus: Turkmenia, Ashkabad region, stony areas, 1000 m, Chapadag mountain, Borrissova 725 (LE!).

2b. *E. transhyrcanus* subsp. *lorestanicus*

*Assadi, subsp. nov.*

Differt a subsp. *transhyrcanus* vagina, rachidi, glumis et lemmate dissimilibus pilosis.

Typus. Lorestan, Doroud, Oshtorankuh, 2400 m, 8.8.1991, Assadi 70738 b (holotypus TARI; isotypus LD);

Kordestan, 15 km NE of Baneh, Gardanekhan, 2450 m, Fattahi, Tavakoli and Hatami 2435.

Perennial, not caespitase, Culms 100 cm., puberulent or hairy. Leaf sheath puberulent, eciliate; ligule ca. 0.5 mm long, lacerate; leaf lamina ca. 20 cm long and 4 mm broad, flat, densely covered with long hairs on the upper surface, puberulent beneath. Spikes up to 12 cm long; rachis densely hairy; spikelets 9-11, 15 mm long, 3-5 flowered, hairy at the base; glumes inequal, lower 11 mm and the upper 13 mm long, 5-7 veined, scabrous on the veins, acute to shortly mucronate at the tip; lemma ca. 14 mm long, veined at the tip, finely hairy, awned; awn ca. 3 mm long; palae somewhat shorter than lemma, distinctly ciliate on the keels. Anthers 5 mm long.

ACKNOWLEDGMENT

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REFERENCE

Assadi, M. 1994: Meiotic configuration and chromosome number in some Iranian species of *Elymus* L. and *Agropyron*


