A TAXONOMIC REVISION OF AEGILOPS CRASSA BOISS. (POACEAE) IN IRAN

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The morphological characters of *Aegilops crassa* Boiss. and its distribution in Iran was studied using 32 populations. A wide range of variation in quantitative (plant height, awn length of lemma of upper spikelet, teeth length of glume of upper spikelet and spike length including awn) and qualitative (spike shape, glume hair and leaf surface) characters were found; however no subdivision in this species reasonably appeared to be valid. Geographically, *Aegilops crassa* occurs mainly along Zagroos mountains in the western parts of Iran.

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Key words. Aegilops crassa, genetic diversity, Iran, intra specific classification.

تاکسونومی گونه **Aegilops crassa (Poaceae)** در ایران

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ویژه گیهای ریخت شناسی گونه *Aegilops crassa* و انتشار آن در ایران با بررسی ۳۲ جمعیت انجام گرفت. تنوع زیادی در ویژگیهای کیفی شامل ارتفاع گیاه، طول سیخک پوشینه سنبلچه بالایی،طول دندانه پوشه سنبلچه بالایی و طول سنبله به همراه سیخک و همچنین ویژگیهای کیفی شامل شکل سنبله، پوشش کرکی پوشه و سطح برگ مشاهده گردید. در این گونه تقسیم بندی تحت گونه‌ای قابل قبولی امکان پذیر نیست. گونه *Aegilops crassa* به طور عمده در کوه‌های زاگرس در غرب ایران انتشار دارد.

Introduction

Aegilops crassa Bioss. is an annual herb belonging to the tribe *Triticeae* (*Poaceae)* known by two cytotypes designated as XD and XDD; with D genome in common with *Tiriticum aestivum* (ABD) (Badaeva et al. 2002). This has caused the importance of local populations of *A. crassa* as a D genome source. This species along with many other members of *Triticeae* is growing in central Asia and the north part of Fertile Crescent (van Slageren 1994), consequently Iran as a part of Fertile Crescent houses a main part of the diversity of this species and other its closely related taxa.

This species was described first by Boissier (1846). Its morphological variability resulted in recognizing different subspecies and varieties within *A. crassa*. Eig (1929) subdivided this species into two varieties: var. *glumiaristata* Eig. and var. *typica*. Hammer (1980) split it into two subspecies: subap. *crassa* with three varieties (var. *crassa*, var. *glumiaristata* Eig., var. *macrathera* Boiss.) and subsp. *vavilovii* Zhuk. However, no subdivision was applied by Chennaveeriah (1960), Witcome (1983) and van Slageren (1994) to this species.

The taxonomic status of this species in Iran has been treated differently: Parsa (1950) reported two varieties (var. *macranthera* and var. *glumiaristata*); Mobayen (1975) recognized only one variety (var. *macranthera*) for the Flora of Iran; and Bor (1970) believed that two varieties (var. *crassa* and var. *macranthera*) occur in this country.

This study is aimed to revise the taxonomic status and the geographical distribution of this species in Iran.

Materials and Method

A total of 32 accessions belonging to *A. crassa* collected during the years 1997 till 2003 and preserved in the herbarium of the University of Isfahan were used in this study (Table 1).

First of all in order to find out the ploidy level of the populations collected we counted their diploid chromosome numbers from the root tips using squash method (Seijo & Fernandez 2003).The morphological studies were carried out on a total number of 320

Table 1. Origin and altitude of the plant materials studied. The abbreviations are given in parantes and indicating the population used for statistical analysis.

No.	Pop. No.	Province	Alt. (m)
1	HBDIU15700 (cr700)	Fars	800
2	HBDIU15701(cr701)	Fars	1050
3	HBDIU15702	Fars	1000
4	HBDIU15703(cr703)	Fars	–
5	HBDIU15704	Fars	1250
6	HBDIU15705	Fars	1150
7	HBDIU15706(cr706)	Chaharmahal-Bakhtiary	1750
8	HBDIU15707	Chaharmahal-Bakhtiary	1020
9	HBDIU15708(cr708)	Markazi	1933
10	HBDIU15709	Kordestan	2050
11	HBDIU15710	Kordestan	1802
12	HBDIU15711(cr711)	Kordestan	1230
13	HBDIU15712	Fars	1000
14	HBDIU2(cr2)	Esfahan	2050
15	HBDIU4	Esfahan	1720
16	HBDIU18	Ilam	1840
17	HBDIU28	Chaharmahal-Bakhtiary	2090
18	HBDIU41(cr41)	Lorestan	2080
19	HBDIU56(cr56)	Fars	–
20	HBDIU73(cr73)	Lorestan	820
21	HBDIU67	Fars	1480
22	HBDIU80	Chaharmahal-Bakhtiary	1680
23	HBDIU82	Chaharmahal-Bakhtiary	1980
24	HBDIU84	Esfahan	1950
25	HBDIU90(cr90)	Azarbayjan	1620
26	HBDIU92	Kordestan	1770
27	HBDIU442(cr442)	Azarbayjan	1430
28	HBDIU144(cr144)	Markazi	1840
29	HBDIU183(cr183)	Kermanshah	1500
30	HBDIU261(cr261)	Azarbayjan	1332
31	HBDIU266	Kordestan	1372
32	HBDIU201(cr201)	Kohkiloye-Boyrahmad	1600

individuals (10 from each accession) provided by growing the accessions in the experimental field of the University of Isfahan. Totally, 12 qualitative and 32 quantitative characters were surveyed (Table 2 and 3).

We entered 16 populations and 9 quantitative characters (marked in table 1 and 2) in our statically analyses. The Euclidean similarity matrix was computed on the average values of the populations. In order to present the relationships among the OTUs a Principle coordinate analysis (PCoA) was performed (Pereira 2007). Our analyses were run using the program NTSYS-pc version 2.11a (Rohlf 2002).

Results and discussion

Our chromosomal results showed that, tetraploid cytotype of *A. crassa* is the only ploidy level of this species occurring in Iran (data not shown).

The results of this study revealed high variability among the quantitative morphological characters (Table 2). A wide range of height variability (37.5 - 97.5 cm) was observed among the populations studied. Our observations showed that this character is not influenced by locality features and climatic conditions. While the spike length including the awn was ranged from the minimum 7.8 to maximum 21.4 cm, its length showed no much variability compare with the excluding the awn. The number of spikelets in each spike ranged as (5-6-) 7-10 (-11). Awn length of lemma of the basal part of the spike appeared to be diagnostic and determining at infra-specific rank. Bor (1970) based on this character recognized two varieties: var. *crassa* (awn length up to 4 cm) andvar. *macranthera* (awn length 4-6 cm) occurring in the Flora Iranica area. However, finding out a continuous change for this character in this study showed that it can not be suggested as a good diagnostic character to separate the infra-specific taxa in this species (Fig 1, 1a-1k).

A high variability also was observed on the qualitative characters. Although the spike shape mostly appeared as cylindrical but in some individuals it showed a zigzag shape (Fig. 1, A-D). Spike color at fruit bearing stage was yellow and dark and bright brown. However Popova (1923) used this character to

Table 2. List of quantitative character, minimum, maximum, average and CV (Coefficient of Variation) of measured characters in populations belonging to *Aegilops crassa*. Stars represent the characters used in statistical analysis.

No.	character	minimum	maximum	average	CV
1	Plant height*	37.5	97.6	67.34	0.31
2	Spike length including awn*	7.8	21.4	13.3	0.35
3	Spike length excluding awn*	6.2	14.1	9.35	0.15
4	Leaf length	6.1	21.7	13.6	0.22
5	Leaf width	0.3	0.82	0.47	0.20
6	Basal spikelet length	0.85	1.88	1.27	0.16
7	Glume length of upper spikelet*	0.7	1.47	0.96	0.21
8	Glume width of upper spikelet	0.12	0.5	0.34	0.22
9	Lemma length of basal spikelet including awn*	0.85	2.05	1.25	0.21
10	Lemma width of basal spikelet	0.12	0.47	0.24	0.18
11	Teeth length of lemma of basal spikelet	0.03	0.9	0.24	0.29
12	Palea length of basal spikelet	0.7	1.06	0.94	0.05
13	Palea width of basal spikelet	0.01	0.16	0.089	0.06
14	Glume length of upper spikelet*	0.75	3.9	1.16	0.37
15	Glume width of upper spikelet	0.08	0.38	0.25	0.17
16	Lemma length of upper spikelet including awn*	0.85	10.7	5.03	0.38
17	Lemma width of upper spikelet	0.08	0.31	0.19	0.12
18	Awn length of lemma of upper spikelet*	0.7	9.9	4.71	0.39
19	Palea length of upper spikelet	0.75	1.05	0.94	0.05
20	Palea width of upper spikelet	0.04	1.00	0.087	0.09
21	Seed length*	0.5	0.92	0.7	0.03
22	Seed width	0.18	0.35	0.31	0.29
23	Teeth length of glume of upper spikelet	0.075	2.85	1.46	0.31

Table 3- List of qualitative characters and their states and the populations of *Aegilops crassa*.

No.	character		population
1	Spike shape	cylindrical	Most individuals
		zigzag	Some individuals
2	Spike color	yellow	Some individuals
		dark brown	Some individuals
		bright brown	Some individuals
3	Glume shape	ovate-truncate	all
4	Teeth or awn of glume of upper spikelet	short awn	Some individual of populations 144,261,98,92,84,82,80,18,15700,15703,15707,15708,15709,15711
		teeth	Rest populations
5	Glume hair	short	261,73,28,2,15706,15707,15702,15705
		long	Rest populations
6	Leaf surface	smooth	261,98,92,80,73,67,2,15700,15701
		hairy	Rest populations
7	Sheath surface	smooth	261,98,92,80,73,67,2,15700,15701,15712
		hairy	
8	Lemma shape	ovate	all
9	Lemma awn of upper spikelet	short	15700,15702,15703,15704,15705,65,67,261
		long	Rest populations
10	Palea shape	elliptic	all
11	Seed shape	short and flat	Some individuals
		thin and long	Some individuals
12	Seed surface	hairy	Some individuals
		smooth	Some individuals

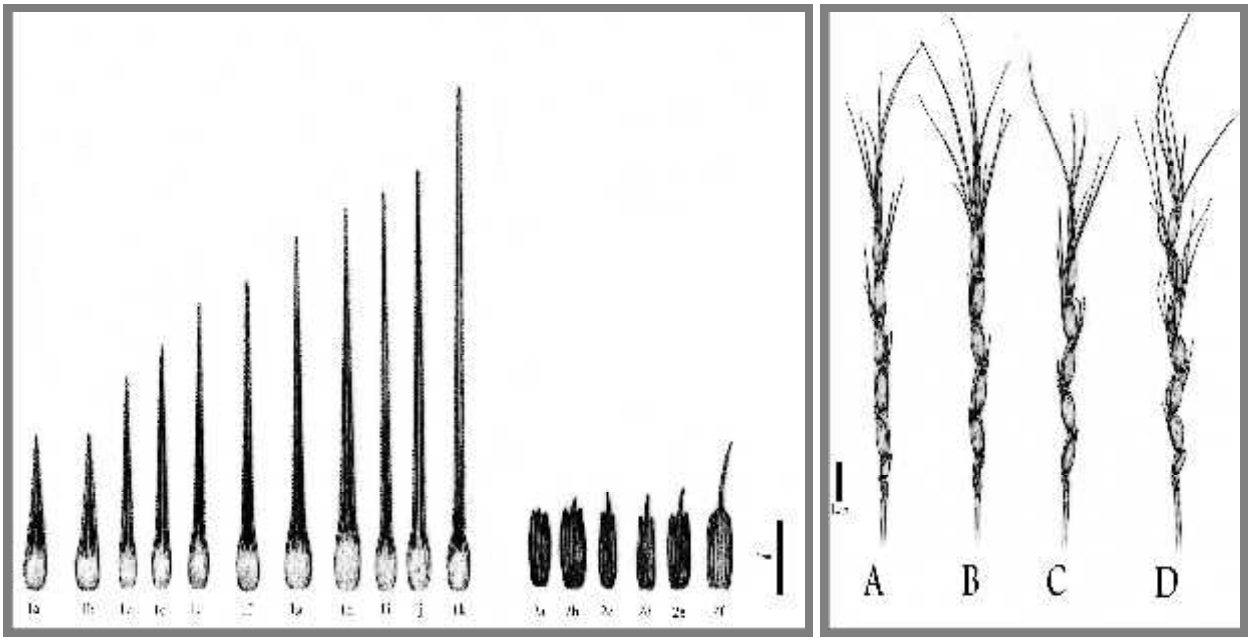

Fig. 1 The diversity of awn length of lemma of the upper spikelet within 11 populations (1a-1k). Diversification of awn length of the upper glume among different individuals of the population 144 (2a-2f) and different articulation from cylindrical to zigzag shape of the spike in population number 4 (A-D) belonging to *Aegilops crassa*. -Scale bar shows 1 cm.

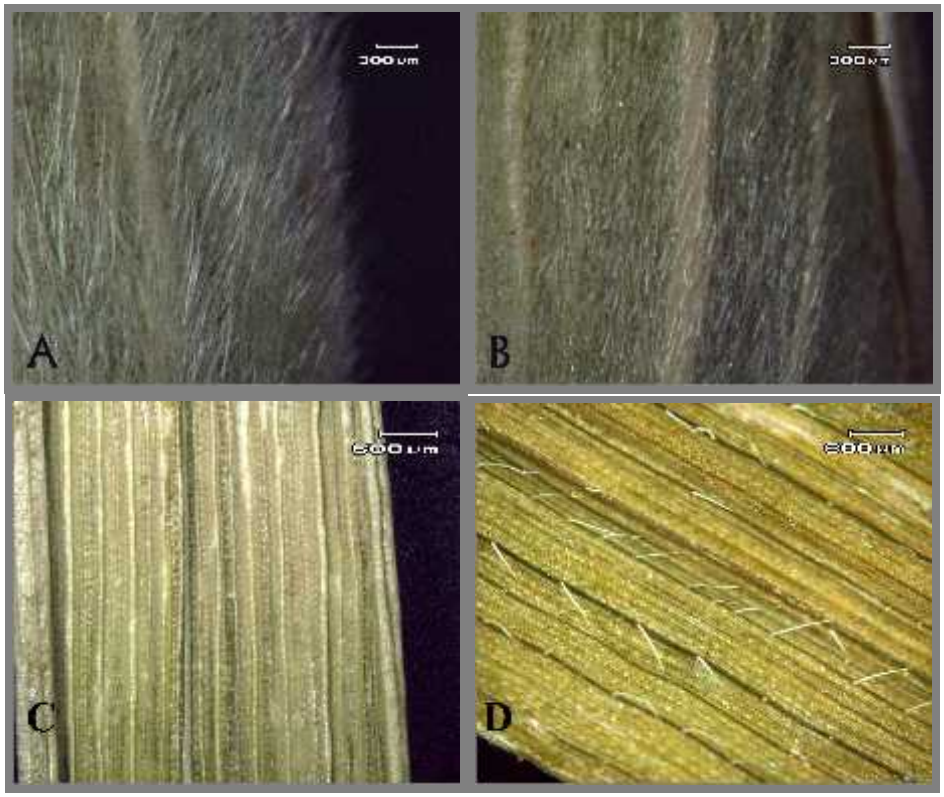

Fig. 2. Two different kinds of hairs of glume and leaf surface in *Aegilops crassa*, A: long hairs, B: short hairs, C: smooth leaf, D: hairy leaf.

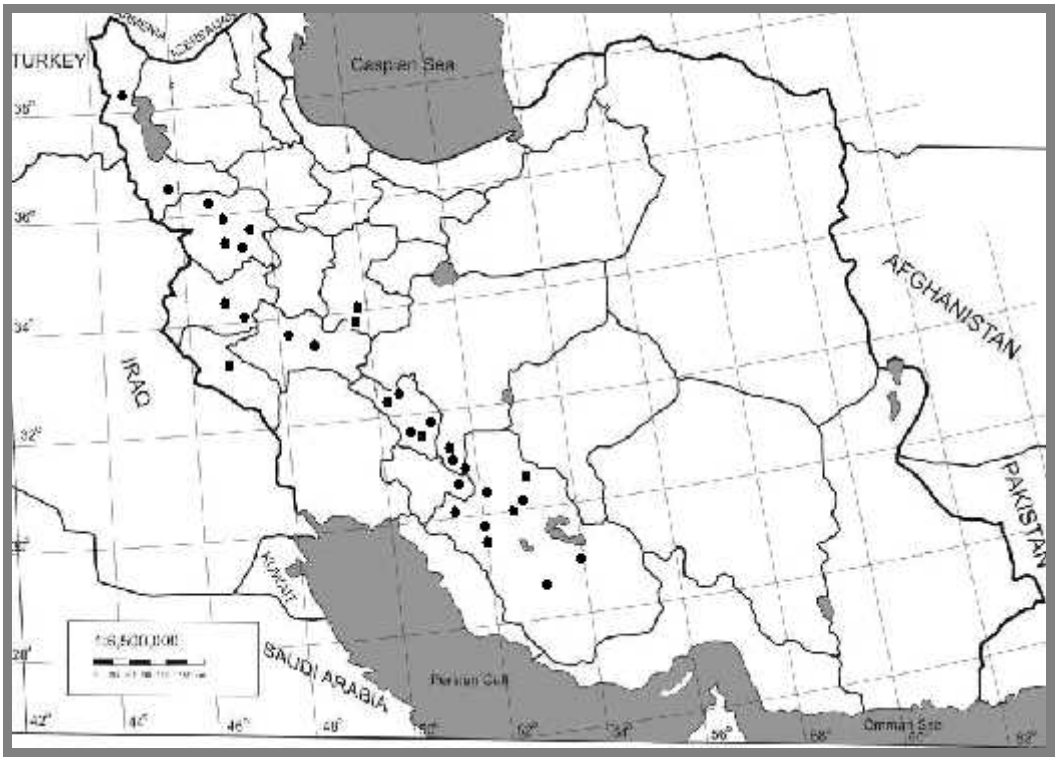

Fig. 3. Geographical distribution of *Aegilops crassa* in Iran. Solid circles represent the collection sites.

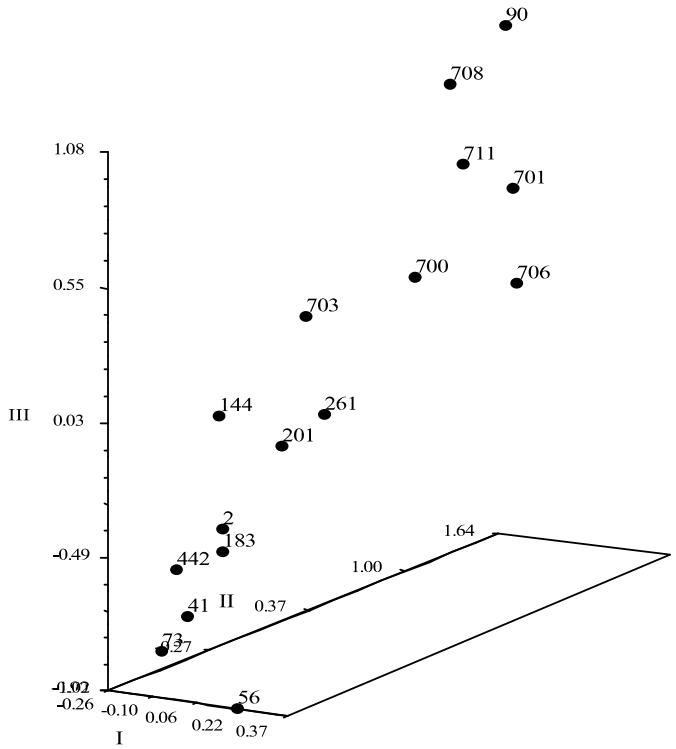

Fig. 4. 3-dimensional plot of Principle Coordinate Analysis of 16 populations belonging to *Aegilops crassa*. The populations are coded according to table1.

distinguish some varieties, it seems that it is not worthy to use this character as a taxonomic and diagnostic character in *A. crassa*. Sometimes the glume teeth of the upper spiklete changed into an awn ranging from the minimum 0.07 to the maximum 2.85 cm (Fig. 1, 2a-2f). Eig (1929) used this character to describe his new variety, i.e., var. *glumiaristata*, which Parsa (1950) believed that it occurs in Iran. Despite the strength of this character as to be a diagnostic feature (as suggested by Eig 1929) but its occurrence among the populations studied, can not confirm the splitting this species into different infra-specific taxa solely on the mentioned feature. We found two kinds of hairs: long and short on the back of the glumes (Fig 2, A and B). No correlation was observed between this character and the others or the locality s conditions. Two kinds of leaf and sheath epidermal surfaces were observed in some populations studied: smooth and hairy (Fig. 2, C and D). Our observations showed that there is no correlation between the locality conditions and the quantitative characters of the populations studied.

This study showed that *A. crassa* grows in western parts of this country along Zagroos Mountains from 800 m (Fars) to 2090 m (Chaharmahal-Bakhtiary) (Table 1 and Fig. 3). As van Slageren (1994) mentioned out that the D genome-bearing species have a better adaptation to the high altitude, Zagroos Mountains seem to be of enough potentiality to diverse this species into local populations with their own more or less isolated gene pools.

The distribution of the OTUs on the PCoA plot constructed can not show any clear distinction between the populations studied (Fig. 4).

Based on the results of this study it can be concluded that there is no meaningful correlation between the geographical distribution and any the characters among the populations studied. The high diversification observed in this species can be interpreted based on the presence of high gene flow among the local populations of *A. crassa*.

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