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Description of Iranian diploid wheat resources

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Abstract

Iran is one of the primary centers of diversity for wheat and its relatives. Wild wheats, in particular diploid species, are extensively distributed in various parts of Iran. Of these, the existence of two "A" genome donor species, i.e., *T. baeoticum* and *T. monococcum*, has already been reported in Iranian floras. However, the existence of the other important "A" genome donor, i.e., *T. urartu*, has not been clearly reported. In a germplasm collection survey in several regions of Iran, *T. urartu* was identified, collected, and described, and is reported here for the first time. In a detailed and extensive taxonomic program, the collected germplasms of the above three species were studied. Morphological characters and species-specific traits of the three species were evaluated and compared. Using the monographs by Gandilyan (1980) and Dorofeev et al. (1979) for the collected germplasms, 14 varieties were identified of *T. boeoticum*, 3 varieties of *T. urartu*, 2 forms of *T. monococcum*. Of these 5 varieties of *T. baeoticum* ssp. *baeoticum* (var. *albinigrum*, var. *garniense*, var. *zuccarinii*, var. *baeoticum*, var. *pseudobaeoticum*), 3 varieties of *T. baeoticum* ssp. *thaoudar* (var. *abovjanii*, var. *albinigrescens*, var. *ebrahimzadehae*, var. *viridinigrireuteri*) and 1 variety of *T. monococcum* (var. *mansfeldii*) are new to Iran. In addition, 1 variety of *T. baeoticum* ssp. *baeoticum* (var. *khorramabadicum*), 3 varieties of *T. baeoticum* ssp. *thaoudar* (var. *ebrehimeadena* var. *taleghanicum*, var. *ilamicum*) and 2 varieties of *T. urartu* (var. *iranicum*, var. *sardashticum*) are new to the wheat botany.

Introduction

Triticum L. is an important genus in the tribe *Triticeae* with a prime role in human nutrition. The genus is comprised of diploid, tetraploid and hexaploid species, among which the wild wheats, in particular the diploid species with useful characters, are of potential use in wheat breeding (Gale and Miller 1987; Appels and Lagudah 1990; Szabó and Hammer 1996).

Exploitation of the genetic variability in the wild species of wheat requires genomic and morphological characterization. Hence, identification of these species and subspecies at different taxon levels are essential and it can facilitate their utilization in wheat breeding.

Wheat species have been widely distributed in the Middle and Near East (Boissier 1884; Post 1932; Nevski 1934; Parsa 1949; Bor and Guest 1968; Bor 1970; Blatter 1937), Iran being regarded as one of the primary centers of diversity for some of these species, especially those of diploid wheats (De Candolle 1885; Vavilov 1926; Zohary 1973; Harlan 1976; Zohary and Hopf 1988). The "A" genome diploid wheats, *T. baeoticum* Boiss., *T. urartu* Thum. ex Gandil. and *T. monococcum* L., are grown in the Fertile Crescent. Although there are some documented reports on *Triticum* species in Iranian floras, such as Flora Iranica (Bor 1970) and Flora of Iran (Parsa 1949), as far as the diploid species of *Triticum* are concerned, there are some gaps in the knowledge.

N. L. Bor (1970 in Flora Iranica) and A. Parsa (1949 in Flora of Iran) reported the presence of *T. baeoticum, T. thaoudar* and *T. monococcum* in Iran, but not the existence of *T. urartu*. Exploration by Witcomb, Pabot, Slageren, Gandilyan and others from 1960–1996 did not produce a comprehensive picture on the presence or distribution of the three diploid wheats. In other reports, only Miller (1987) and Gandilyan (1998) did hint to the likelihood of presence of *T. urartu* in Iran. In addition to the shortfalls in the inventory list of diploid wheat species of Iran, there is not any report on the description of their botanical varieties.

The objectives of this study were to clarify the presence of absence of *T. urartu* in Iran, to provide a description of this species as well as descriptions of the botanical varieties of *T. baeoticum* and *T. monococcum*.

Material and Method

Exploration missions were launched from 1996–2000 during which time visits were made to over 200 sites in the North, South, West, Northwest, Southwest and Central parts of Iran in a journey of about 10,000 Km (Figure 1). During this exploration 90 accessions of seed and plant specimens suspected to belong to the three species in question were collected and transferred to the laboratory for further studies. In addition 5 other samples were received from the National Plant Gene Bank of Iran. Three herbaria (out of about 16 in country), i.e., Forest and Rangeland Research Institute, Pest and Disease Research Institute and Agriculture Faculty of Tehran University, were contacted and found to have only one specimen belonging to the species in question. The collected seeds were grown in the field and morphological date were recorded and species were accordingly described. Based on morphological examination, botanical varieties were determined in accordance with the Gandilyan (1980) and Dorofeev et al. (1979) monographs.

Results

In the following key to the species, descriptions and notes on varieties are provided. All of the specimens are deposited in the Herbarium of the Tarbiat Moallem University in Tehran.

Key to species:

- 1- Spike fragile 2
- 1*-Spike not fragile or only by touching 3
- 2- Glumes with keel tooth ca. 3 mm long and acute tooth of main lateral vein 0.2–0.5 mm long, leaf blade covered with very short and dense hairs, anthers ca. 2.5 mm long, seeds only brown. . . . . *T.urartu*
- 2*-Glumes with keel tooth 1.0–2.5 mm long and acute tooth of main lateral vein 0.5–1.5 mm long, leaf blade covered with long hairs, anthers ca. 4 mm long, seeds green, brown or brown with greenish traces . . . . . *T. baeoticum*
- 3- Glumes with keel tooth 1.0–1.5 mm long and acute tooth of main lateral vein 0.5–1.5 mm long, leaf blade very weekly or not pubescent, anthers ca. 4 mm long, seeds yellow . . . . *T. monococcum*

T. baeoticum Boiss.

T. baeoticum Boiss., Diagn Ser. 1(13) : 69 (1853)
Annual. Stems tufted, up to 135 cm tall, green, pubescent or pilose at nodes. Leaf sheaths villous-pilose, leaf blades 7–17 mm wide, veins villous-pilose, margins scabridulous. Spike erect, 8.5–15 cm, slender, lax, laterally compressed. Rachis hairy at nodes and margins, internodes 2.5–5(− 6) mm, brittle, disarticulating below the spikelet at maturity. Spikelet with 3 florets, usually two-fertile, glumes 9–11 mm, coriaceous, yellow to blackish-purple, glabrous or pubescent-pilose, long, with two dentate keels, one of which is prominent; scabridulous towards apex, arista scabridulous, fertile lemma navicular, 10–16 mm glabrous. Palea10–15 mm, splitting at maturity. Anthers linear, ca. 4 mm, yellow. Caryopsis ellipsoid 7.5–11 × 1.7–2.7 mm, endosperm flinty.

Habitat
grassland on lower limestone mountain slopes, in degraded oak forest amd oak shrub.

General distribution
S.E. Europe (Balkan, Crimea), Syria, Jordan, Israel, Turkey, Transcaucasia, Iraq, Iran

T. baeoticum has two subspecies:

- 1- spikelet mostly one-grained (one floret fertile) and with two unequal awns, one is shorter than the other (less than half) . . . . . .subsp. *baeoticum*

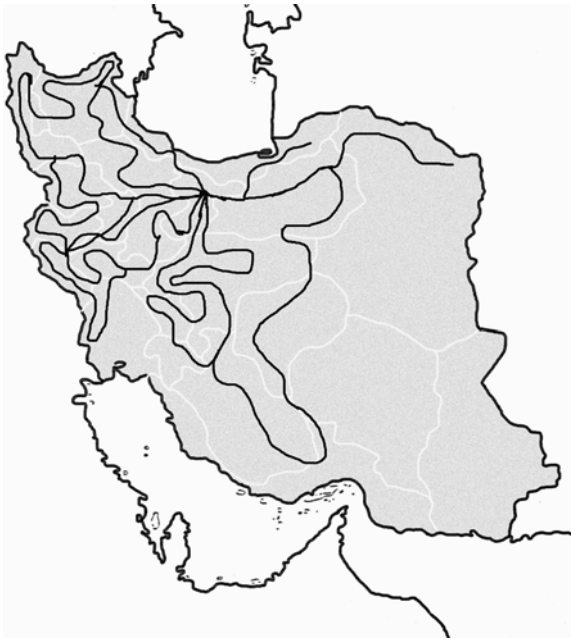

Figure 1 Map of Iran, –route taken for collection of diploid wheats.

- 2- spikelets often with both florets fertile (two-grained) and with two unequal awns, one is slightly shorter than other . . . .subsp. *thaoudar*

Color of seeds in the two subspecies are brown-green or green, in subsp. *thaoudar*, broader seed is brown-green and narrower seed is only green. In subsp. *baeoticum*, seeds are usually brown with greenish traces.

T. baeoticum subsp. *baeoticum*

Syn:
Crithodium aegilopoides Link in Linnaea 9:132, t3 (1834); *Aegilops crithodium* (Link) Steudel, Syn. Pl. Glum 1:355 (1855); *T. aegilopoides* (Link) Bal., Pl. Ox. Exs. (1857), nomen; *T. monococcum* L. var. *lasiorrhachis* Boiss., Fl. Or. 5:673 (1884); *T. aegilopoides* (Link) Bal. ex Koern. in Koern. et Werner, Handb. Getreideb. 1:109 (1885) et Hausskn. In Mitt. Thũr. Bot. Ver. 13:65 (1899) non Forsskal (1775) nec Turcz. ex Griseb. (1853) nec Thurb. ex A.Gray (1863); *T. tenax* Hausskn. In Mitt. Thũr. Bot. Ver. 13:67 (1899); *T. monococcum* L. proles *aegilopoides* (Link) Aschers. et Graebn., Syn. Mitteleur. Fl. 2(1): 701 (1901); *T. monococcum* L. subsp. *aegilopoides* (Link) Stranski var. *baeoticum* (Boiss.) Stranski in Bull. Soc. Bot. Bulg. 3:222 (1929); *T. monococcum* L. var. *baeotica* (Boiss.) Kneuck in Allg. Bot. Zeitschr. 9:34 (1903); *T. baeoticum* Boiss. subsp. *aegilopoides* (Link) Grossh. in Trudy Azerb. Otd. Zakavk. Fil. Akad. Nauk SSSR, Bot. 8:350 (1939); *T. monococcum* L. subsp. *baeoticum* (Boiss.) Hayek, Prodr. Fl. Balc. 3:228 (1932); *T. monococcum* L. subsp *baeoticum* (Boiss.) Yen in Acta Phytotax. Sinica 21(3):292 (1983) comb. superfl. Ic: Percival, Wheat Plant f. 114 (1921) as *T. aegilopoides* var. *boeoticum* (Boiss.) Percival.

Habitat
Basalt, calcareous soil, over-grazed steppe, fields by roadside and ditches.

Type
[Greece] in planitie Baeotica, Spruner (holo, G.)

General distribution: Balkans, Crimea, Caucasia, W. Syria. N. Iraq, Iran

Varieties of *T. baeoticum* subspecies *baeoticum* in Iran

Morphological characters used for all varieties are presented in (Table 1).

var. *albinigrum* (Thum.) A. Filat. et Dorofeev 1979, in Dorof. et al., Kult. Fl. I:287.

T. aegilopoides var. *albonigrum* Thumanian 1934, Tr. Prikl. Bot. Gen. Sel. 5, 2:257; *T. spontaneum* var. *baeoticum* f. *albonigrum* (Thum.) Flaksb. 1935, Kult. Fl. I:352.

Spikelet with long, unequal awns, one is much shorter than the other, color of awns is the same as glumes; glumes glabrous, yellow with black margins; caryopsis brown.

General distribution: Armenia, Iran (Lorestan)
This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979))

var. *baeoticum* (Fig. 2-c)

T. aegilopoides var. *album* Thum., 1934, Tr. Prikl. Bot. Gen. Sel. 5, 2:255; *T. spontaneum* var. *baeoticum* f. *album* (Thum.) Flaksb. 1935, Kult. Fl. I:350.

Table 1. Characters used for the identification of varieties of *Triticum baeoticum* subsp. *baeoticum* (according to Gandilyan (1980) and Dorofeev et al. 1979)). Glume (C: color; H:hairy): C1 = yellow, C2 = yellow with black margins, C3 = yellow with black shades and striations, C4 = brown, C5 = brown with black shades and striations, C6 = brown with black margins, H1 = not hairy H2 = hairy Awn (C: color; S: size; C′1 = the same color as glumes, C′2 = black, S1 = long, S2 = short). Caryopsis (C″: color C″1 = yellow, C″2 = brown, C″3 = green).

Varieties	Glume								Awn				Caryopsis		
	C1	C2	C3	C4	C5	C6	H1	H2	C′1	C′2	S1	S2	C″1	C″2	C″3
albinigrum		*					*		*		*			*	
zuccarinii	*							*	*		*			*	
baeoticum	*						*		*		*			*	
garniense		*						*	*		*			*	
khorramabadicum		*						*		*	*			*	*
pseudobaeoticum	*						*			*	*			*	

* = The character is present

Spikelet with long, unequal yellowish awns, one is much shorter than the other; glumes glabrous, yellow; caryopsis brown.

General distribution: Armenia, Iran (East Azerbaijan and West Azerbaijan).

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979)).

var. *garniense* (Thum.) A. Filat et Dorof. (1979), in Dorof. et al., Kult. Fl. I:288.

T. aegilopoides var. garniense Thum. 1934, lc.:257 *T. spontaneum* var. *zuccarinii* f. *garniense* (Thum.) Flaksb. 1935, l.c.: 354.

Spikelet with long, unequal awns, one is less than half of the other, color of awns is the same as glumes; glumes pubescent, yellow with black margins; caryopsis brown.

General distribution: Armenia, Iran (Lorestan).

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979)).

var. *zuccarinii* (Flaksb.) A. Filat. et Dorof. (1979), in Dorof. et al., Kult. Fl. I:290 (Figure 2-b).

T. aegilopoides var. *zuccarinii* Flaksb. 1929, l.c.: 463; *T. monococcum* var. *zuccarinii* Flaksb. 1913, Tr. Buro Prikl. Bot. 6: 683; *T. spontaneum* var. *zuccarinii* (Flaksb.) Flaksb. 1935, l.c.:353.

Spikelet with long, unequal, yellowish awns, one is much shorter than the other; glumes pubescent, yellow; caryopsis brown.

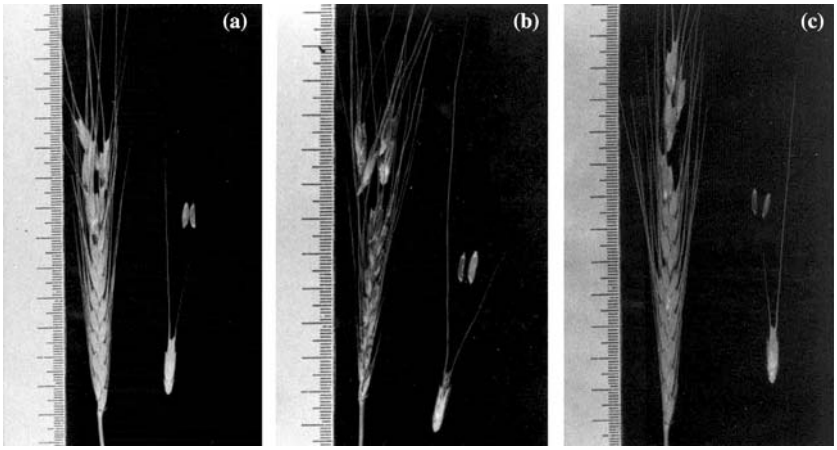

Figure 2 Spike, spikelet and seeds in: a) *T. baeoticum* subsp. *baeoticum* var. *khorramabadicum* b) *T. baeoticum* subsp. *baeotiucm* var. *zucarinii* c) *T. baeotium* subsp. *baeoticum* var. *baeoticum*.

General distribution: Iraq, Syria, Armenia, Iran (West Azerbaijan), Balkan, Crimea, Asia Minor

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979) monographs.

var. *pseudobaeoticum* (Flaksb.) A. Filat. et Dorof. (1979), in Dorof. et al., Kult Fl. I:289.

T. monococcum A. aegilopoides var. pseudobaeoticum Flaksb. *1925*, Tr. Prikl. Bot. Gen. Sel. 25, 1: *207*; *T. aegilopoides* var. *pseudoalbum* Thum. 1934, l.c.: 257 nom. nud; *T. spontaneum* var. *pseudobaeoticum* Flaksb. 1935, l.c.:351.

Spikelet with long, unequal, blackish awns, one is less than half of the other; glumes glabrous, yellow; caryopsis brown.

General distribution: Azerbaijan, Armenia, Crimea, Yugoslavia, Iran (East Azerbaijan).

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. 1979).

var. *khorramabadicum* Salimi (Fig. 2-a)

T. baeoticum var. *khorramabadicum* Salimi, var. nov. *A T. baeoticum* var. *garniens* (Thum.) A.Filat. et Dorof. caryopsidibus viridibus et aristis nigris differt.

Spikelet with long, unequal, blackish awns, one is less than half of the other; glumes pubescent, yellow with black margins; caryopsis green.

Typus: Iran, Tarbiat Moalem Herbarium, Tarbiat Moalem University (TRI 101, August 1996).

General distribution: Iran, Lorestan

T. baeoticum* subsp. *thaoudar

T.baeoticum subsp. *thaoudar* (Reuter ex Hausskn.) Grossh., Fl. Kavk. ed. 2, 1(1939):350, Schiemann, Weizen, Roggen, Gerste: 28(1948)

Syn:
T. thaoudar Reuter ex Hausskn. In Mitt. Thür. Bot. Ver. N. F. 13:66 (1899); *T. monococcum* L. var. *thaoudar* (Reuter ex Hausskn.) Flaksb. In Trudy Bjuro Prikl., Bot. 6:673 (1913); *T. monococcum* L. subsp. *aegilopoides* (Link) Stranski var. *thaoudar* (Reuter ex Hausskn.) Stranski in Bull. Soc. Bot. Bulg. 3:221 (1929); *T. monococcum* L. subsp. *thaoudar* (Reuter ex Hausskn.) Zhuk. In. Bot. Zhurn. 53(4):442 (1968) comb. illeg. I.c.: Fl. Iraq 9: t. 68(1968)

Habitat
Basalt slopes with *Aegilops*, open shrub, steppe uncultivated fields, by roadside, 600–2000 m in degraded oak forest and oak shrub.

Type
Lycia, Bourgeau, Pl. exc. No. 281(holo, Je, iso. BM! E! K!)
General distribution: Crimea, Transcaucasia, N. Iraq, N. and W. Iran, Syria, Turkey

Varieties of T. baeoticum subsp. thaoudar in Iran

Morphological characters used for all varieties are presented in (Table 2).

var. *abovjanii* A. Filat. et Dorof. (1979), in Dorof. et. al., Kult. Fl. I: 290. *T. baeoticum* var. *biarnual* (*vir*) Gandil. 1967, Biol. Zhurn. Arm. 20, 4:96, sine typo.

Spikelet with long, unequal yellowish awns, one is slightly shorter than the other; glumes glabrous, yellow; caryopsis green.

General distribution: Armenia, Iran, Lorestan, Kermanshah, East Azerbaijan.

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979)).

var. *albinigrescens* Flaksb. A. Filat. et Dorofeev. (1979), in Dorof. et al., Kult. Fl. I: 290.

T. thaoudar var. *albinigrescens* Flaksb. 1929, Tr. Prikl. Bot. Gen. Sel. 21,5:465; *T. thaoudar* var. *atratum* Thum. 1934. Tr. Prikl. Bot. Gen. Sel. 5,2:259; *T. spontaneum* var. *albinigrescens* Flaksb. 1935, Kult. Fl. I:346.

Spikelet with long, unequal blackish awns, one is long and the other is nearly half; glumes glabrous, yellow with black shades and striations, with a well developed tooth at the keel; anthers linear ca. 4 mm; caryopsis brown.

General distribution: Armenia, Iran (West Azerbaijan, Lorestan), Syria, N. Iraq, Asia Minor

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979)).

var. *viridialbinigrescens* A. Filat et K. Hammer

T. baeoticum var. *viridialbinigrescens* A. Filatenko and Hammer (1997), Genetic Resources and Crop Evolution 44: 288.

Spikelet with long, unequal awns, one is nearly half of the other, color of awns is the same as

Table 2. Characters used for the identification of varieties of *Triticum baeoticum* subsp. *thaoudar* (according to (Gandilyan 1980) and Dorofeev et al. (1979). Glume (C: color; H:hairy): C1 = yellow, C2 = yellow with black margins, C3 = yellow with black shades and striations, C4 = brown, C5 = brown with black shades and striations, C6 = brown with black margins, H1 = not hairy, H2 = hairy, Awn (C′: color; S: size; C′1 = the same color as glumes, C′2 = black; S1 = long; S2 = short). Caryopsis (C″: color, C″1 = yellow, C″2 = brown, C″3 = green).

Varieties	Glume								Awn				Caryopsis		
	C1	C2	C3	C4	C5	C6	H1	H2	C′1	C′2	S1	S2	C″1	C″2	C″3
abovjanii	*						*		*		*				*
albinigrescens			*				*			*	*			*	
viridialbinigrescens			*				*		*		*				*
taleghanicum				*				*	*			*			*
viridinigrireuteri		*					*		*		*			*	*
ebrahimzadehae	*							*	*		*	*			*
ilamicum						*		*	*		*	*			*
balansae				*			*		*		*			*	

* = The character is present

glumes; glumes glabrous, yellow with black shades and striations; caryopsis green.

General distribution: Turkey, Iran (West Azerbaijan).

var. *ebrahimzadehae* Salimi var. nov.

T. baeoticum var. *biarpual*(*vir*) Gandil. 1975, l.c.:72, descr.ross.nom.illeg.

A.T. baeotico var. virid. album

A. Filat Aristidis albis different.

Spikelet with long, yellowish unequal awns, one is nearly half of the other; glumes pubescent, yellow; caryopsis green.

General distribution: Armenia, Iran (Kermanshah).

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979)).

var. *balansae* (Flaksb.) A. Filat. et Dorofeev (1979) in Dorof. et al., Kult. Fl. I:291. (Fig. 4-b).

T. thaoudar var. *balansae* Flaksb. *1929*, *l.c.: 463; T. thaoudar* var. *roseum* Thum. 1934, Tr. Prikl. Bot. Gen. Sel., 5, 2: 259; *T. spontaneum* var. *roseum* (Thum.) Flaksb. 1935, l. c.: 346.

Spike with slightly long Spikelets: Spikelets with long, brownish, unequal awns; glumes brown, glabrous, with a well developed tooth at the keel. Anthers linear ca. 4 mm; caryopsis brown.

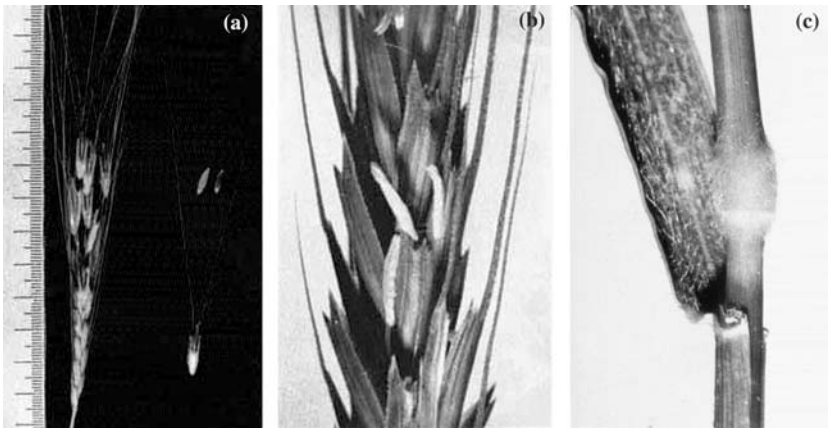

Figure 3 T. baeoticum subsp. *thaoudar* var. *virldinlgrireuteri* a) Spike, spikelet and seeds. b) Spike in large magnification: status of keels, teeth and hairiness on glumes and scabridulous awns and anthers are shown (×56.4). c) Distribution of hairs on sheath, leaf blade and stem node are shown (×56.4).

General distribution: Armenia, Iran (Kordestan), Asia Minor, N. Iraq.

var. *ilamicum* Salimi, var. nov.

T. baeoticum var. *ilamicum* Salimi, var. nov. A *T. baeotico* var. *tchivicum* A. Filat et Dorof. aristis rubris differt.

Spikelet with long, unequal awns, one is slightly shorter than the other, color of awns is the same as glumes; glumes pubescent, brown with black margins; caryopsis green.

Typus: Iran, Tarbiar Moalem Herbarium, Tarbiat Moalem University (TRI 102, June 2000).

General distribution: Iran (Ilam).

var. *taleghanicum* Salimi, var. nov. (Fig. 4-a) *T. baeoticum* var. *taleghanicum* Salimi, var. nov. *A. T. baeotico* var. *viridihaussknechtii* K. Hammer et A. Filat. aristis brevis differt.

Latin Diagnosis: spiculae biaristatae, aristae breviore, fere aequales; glumae brunneae, pubescentes; caryopsis viridis.

Description: spikelet with short (ca.1–1.5 cm) brownish unequal awns; glumes pubescent, brown; caryopsis green.

General distribution: Iran (Qhazvin.).

Typus: Iran, Tarbiar Moalem Herbarium, Tarbiat Moalem University (TRI 103, August 1996).

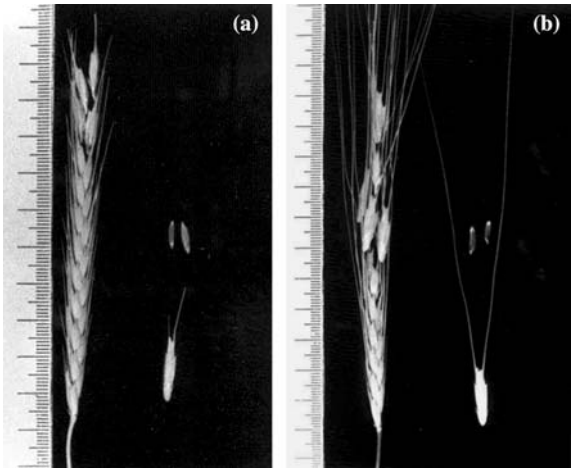

Figure 4 Spike, spikelet and seeds in: a) *T. baeoticum* subsp. *thaoudar* var. *taleghanicum* b) *T. baeoticum* subsp. *thaoudar* var. *balansae*.

var. *viridinigrireuteri* K. Hammer et A. Filat. (Figure 3)

T. baeoticum var. *viridinigrireuteri* K. Hammer and Filatenko (1997), Genetic Resources and Crop Evolution, 44:288.

Spikelet with long, unequal awns, one is slightly shorter than the other, color of awns is the same as glumes; glumes glabrous, yellow with black margins; caryopsis green.

General distribution: Iran (Lorestan).

This variety is new to Iran (compare to Gandilyan (1980) and Dorofeev et al. (1979)).

Triticum urartu

T. urartu Thumanian ex Gandilyan, Bot. Zhurn. 57:176 (1972); *T. urartu* Thumanian, Trans. Armenian Fil. AN SSSR Ser. Biol. 2:221(1938), descr. ross. Wild form.

Annual. Stems tufted, up to 129 cm. tall, green, purple at maturity, peduncle long up to one third of stem in length. Stem below the nodes purple, pubescent. Leaf sheath villous-pilose. Leaf blades 10–13 mm broad, villouse-pilose, hairy with very short, whitish hairs, velvety, flag leaf densely hairy, hairs small, margins scabridulous. Spike erect, 11.9–13 cm, slender, lax, laterally compressed. Rachis densely hairy at margins, sparsely hairy at nodes, internodes 2.9–4.6 mm, brittle disarticulating below the spikelet at maturity, spikelets with 2-fertile florets, two black, short (with less unequal) awns with 2–2.5, 3–3.5, 5–5.5 mm, (from below of spike up to apex), arista scabridulous. Glumes long, 11.2–11.6 mm, coriaceous, yellow, glabrous, with a well developed tooth at the keel and abaxial second tooth much reduced, scabridulous toward apex. Lemma 12.8–13.7 mm, glabrous. Palea 11.1–12.8 mm, splitting at maturity. Anthers linear ca. 2.5 mm, yellow. Caryopsis brown, ellipsoid 7.3–9.2×1.3–1.95 mm. endosperm flinty.

Habitat

Overgrazed steppe, grassland at margins of field, in thickets of hills.

Type

Inst. Bot. Acad. SG. Armenia.

Table 3. Characters used for the identification of varieties of *Triticum urartu* (according to Gandilyan (1980) and Dorofeev et al. (1979)). Glume (C: color; H: hairy): C1 = yellow, C2 = yellow with black margins, C3 = yellow with black shades and striations, C4 = brown, C5 = brown with black shades and striations, C6 = brown with black margins; H1 = not hairy, H2 = hairy; Awn (C′: color; S: size; C′1 = the same color as glumes, C′2 = black; S1 = long; S2 = short). Caryopsis (C″: color, C″1 = yellow, C″2 = brown, C″3 = green).

Varieties	Glume								Awn				Caryopsis		
	C1	C2	C3	C4	C5	C6	H1	H2	C′1	C′2	S1	S2	C″1	C″2	C″3
iranicum				*				*		*		*		*	
sardashticum				*				*	*			*		*	

* = The character is present

General distribution: Eastern Turkey, Syria, Iraq, Iran, Armenia, Palestine, Jordan.

Varieties of T. urartu in Iran

Morphological characters used for all varieties are presented in Table 3.

var. *iranicum* Salimi (Figure 5)

T. urartu var. *iranicum* Salimi var. nov., *A T. urartu* var. *spontaneorubrum* Thum. aristis nigris differt.

Spikelet with short, blackish, nearly unequal awns; glumes pubescent. brown: caryopsis brown.

Typus: Iran, Tarbiat Moalem Herbarium, Tarbit Moalem University (TRI 131, August 2000).

General distribution: Iran. Kermanshah, Chahar-mahal.

var. *sardashticum* Salimi

T. urartu var. *sardashticum* Salimi, var. nov.-A *T. urartu* var. *spontaneorubrum* Thum. ex Dorof. et A. Filat. glumis pubescentibus differt.

Spikelet with short brownish awns; glumes pubescent, brown; caryopsis brown.

Typus: Iran, Tarbiat Moalem Herbarium, Tarbiat Moalem University
(Tri 132, August 1996).

General distribution: Iran, West Azerbaijan.

T. monococcum L.

T. monococcum L., Sp. Pl. 86(1753)

Syn:

T. pubescens Bieb., Beschr. Länd. Terek Kur. Kasp. Meere; 81 (1800); *T. monococcum* L. var. *eu-monococcum* Hayek et Markgr., Prodr. Fl. Balc. 3:228 (1932) nom. non. rite public. Map 47.

Annual. Stems tufted, 95–100 cm, Slender, light green, glabrous, nodes restrorsely pilose, leaf sheaths glabrous(Lower pilose), margin smooth.

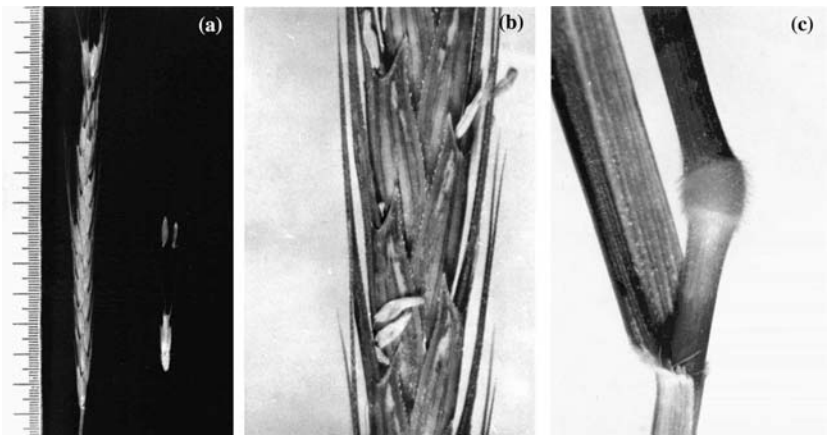

Figure 5 Triticum urartu var. *iranicum* a) Spike, spikelet and seeds. b) Spike showing status of keels, teeth and hairiness on glumes and scabridulous of awns and anthers (×56.4). c) Distribution of hairs on sheath, leaf blade and stem node (×56.4).

Leaf blades 13–15 mm broad, scabridulous or puberulent, margins smooth or slightly scabrid. Spike erect 9.5–10 cm, shorter and more compact than in *T. baeoticum*, strongly laterally compressed, glabrous, more rarely pubescent. Rachis internodes ca. 2 mm long, sparsely short pubescent margins, brittle only on touching. Spikelets 3-flowered, only one fertile.

Glumes 8–9 mm, coriaceous 2-dentate 2-keels, one of the keels prominent. Fertile lemma navicular, 9.6–10 mm, with (4.5)–6.5–9.5 cm, scabrid awns. Palea 9.2–9.5 mm, splitting to base at maturity. Anthers linear ca. 4 mm, yellow. Caryopsis yellow, ellipsoid 7.2–9.3 × 2.5–2.9 mm. Endosperm flinty or other.

Type
Non-indicated (Described without locality-Hb. Linn. 104/4!)

Habitat
cultivated

General distribution
Europe (Cultivated as a cereal 'einkorn'), Crimea, Caucasia, N. Iraq, W. Iran, N.W. East Azerbaijan, N. Africa.

var. *mansfeldii* K. Hammer et A. Filat. (Figure 6)
T. monococcum var. *mansfeldii* K. Hammer A. Filat., 1997, Genetic Resources and Crop Evolution, 44:285.

Spikelet with long, yellowish unequal awns; glumes glabrous, yellow; caryopsis yellow.

General distribution: Turkey, Azerbaijan, Iran, N.W. East Azerbaijan.

This variety is new to Iran (compare Gandilyan (1980) and Dorofeev et al. (1979)).

Today, *T. monococcum* cultivation is limited to small isolated regions within Azerbaijan in Iran. There are two forms of *Triticum monococcum* var. *mansfeldii* in Iran; one form is large and has spikelets with two unequal awns, the other form is small and has spikelets with two very unequal scabrid awns.

Discussion

The present study clearly provides documented evidence for the existence of *T. urartu* in Iran. Two accessions from Iran have already been reported by Filatenko et al. (2001), Table 2. This species is generally distributed along roadsides and margins of fields and sometimes it is found in the vicinity of *T. baeoticum*. However, despite cohabitation in such places, populations of each species have conserved their own identity.

The following morphological characters allows us to distinguish *T. urartu*, *T. baeoticum* and *T. monococcum*.

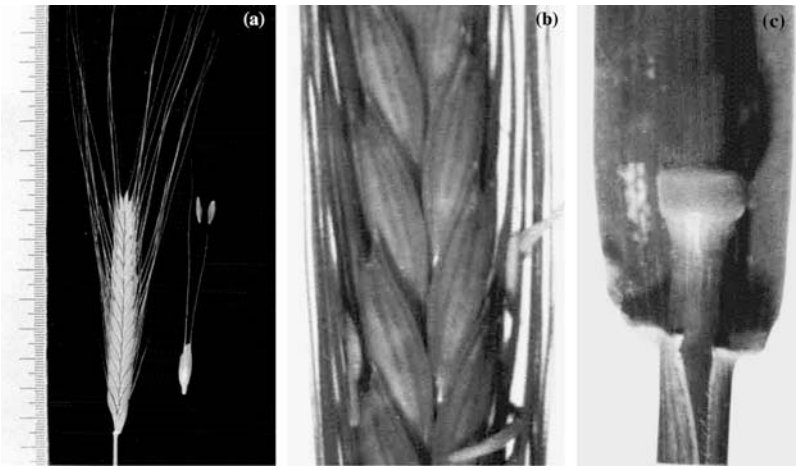

Figure 6 Triticum monococcum var. *mansfeldii* a) spike, spikelet and seeds. b) Spike showing keels, teeth, hairy glumes and scabridulous awns (×56.4). c) There are few hairs on stem node and no hairs on leaf blade (×56.4).

The leaf blade of *T. urartu* is covered by close short hairs, whereas *T. baeoticum* has long hairs on the veins and little short hairs on the leaf, and *T. monococcum* has no covering hairs. This trait is very significant in identification of the species, even in the vegetative stage. Our results are in agreement with these of Gandilyan (1972) and Dorofeev, 1979.

Anther size is an important trait for the identification of species in the reproductive stage. Anther size in *T. urartu* is short (2.5 mm), whereas in *T. baeoticum* and *T. monococcum* it is longer (4 mm) and similar for both species. This observation corresponded with measurements of Gandilyan (1972, 1998), Slageren (1994), Kit Tan (1985) and Chelak (1991).

Glumes teeth on spikelets have also been used to distinguish diploid species. In *T. urartu* one of the teeth is very prominent and the other is much reduced. In different populations of Iranian *T. baeoticum* this character can be diverse, in some populations the teeth being similar to *T. urartu* and in others varying in size to different extents, the size differences sometimes even being very small. Although teeth size has been regarded as an important character for identification of *T. urartu* (Gandilyan 1972, 1988), our observations do not agree with this as the existence of diversity in teeth size in populations of *T. baeoticum* could produce misleading results and hence may wrongly identify *T. baeoticum* as *T. urartu* see also Filatenko et al. 2001.

Awn size is another trait in distinguishing the two species from each other. In *T. urartu* each spikelet has a pair of short and nearly equal awns, whereas in *T. baeoticum* as well as in *T. monococcum* awns are usually long and unequal in size. These results did not correspond with those of Gandilyan (1998).

Size difference in awns is a good trait in identification of sub species of *T. baeoticum*. Nevertheless awn characteristics alone are not sufficient to identify the three diploid species from one another and other characters should also be taken into consideration (see Hammer et al. 2000). This is highlighted by the observation that in *var. taleghanicum* awns are short and similar to *T. urartu*.

Color, number and size of seeds in each spikelet is another important feature in differentiating these species from one another. In *T. urartu* seeds are brown whereas in *T. baeoticum* seeds are either green, brown or brown with greenish traces. When there are two seeds in a spikelet and the seed is brown the seed is usually broader and if the seed is green it is usually narrower in width. However, in *T. monococcum* seeds are yellow. The number and size of seeds varies, *T. urartu* have two seeds in each spikelet and similar in size. In *T. baeoticum* ssp. *thaoudar* each spikelet has two seeds different in size, one broader and one narrower. In *T. monococcum* there is only one – grain in each spikelet. Our obsevation on seed color is in agreement with Gandilyan's report (Gandilyan 1998).

Therefore, adding up, awn size, seed characteristics, anther size and hairiness of leaf blade are the most important features in identification of the above diploid species from in vegetative, reproductive and mature stages.

The extent of distribution of these species from North, West north to West south and Central Iran, merit the country as one of the important gene pool centers for the "A" genome species. Co-existence of these species with other wheat ancestors provides an important ground for the evolution of bread wheat and highlights Iran as one of the original habitats of bread wheat (Dvořak et al. 1993, 1998; Lawton and Wilke 1979).

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