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A TAXONOMIC REVIEW OF THE HORDEUM MARINUM SENSU LATO (POACEAE: TRITICEAE) IN IRAN *

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Abstract – This study concerns the taxonomic status of *Hordeum marinum* sensu lato in Iran. Its geographical distribution in Iran has been reported. Based on the morphological study, the taxon contains two subspecies: *marinum* and *gussoneanum* (Parl.) Thell. in Iran. Morphological descriptions along with a key separating the two subspecies are provided. Furthermore, morphological variations of the subspecies of *Hordeum marium* Hudson in various habitats have been studied. In order to facilitate identifications, three photographs and drawings illustrating the herbarium specimens have been provided.

Keywords – Poaceae, triticeae, hordeum marinum s. l., Iran

1. INTRODUCTION

The taxonomic situation of *Hordeum marinum* sensu lato has been the matter of several taxonomic treatments. Tzvelev [1], Bothmer *et al*., [2], Bothmer *et al*., [3] and Bothmer *et al*., [4] recognized the morphological variants encountered in the group (*Hordeum marinum* sensu lato) as *marinum* and *gussoneanum. Marinum* is a diploid form with flattened glumes occurring mainly in the Western Mediterranean area; and *gussoneanum* (Parl.) Thell., a form containing both di-and tetraploid levels with setaceous glumes occurring in the Eastern Mediterranean area [5]. In their taxonomic treatments, Bothmer *et al*., [2] and Bothmer *et al*., [3] have treated many closely related described taxa to the group as synonyms under these two subspecies:

a) Hordeum marinum Huds. subsp. marinum

Synonyms: *H. maritimum* With., Bot. Arr. Veg. Brit. Ed. 2,1: 127(1787).- *H. maritimum* Pourr., Chlo. Narb.: 320 (1788).- *H. rigidum* Roth, Cat. Bot. 1:24(1797).- *H. pubescens* Guss., Fl. Sic. Prod, 1: 144(1827).- *H. secalinum* Schreb. subsp. *marinum* (Huds.) Fouill. & Lit., Bot. Soc. Fr. 73:223(1926).-*H. marinum* Huds. var. *pubescens* (Guss.) Nevski, Bot. Acad. Sci. USSR 5:213(1941).- *Critesion marinum* (Huds.) A. Löve. Taxon 29: 350 (1980).

b) Hordeum marinum Huds. subsp. gussoneanum (Parl.) Thell.

Synonyms: *H. geniculatum* All., Fl. Ped. 2:259(1785).-*H. hystrix* Roth, Cat. Bot. 1: 23(1797).- *H. utriculatum* Bertero, Amer. J. Sci. Arts 23:86(1833).-*gussoneanum* Parl., Fl. Palerm. 1:

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246(1845).- *H. pratense* Huds. var. annum Lange , Vid. Medd. II, 1: 54(1860).- *H. marinum* Huds. var. *gussoneanum* (Parl.) Tackholm, Fl. Egypt 1: 277(1941).- *Critesion geniculatum* (All.) A. Love, Taxon 29:350(1980).- *C. hystrix* (Roth) A. Love, Fedd. Report. 95:440(1989).- *H. gussoneanum* Parl. var. *uniflorum* Lojacono, Fl. Sicul. 3:365(1909).- *H. pavisii* Preaub., Bull. Soc. Sci. Angers 38:54(1990).

Some workers such as Hitchcock [6], Nevski [7], Covas [8], Bowden [9], Bor [10,11], Humphries [12] and Baum & Bailey [13, 14] concluded that the mentioned variants are to be treated as two distinct species: *H. marinum* Huds. and *H. geniculatum* All. .

Bor [11] in the *Flora Iranica* area has recognized *H. geniculatum* All. as a distinct species from *H. marinum Huds.* with two varieties: *marinum* and *pubescens* (Guss.) Nevski. In the latter, Bor [11] has described the varieties *marinum* and pubescens as having glaber and pubescent spikelets, respectively. He has also pointed out that the only variety occurring in Iran is *pubescens.* According to Bor [10], *H. marinum* Huds. with flattened lower glumes is found in western and southern Europe, the Aegaean Isles, Cyprus, Syria, Palestine, Jordan, Egypt, Turkey, Caucasus, Iran, Afghanistan, N. Africa, Macaronesia and tropical South Africa and *H. geniculatum* All.with setaceous glumes is found in western, central and southern Europe, the Balkans, Crimea, the Aegaean Isles, Syria, Sinai, Egypt, Turkey, Caucasus, Iran, Central Asia, North Africa and tropical South Africa.

The aims of this study are: first, to evalute the described taxa belonging to *H. marinum* sensu lato in Iran; second, to present the geographical distribution of the taxa *H. marinum* sensu lato in Iran; and thirdly, to attempt to find out the taxonomic characters separating the taxa belonging to the *H. marinum* sensu lato in Iran.

2. MATERIALS AND METHODS

This study was performed using field and herbarium materials.

The geographic origin and population number of *H. marinum* s. l. collections from Iran are listed in Table 1. Voucher specimens are deposited in the herbarium of Isfahan University (IUH). Also herbarium materials from the following herbaria: IUH, TUH (Herbarium of Tehran Univ.), TARI (Herbarium of Tehran Botanical Garden) and IRAN (Herbarium of the Plant Pests and Diseases Research Institute of Ewin) have been studied.

Table 1. Geographic origin and population number of *H. marinum* s. l. collections from Iran

Collecting site	Population Number
C: Isfahan; 20 km west of Isfahan, Falavarjan, 51º 30´ E, 32º 34´ N, elev. c. 1600 m	1
C: Isfahan; Zayand-e Rud river banks, 51º 39´ E, 32º 38´ N, elev. c. 1550 m	2
E: Sistan; Iranshahr, Bampour, 60º 27´ E, 27º 10´ N, elev. c. 570 m	3
S: Fars; Shiraz, Passargad 53º 10´ E, 30º 14´ N, elev. c. 1750 m	4
W: Chaharmahal and Bakhtiari, Lordegan, 35 km NW of Lordegan, Sarkhoun village, 50º 37´ E, 31º 41´ N, elev. c. 1940 m	5

SW: Kohkiloyeh-e and Boyerahmad, Yassudj, 51º 41´ E, 30º 49´ N, elev. c. 1800 m	6
W: Ardabil; 30 km north of Ardabil towards Astara, 48º 37´ E, 38º 23´ N, elev. c. 1450 m	7
W: Kermanshah, 35 km east of Kermanshah, 47º 27´ E, 34º 25´ N, elev. c. 1270 m	8
W: Khuzistan; Dezful towards Andimesk, 48º 22´ E, 32º 27´ N, elev. c. 150 m	9
W: Kurdestan; Sanandaj, 25 km north of Camyaran, 46º 50´ E, 34º 55´ N, elev. c. 1660 m	10

In order to find out the environmental variants (phenoplasticity), ten seeds from each accession were grown under identical conditions (24 ± 2°c and 80 ± 5 % Relative Humidity) in the greenhouse. Morphological comparisons were made between the material collected from the field and at least ten plants grown from the same collections in the greenhouse. The morphological characters evaluated in this study are listed in Table 2. The morphological terminology used in this study is based on Stearn [15].

Finally, diagnostic (key) characters for separations of *H. marinum* s.l. taxa have been chosen.

Table 2. Morphological characters, states and codes used in the *H. marinum* s. l. study (FP = Field plants and GP = Greenhouse plants)

No	Characters	Population number									
		1	2	3	4	5	6	7	8	9	10
		FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FPG P
1	**Tillering habit** Solitary (0); loosely fasciculate (1)	1 1	1 1	1 1	0 1	1 1	0 1	1 1	1 1	1 1	1 1
2	**Culm base shape** Erect (0); geniculate (1)	1 1	1 1	1 0	0 1	1 0	1 1	1 1	1 1	1 1	1 1
3	**Culm nodes hairiness** Hairy (0); glaber (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
4	**Culm mean length including spike** 15-20 cm (0); 21-50 cm (1)	0 1	0 1	0 1	1 1	0 1	1 1	0 1	0 1	0 1	1 0
5	**Leaf abaxial side hairiness** Glaber (0); hairy (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
6	**Leaf adaxial side hairiness** Glaber (0); hairy (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
7	**Leaf sheath abaxial side hairiness** Glaber (0); hairy (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
8	**Auricle presence** Absent (0); present (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
9	**Spike mean length including awns** < 4.5 cm (0); 4.6-7cm (1)	1 0	0 0	1 0	0 1	0 0	1 1	0 0	0 0	0 0	0 0
10	**Spike mean width** 1-1.5 cm (0); 1.6-2 cm (1)	1 0	0 0	1 0	0 0	0 0	1 0	0 0	0 0	1 0	0 0
11	**Rachis brittleness** Brittle (0); tough (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0

Table 2 Continued

No	Characters	Population number									
		1	2	3	4	5	6	7	8	9	10
		FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FPG P
12	**Rachis internods margin hairiness** Glaber (0); ciliate (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
13	**Central spikelet base** Sessile (0); pedicelate (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
14	**Lateral spikelet base** Sessile (0); pedicelate (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
15	**Central spikelet fertility** Sterile (0); fertile (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
16	**Lateral spikelet fertility** Sterile (0); fertile (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
17	**Central spikelet glumes shape** Isomorphic (0); heteromorphic (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
18	**Lateral spikelet glumes shape** Isomorphic (0); heteromorphic (1)	1 1	1 1	0 0	0 0	1 1	0 0	1 1	0 0	1 1	0 0
19	**Central spikelet glumes abaxial side hairiness** Glaber (0); scaber (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
20	**Central spikelet glumes adaxial side hairiness** Glaber (0); scaber (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
21	**Lateral spikelet glumes abaxial side hairiness** Glaber (0); scaber (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
22	**Lateral spikelet glumes adaxial side hairiness** Glaber (0); scaber (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
23	**Central spikelet lemma abaxial side hairiness** Glaber (0); hairy (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
24	**Central spikelet lemma adaxial side hairiness** Glaber (0); hairy (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
25	**Lateral spikelet lemma abaxial side hairiness** Glaber (0); slightly scaber (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
26	**Lateral spikelet lemma adaxial side hairiness** Glaber (0); slightly hairy (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
27	**Central spikelet palea abaxial side hairiness** Glaber (0); ciliate (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
28	**Central spikelet palea adaxial side hairiness** Glaber (0); slightly hairy (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
29	**Lateral spikelet palea abaxial side hairiness** Glaber (0); ciliate (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
30	**Lateral spikelet palea adaxial side hairiness** Glaber (0); slightly hairy (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
31	**Central spikelet glumes nerves number** 1 Nerved (0); 3 nerved (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1

Table 2 Continued

No	Characters	Population number									
		1	2	3	4	5	6	7	8	9	10
		FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FP GP	FPG P
32	**Lateral spikelet glumes nerves number** 1 nerved (0); 3 nerved (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
33	**Central spikelet lemma nerves number** 3 nerved (0); 5 nerved (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
34	**Lateral spikelet lemma nerves number** 3 nerved (0); 5 nerved (1)	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
35	**Central spikelet lodicules margin hairiness** Glaber (0); ciliate (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
36	**Lateral spikelet lodicules margin hairiness** Glaber (0); eiliate (1)	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0

3. RESULTS

The results of this study showed that the geographical distribution of *H. marinum* in Iran is more restricted than the other wild taxa belonging to the genus *Hordeum* in this country (Table 1).

H. marinum plants usually grow along river banks, rood sides and also around fields at elevations of 150-1940 m. Four new localities (2, 3, 5 and 6 in Table 1) are added to the former mentioned localities for the taxon in Iran [11, 16].

Morphological studies of this research showed that in the plants of population numbers 1, 2, 5, 7 and 9, the glumes of lateral spikelets are heteromorphic, with the lower one being distinctly flattened and winged at the base, while in populations 3, 4, 6, 8 and 10, the lateral glumes are isomorphic or the lower one is slightly flattened, but not winged at the base.

Comparing morphological characters between the plants collected from the field and those that were grown in the greenhouse, some phenoplasticities were shown on a number of characters including tillering habit, culm habit, culm mean length including spike (4.5-7cm), spike mean length including awns, and spike mean width, which is affected by the environmental condition (Table 2).

Based on the results of this study, the morphological description of *H. marinum* s. l. is as follows:

Annual. Culms solitary or loosely fasciculate, erect or somewhat geniculate at the base, 15-50 cm. tall; nodes and internodes glabrous. ***Leaves*** mostly flat, hairy on both sides; auricles usually lacking, if present, very small. ***Collar*** usually closed. ***Spikes*** dense, stiff, ovate or oblong, green to glaucous, 4.5-5 (-7) cm. long, 1-1.5 (-2) cm. broad; rachis brittle rather late in maturity, ciliate on the angles. ***Spikelets*** in three, the central spikelets much longer than the lateral ones. ***Central spikelet*** sessile, fertile; glumes isomorphous, setaceous or compressed, abaxial side scabrous, adxial side glabrous, 3-nerved; lemma awned, abaxial and adaxial sides smooth and glabrous, 5-nerved; palea awnless, abaxial side glabrous or with short cilia on the keels, adaxial side sparsely hairy, 2-nerved; lodicules entire and glabrous. ***Lateral spikelets*** pedicelate, sterile; upper glume setaceous, lower glume setaceous to compressed or broadly winged on one side, abaxial side glabrous or slightly scabrous, adaxial side glabrous, 3-nerved; lemma awned, abaxial side glabrous or somewhat scabrous,

adaxial side sparsely hairy, 5-nerved; palea awnless, abaxial side glabrous or with short cilia on the keels, adaxial side sparsely hairy, 2-nerved; lodicules entire and glabrous (Figs. 1-3).

Fig. 1. Habit of *Hordeum marinum* Huds. A: ssp. *marinum* (Isfahan, Zayand-e Rud river banks)
B: ssp. g*ussoneanum* (Parl.) Thell. (Shiraz, Passargad)

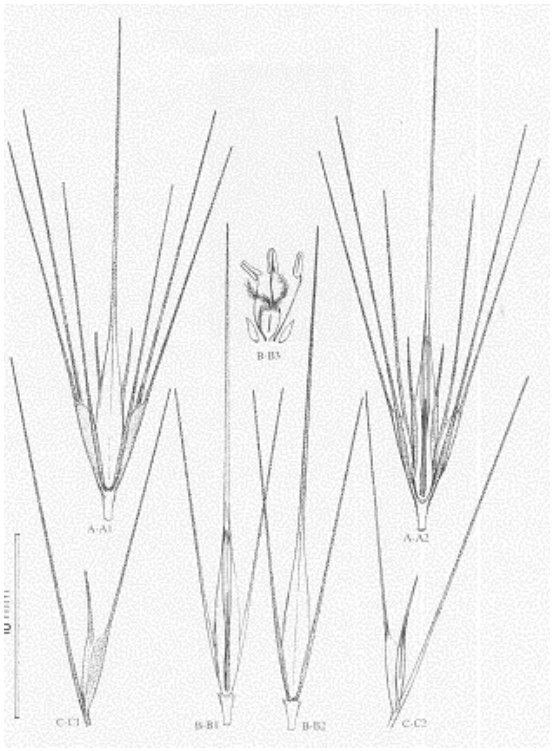

Fig.2. *Hordeum marinum* Huds. ssp. *marinum* (Isfahan, Zayand-e Rud river banks). A: Triplet of spikelets, A1; Abaxial side, A2; Adaxial side. B: Central spikelet, B1; Adaxial side, B2; Abaxial side, B3; Flower. C: Lateral spikelet, C1; Abaxial side, C2; Adaxial side

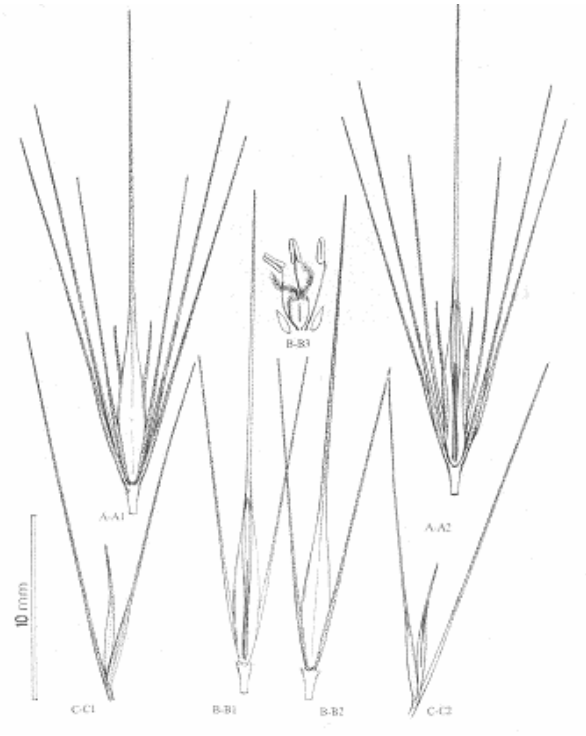

Fig.3. *Hordeum marinum* Huds.ssp. g*ussoneanum* (Parl). Thell. (Shiraz, Passargad). A: Triplet of spikelets, A1; Abaxial side, A2; Adaxial side. B: Central spikelet, B1; Adaxial side, B2; Abaxial side, B3; Flower. C: Lateral spikelet, C1; Abaxial side, C2; Adaxial si

4. DISCUSSION AND CONCLUSION

As previously mentioned, the *H. marinum* group has been treated in several different ways taxonomically. For example, Bor [11], treating the group in the *Flora Iranica* area, divided *H. marinum* s.l. into two distinct species: *H. geniculatum* and *H. marinum*. According to Bor [11], in the first species the glumes of lateral spikelets are isomorphic or the upper one is slightly flattened at the base, but not winged, while in the second species they are heteromorphic and the upper one is flattened and winged at the base. The results of this study showed that the lower glumes of the lateral spikelets are as mentioned above. Based on the results of this study, the observed variation between two subspecies: *marinum* and *gussoneanum* is at the level of ecotype (i.e. genetically) controlled. As indicated in Table 1, and considering the subspecies of each plant population, a significant correlation between the geographical condition and the distribution of these subspecies in various regions of Iran does not seem probable. Bor [11] also mentioned that *H. marinum* contains two varieties, viz. *marinum* and *pubescent.* Bor [11] believes that var. *pubescent* with hairy spikelets is the only taxon from *H. marinum* occurring in Iran. The results of the present study showed that all specimens studied belonging to *H. marinum* s. l. have glaber or slightly scaber spikelets. These results indicate that the taxonomic key in *Flora Iranica* [11] should be corrected.

Based on the morphological studies of the present research, Bothmer's classification [2-5] for *H. marinum* s. l. is confirmed. In addition, it is concluded that *H. marinum* s. l. with two subspecies occurs in Iran. The two subspecies are distinct from each other as follows:

1. Glumes of the lateral spikelets isomorphous, setaceous or the lower one slightly flattened at the base, but not winged……subsp. *gussoneanum* (Parl.) Thell.
2. Glumes of the lateral spikelets heteromorphous, the lower one distinctly flattened and winged at the base .....……..…….... subsp. *marinum*

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