

## A TAXONOMICAL, MORPHOLOGICAL AND CYTOLOGICAL REVISION OF THE GENUS FORMERLY TREATED AS NARDURUS REICHENB. (POEAE, POACEAE) IN IRAN

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Received 22.02.2011. Accepted for publication 16.11.2011.

Zoughi, S., Saeidi, H. & Rahiminejad, M. R. 2011 12 31: A taxonomical, morphological and cytological revision of the genus *Nardurus* Reichenb. (*Poeae*, *Poaceae*) in Iran. -*Iran. J. Bot.* 17 (2): 189-199. Tehran.

The taxonomic status of the two species previously treated as *Nardurus subulatus* (now *Lolium subulatum*) and *Nardurus maritimus* (now *Vulpia unilateralis*) are reviewed and improved according to the latest classifications for these taxa. A critical study of 30 herbarium specimens and 490 plant individuals collected all around Iran were studied based on the morphological and cytological characters. Cytological analysis showed that  $2n = 2x = 14$  and all karyotype symmetry indices indicated symmetric karyotypes for both species with metacentric chromosomes. This is the first report on chromosome number of *Lolium subulatum*. Two species were clearly separated by morphological data and a close relationship between both species and two species of *Vulpia* (*V. persica* and *V. hirtiglomis*), used as controls, was observed. Regarding high similarity between *Lolium subulatum* and the species of *Vulpia* we propose to transfer this species to the genus *Vulpia*.

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**Key words.** Cytology, Iran, *Lolium*, *Nardurus*, *Poeae*, Taxonomy, *Vulpia*.

مطالعه تاکسونومی، ریخت‌شناسی و سلولی جنس معرفی شده با نام قبلی *Nardurus Reichenb.* (Poeae, Poaceae) در ایران

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موقعیت تاکسونومی دو گونه *Nardurus subulatus* و *N. maritimus* (اکنون با نام جنس *Vulpia*) بررسی و بر اساس آخرین طبقه‌بندی‌ها معین می‌گردد. این مطالعه بر روی تعداد ۳۰ نمونه هرباریومی و ۴۹۰ گیاه جمع‌آوری شده از سطح ایران بر اساس ویژگیهای ریخت‌شناسی و سلول‌شناسی انجام شده است. مطالعات سلول‌شناسی  $2n=2x=14$  را با کاریوتیپ متقارن و کروموزومهای متاستریک برای هر دو گونه نشان داد. گزارش کروموزومهای گونه *Lolium subulatum* برای اولین بار است. مشاهدات نشان می‌دهد که دو گونه به آسانی از همدیگر تفکیک می‌شوند و از طرف دیگر شباهت گونه *Lolium subulatum* با گونه‌های جنس *Vulpia* موجب پیشنهاد انتقال این گونه به جنس *Vulpia* می‌گردد.

### INTRODUCTION

Taxonomic complexities are common features of many genera within the tribe *Festuceae*. The genus *Nardurus* was referred to a combination of small, racemose annual species that were previously placed in the genera *Brachypodium*, *Triticum* and *Festuca*, by Reichenbach (1844). Because of high taxonomic complexities, the genus has undergone many taxonomic innovations since its first establishing in 1844. As reviewed by Stace (1978), 10 species (*N.*

*salzmannii* Boiss., *N. subulatus* (Banks & Solander) Bor, *N. persicus* Boiss. & Buhse, *N. patens* (Brot.) Hackel, *N. cynosuroides*, (Desf.) Trabut, *N. demnatensis* (Murb.) Maire, *N. tuberculosus* (Moris) Hayek, *N. mamoraues* Maire, *N. maritimus* (L.) Murb. and *N. maririmus*) were placed in this genus by different authors. Stace (1978) believed that the genus *Nardurus* s.l. is very heterogenous and all of the species in this genus could be placed in separate genera (*Castelia* Tineo, *Narduroides* Rouy, *Lolium* Krecz. &

Table 1. Population codes, locations and other details regarding the populations of *Nardurus maritimus* and *N. subulatus* used in this study.

Population Code	Location	Date	Collected by	Herbarium number
NS16	C: Isfahan toward Kashan, 25 km to Abyaneh	30/4/2009		HUI16926
NS13	C: Karaj, Botanical Garden	8/5/2009	Zoghi & Naderi	HUI16923
NS 12	C: Qom toward Isfahan, 116 km to Salafchegan	9/5/2009	Zoghi	HUI16922
NS 9	C: Isfahan, University of Isfahan campus	19/5/2009	Zoghi	HUI16919
NS 14	W: Kamyaran, 20 km to Sanandaj (N: 35° 05.655', E: 46° 56.070'), 1370 m	25/5/2009	Zoghi	HUI16924
NS 5	W: Road of Sanandaj to Hamedan (N: 35° 17.343', E: 47° 5.614'), 1690 m	26/5/2009	Zoghi	HUI16915
NS 10	W: Hamedan, 20 km to Malayer (N: 34° 21.625', E: 48° 0.775'), 1790 m	27/5/2009	Zoghi	HUI16920
NS 1	C: Arak, northern mountains slopes (N: 34° 4.201', E: 49° 44.807'), 1743 m	28/5/2009	Zoghi	HUI16910
NS 2	C: Arak toward Khomein, 22 km to Khomein (N: 49° 54.36', E: 33° 51.873'), 1982 m	28/5/2009	Zoghi	HUI16912
NS 4	C: Arak toward Khomein, 20 km to Khomein (N: 33° 36.869', E: 50° 120.492'), 1940 m	28/5/2009	Zoghi	HUI16914
NS 3	C: Saveh to Salafchegan (N: 34° 33.931', E: 50° 240.702'), 1365 m	29/5/2009	Zoghi	HUI16913
NS 8	W: Around of Uromieh Lake (N: 38° 0.476', E: 45° 5.956'), 1288 m	25/6/2009	Zoghi	-
NS 11	W: Uromieh toward Salmas, 4 <sup>th</sup> km (N: 38° 2.649', E: 45° 7.807'), 1496 m	25/6/2009	Zoghi	HUINS 11
NS 7	C: Saveh toward Tehran, 60 km to Tehran, 1150 m	1/7/2009	Zoghi	HUI16917
NS 6	NE: Mashhad, Golmakan	31/6/2009	Zoghi	HUI16916
NS 15	C: Isfahan, Mouteh Protected Area	25/6/2009	Naderi	HUI16925
NS 17	C: Isfahan, Kolah Ghazi Protected Area	8/4/2009	Zoghi	HUI16927
NS 19	SW: Chaharmahal-o-Bakhtiahi, Sarkhon toward Dehdez	10/4/2009	Zoghi	HUI16929
NS 18	C: Isfahan, University of Isfahan	21/4/2009	Naderi	HUI16928
NS 20	C: Karaj	29/4/2009	Zoghi	HUI16930
NS 24	S: Fars, Shiraz, Shahrak Sadra	23/5/2009	Zoghi	HUI16934
NS 25	S: Fars, Shiraz, 10 km to Shahrak Sadra	23/5/2009	Zoghi	HUI16935
NS 27	C: Yazd toward Tabas, 50 km to Deyhok (N: 33° 23.255', E: 57° 9.562'), 1028 m	25/5/2010	Naderi	HUI16937
NS 28	C: Yazd toward Tabas, Deyhok, 20 km to Chirok (N: 33° 22.812', E: 57° 15.395'), 1435 m	25/5/2010	Naderi	HUI16938
NS 29	C: Yaz toward Tabas, Deyhok, 10 km to Critlam (N: 33° 24.392', E: 57° 15.144'), 1772 m	25/5/2010	Naderi	-
NS 30	W: Mashhad toward Neyshabour, 10 km to Neyshabour (N: 35° 20.155', E: 58° 28.072'), 1341 m	26/5/2010	Naderi	HUI16940
NS 23	E: Kerman, Dehe Bakri toward Bam (N: 29° 32.76', E: 57° 54.18'), 2134 m	28/5/2010	Zoghi	HUI16933
NS 22	E: Kerman, Chahe Chaghok, 65 km to Hajiabad (N: 28° 46.52', E: 55° 49.50'), 1868 m	28/5/2010	Zoghi	HUI16932
NS 21	S: Bande Sivand, Chah Siah Mountain (N: 30° 64.39', E: 52° 55.37'), 1723 m	6/6/2010	Zoghi	HUI16931
NS 26	S: Fars, Marvdasht toward Sivand (N: 29° 57.24', E: 52° 54.1'), 1625 m	6/6/2010	Zoghi	HUI16936
NS 32	W: Mashhad, 130 km to Torbat e Heydarieh	21/6/2010	Zoghi	HUI16942
NS 34	C: Semnan to Shahrod, Nekarman Village	21/6/2010	Zoghi	HUI16944
NS 31	E: Khorasan, 10 km to Gonabad	23/6/2010	Zoghi	HUI16941
NS 33	C: Damghan toward Shahroud, 20 km to Shahroud	23/6/2010	Zoghi	HUI16943
NM11	W: Sanandaj, 15 km to Kamyaran (N: 34° 12.458', E: 47° 48.02'), 1415 m	24/6/2010	Zoghi	HUI16954

Table 1. Continued

Population Code	Location	Date	Collected by	Herbarium number
NM 10	W: Kamyaran toward Sanandaj, 45 km to Sanandaj (N: 34° 56.326', E: 46° 57.254'), 1611 m	24/6/2010	Zoghi	HUI16953
NM 8	W: Kamyaran toward Sanandaj, 20 km to Sanandaj (N: 35° 5.655', E: 46° 56.07'), 1370 m	24/6/2010	Zoghi	HUI16951
NM 6	W: Sanandaj toward Saghez, 165 km to Saghez (N: 36° 52.965', E: 49° 21.193'), 1619 m	24/6/2010	Zoghi	HUI16949
NM 4	W: Sanandaj toward Divandarreh, 45 km to Divandarreh (N: 33° 11.843', E: 50° 02.543'), 1645 m	24/6/2010	Zoghi	HUI16947
NM 2	W: Piranshahr, 15 km toward Mirabad (N: 35° 33.989', E: 47° 8.430'), 1355 m	24/6/2010	Zoghi	HUI16945
NM 9	W: Sardasht (N: 35° 33.989', E: 47° 8.403'), 1360 m	24/6/2010	Zoghi	HUI16952
NM 7	W: Sanandaj toward Divandarreh (N: 35° 33.991' E: 47° 8.43'), 1700 m	24/6/2010	Zoghi	HUI16950
NM 1	W: Oshnavieh toward Uromieh, 20 <sup>th</sup> km (N: 36° 56.43', E: 45° 10.443'), 1650 m	24/6/2010	Zoghi	HUI16944
NM 3	W: Around of Uromieh lake (N: 38° 0.476', E: 45° 5.956'), 1288 m	25/6/2010	Zoghi	HUI16946
NM 5	C: Damavand city, Islamic Azad University campus, 1900 m	27/6/2010	Naderi	HUI16948
NM 15	W: Fars, Shiraz, Sadra town	24/4/2010	Zoghi	HUI16958
NM 12	E: Kerman, Dehbakri toward Bam (N: 29° 32.76', E: 57° 54.189'), 2134 m	25/4/2010	Zoghi	HUI16955
NM 14	S: Fars, Shiraz toward Kazeran, 45 km to Kazeran (N: 29° 31.4', E: 51° 58.175'), 1651 m	24/4/2010	Zoghi	HUI16957
NM 13	S: Bande Sivand, Chahe Siah Mountain (N: 30° 64.39', E: 52° 55.37'), 1723 m	24/6/2010	Zoghi	HUI16956

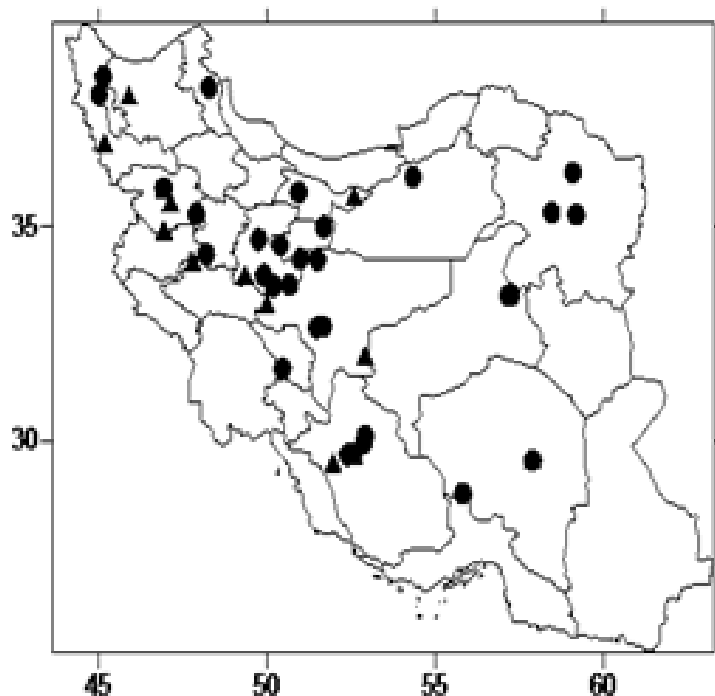


Fig. 1. Distribution of species previously treated as *Nardurus* in Iran. *Lolium subulatum* (□) and *Vulpia unilateralis* (▲) analyzed in this study.

Table 2. The evaluated qualitative and quantitative morphological characters and their character states observed in species studied. The quantitative characters were multistate.

No	Character	Character states	No	Character	Character states
<i>Qualitative characters</i>					
1	Adaxial blade surface hairs	absent present	23	Lower floret lemma tip	obtuse acute acuminate
2	Abaxial blade surface hairs	absent present	24	Lower floret lemma margins	glabrous pubescence
3	Adaxial leaf	smooth nerved ridged	25	Lower floret palea hairs	glabrous pubescence
4	Abaxial leaf	smooth nerved ridged	26	Hair on palea veins	absent present
5	Blade marginal	glabrous pubescence	27	Lower floret palea veins number	0, 1, 3
6	Blade tip shape	obtuse acute acuminate	28	Lower floret palea tip shape	obtuse acute truncate
7	Leaf ligule shape	lacinate bidentate	29	Lower floret palea margins	glabrous pubescence
8	Ligule hairs	absent, present	30	Upper floret lemma hairs	absent present
9	Pedicel hairs	absent, present	31	Hair status on lemma veins	absent present
10	Upper glume hairs	absent present	32	Number of upper floret lemma veins	1, 2, 3, 5
11	Hair status on glume veins	absent present	33	Tip shape of upper floret lemma	obtuse acute acuminate
12	Upper glume veins number	1, 2, 3	34	Upper floret lemma margins	glabrous pubescence
13	Upper glume tip shape	obtuse acute acuminate	35	Upper floret palea hairs	absent present
14	Upper glume margins	glabrous pubescent	36	Hair status of palea veins	absent present
15	Lower glume hairs	absent present	37	Upper floret palea veins number	0, 1, 3
16	Lower glume veins number	0, 1, 2, 3	38	Upper floret palea tip shape	obtuse acute truncate
17	Lower glume tip shape	obtuse acute acuminate	39	Upper floret palea margins	glabrous pubescence
18	Lower glume margins	glabrous pubescence	40	Caryopsis shape	ovate oblong elliptic
19	Rachilla	glabrous pubescence	41	Node status	smooth sulcate
20	Lower lemma hairs	glabrous pubescence	42	Angle of two glumes related to rachis	close open

Table 2. Continued

No	Character	Character states	No	Character	Character states
21	Hair status on lemmas veins	glabrous pubescence	43	Pedicel	absent present
22	Number of lower lemma veins	0, 1, 2, 3, 5			
<i>Quantitative characters; characters were multistate</i>					
44	Leaf length	mm	57	Lower glume width	mm
45	Leaf width	mm	58	Lower floret lemma length	mm
46	Inflorescence length	mm	59	Lower floret lemma width	mm
47	Plant height	cm	60	Awn long of lower floret lemma	mm
48	Inflorescence width	mm	61	Lower floret palea length	mm
49	Number of nodes	mm	62	Lower floret palea width	mm
50	Number of spikelets per inflorescence	mm	63	Upper floret lemma length	mm
51	Spikelet length	mm	64	Awn length of upper floret lemma	mm
52	Spikelet width	mm	65	Second palea length	mm
53	Number of florets per spikelet	mm	66	Upper floret palea width	mm
54	Upper glume length	mm	67	Caryopsis length	mm
55	Upper glume width	mm	68	Caryopsis width	mm
56	Lower glume length	mm			

Borbov, *Wangenheimia* Moench, *Micropyrum* Link and *Nardurus* s.s. Reichenb.). This classification was commonly accepted and followed by taxonomists in subsequent literatures. The *Nardurus* s.s. contains only one species *N. maritimus*. All the diagnostic characters of this species were applicable to the genus *Vulpia*, therefore, Stace (1978) has transferred this species to the genus *Vulpia*, under section *Nardurus* as *Vulpia unilateralis* (L.) Stace.

Parsa (1950) recognized 3 species *N. tenoiflorus* Boiss., *N. orientalis* Boiss. and *N. persicus* from Iran. All of these taxonomic names are synonym of *Nardurus maritimus* or *N. subulatus* which are growing in Iran (Bor 1970). As mentioned above, *N. maritimus* is now a synonym of *V. unilateralis* (L.) Stace and *N. subulatus* is now transferred to the monotypic genus *Lolium* as *L. subulatum* (Bank & Soland) Eig. (Stace, 1985).

The populations of *Nardurus* species are growing in different regions of Iran with a wide range of ecological conditions. The information on taxonomy and diversity of *Nardurus* species are meager and the taxonomic literatures are not modified according to the latest classifications. The monotypic genus *Lolium* grows in Iran and some neighboring countries and relationships between this genus and its relative genera such as *Vulpia* is not well documented.

In this study we aimed to revise the taxonomic status of species previously treated as *Nardurus* in Iran, evaluate the morphological and cytological variation of the species and their relationships with closely related

genus *Vulpia* and to improve the literatures according to the latest accepted classifications.

## MATERIAL AND METHODS

A total of 490 plant individuals belonging to 34 populations of *N. subulatus* and 15 populations of *N. maritimus* were collected from various regions of Iran (Fig. 1, Table 1). The samples were collected from different regions with wide range of ecological conditions to sample all possible adaptation dependent/independent variations. These were identified according to Bor (1970). Thirty herbarium specimens were also analyzed. Two species of closely related genus, *Vulpia* (*V. persica* and *V. hirtiglomis*), were also included in the analysis as controls. 68 qualitative and quantitative morphological characters were measured with special focus on the characters that are taxonomically important in the tribe *Poeae* (Table 2). The multistate quantitative characters were converted to binary states using frequency distribution

and standardizing method  $[X_s = (x - \frac{\min}{\max - \min})n]$ ; in

which  $X_s$  is standardized data,  $X$  is raw data,  $n$  is number of observations and  $\max$  and  $\min$  are maximum and minimum amount of data].

Morphological data were analyzed using NTSYS pc ver. 2.2 (Rohlf 1997). Morphological similarities among populations were calculated using different similarity coefficients. The morphological data and calculated similarity matrices were then used for

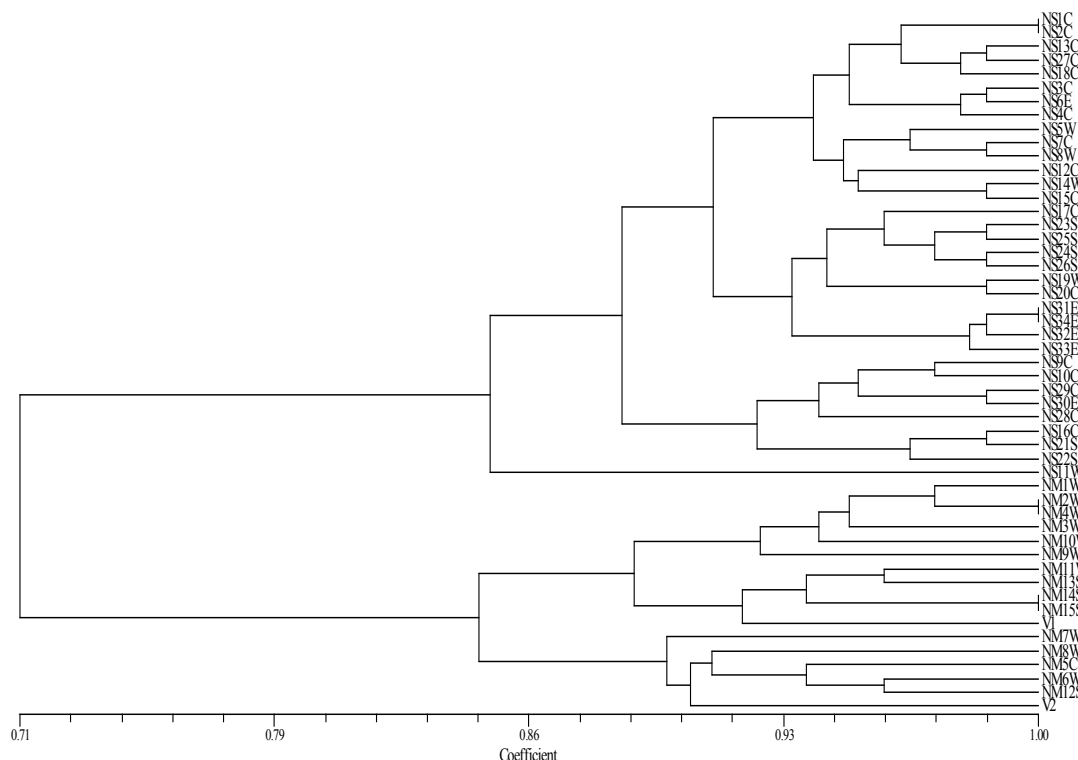


Fig. 2. A morphological similarity based UPGMA dendrogram showing relationships among 49 populations of two species previously treated as *Nardurus subulatus* (now, *Lolium subulatum*) and *N. maritimus* (now, *Vulpia unilateralis*). The population codes are provided with species names (*N. maritimus* = NM and *N. subulatus* = NS) and geographic regions (C = Center, E = East, W = West, S = South). V1 = *Vulpia persica*, V2 = *V. hirtiglomis*.

generating dendrogram showing relationships between populations and species.

In order to evaluate cytological features of the species, 7 populations belonging to two species were analyzed. Seeds were germinated in petri dish and chromosome slides were prepared from root meristems according to Aghayev (1996) method. Briefly, the 1.5-2 cm roots were placed in 1%  $\alpha$ -bromonafthalin for 4-6 h. Then the roots were transferred in fixative of Levitsky (Sharma and Sharma 1999) in fridge. Roots were washed under running water for 3 h and transferred in 70% ethanol. Root were placed for 10 min. in 1N NaOH at 60°C, stained by Hematoxylin for 24 h in 30°C and squashed on microscopic slides after 10 min. in Cellulase-Pectinase enzyme solution and visualized under light microscope.

Chromosomes were categorized according to Levan et al. (1965). Several parameters regarding the karyotypes symmetry/asymmetry such as total form percent ( $TF\% = \frac{\sum(Total\ lengths\ of\ short\ arms\ of\ chromosomes)}{\sum(Total\ chromosome\ lengths)}$ ),

Stebbins Coefficient (Stebins 1971;  $S\% = \frac{(shortest\ chromosome\ length)}{(biggest\ chromosome\ length)}$ )

Mean Chromosome Length  $\pm$  Standard Error (MCL  $\pm$  SE) and Coefficient of Variation (CV = SE/(Average of total chromosome lengths in all populations)) were calculated for each species. Details regarding karyotypes are summarized in Table 3.

## RESULTS AND DISCUSSION

Based on reviewed literatures, the genus *Nardurus* comprised no accepted taxa for the time being. The *Nardurus maritimus* is synonym of *Vulpia unilateralis* and *N. subulatus* is synonym of *Lolium subulatum*. Based on the studied specimens, *Vulpia unilateralis* grows mainly along Zagros Mountains and *Lolium subulatum* can be found in different regions of Iran with a wide range of ecological conditions. As it is observed in dendrogram (Fig. 2), the results of morphological data showed clearly separation within two species. The two species *Vulpia persica* and *V. hirtiglomis* were placed in the *V. unilateralis* (*N. maritimus*) cluster supporting the transferring of *Nardurus maritimus* to the genus *Vulpia*, subgenus *Nardurus*. Regarding high similarity between *V. unilateralis* and other species of *Vulpia* (from sect. *Vulpia*), relationships between sections *Nardurus* and



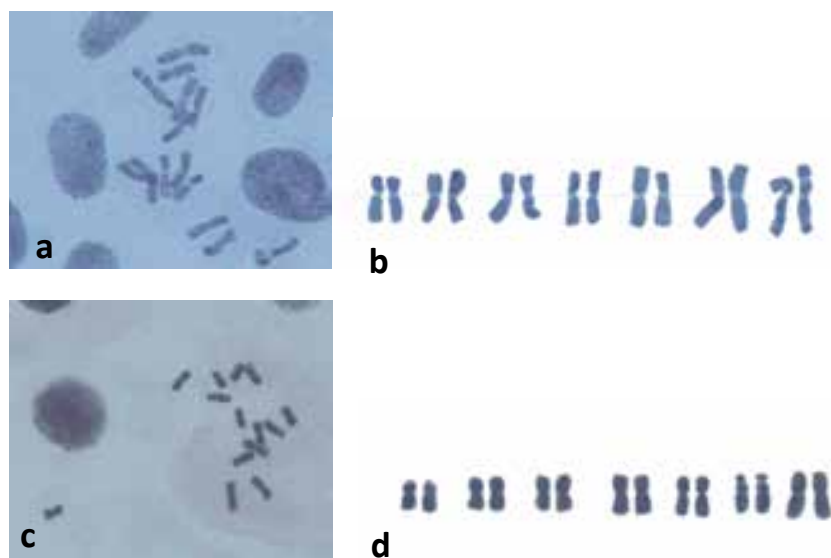


Fig. 3. Chromosome spread and Karyotype of *Vulpia unilateralis* (a, b) and *Lolium subulatum* (c, d).

*Vulpia* in the genus *Vulpia* needs to be revised. The populations of *V. unilateralis* were divided into two groups in the dendrogram, suggesting the presence of two different genotypes within Iranian populations of this species.

The results of morphological data distinguished all populations and there was no clear groupings related to the geographic regions, but some local groupings among geographically closely distributed populations were evident (Fig 2).

### Cytotaxonomy

Both species were diploid with  $2n = 2x = 14$ . No B chromosome was observed. Two satellites at the end of the short arm of one homolog chromosome pairs in both species were observed. All of the karyotype symmetry indices showed that the karyotypes of two studied species are symmetric with big and metacentric chromosomes. Only one chromosome of *Lolium subulatum* was sub-metacentric. There were no significant differences in measured karyotype parameters for both species indicating high cytological similarities between two species (Table 3 and Fig. 3).

### Morphological Characters

In this study, the following characters were taxonomically valuable: glumes sizes ratio, lemmas texture, lemmas tip (attenuate or owned), adherence of the caryopsis to the palea, hilum shape and size, presence of protruded nodes, unilateral or bilateral inflorescence, inflorescent length, spikelet length,

glume length and width, own length of first and second florets, paleas length of first and second florets, lemma and palea margins status.

### Taxonomic discussion

Based on this study, the following discussion and conclusions concerning the taxonomic status of the species formerly recognized as *Nardurus* species (*Vulpia unilateralis* and *Lolium subulatum*) in Iran can be made:

***Vulpia unilateralis* (L.) Stace** in Bot. J. Linn. Soc. 76:350 (1978). Fig. 4.

Syn: *Triticum unilaterale* L., Mant. 35 (1767); *Nardurus maritimus* (L.) Murb. in Lunds Univ. Arsskr. 2(1) 25 (1900). Ic: Proc. Bot. Soc. Brit. Is. 4:248 (1961); Hubbard «Grasses ed. 2: 164 (1968). This species was treated as *Nardurus maritimus* (L.) Murb. in Flora Iranica (Bor 1970).

Annual, herbaceous. Stems 3-45 cm high, usually single, erect or rarely ascendant. Leaf sheaths glabrous to pubescent; ligules membranous, truncate to jagged, 0.5-1 mm long; blade partly conduplicate, 1-5 cm long and 0.5 wide. Inflorescent simple or second spike-like raceme, 1-16 cm long. Rachis straight to curved; spikelets arranged at one side (unilateral), condensed, with one spikelet at each node. Spikelets pedicellate, 4-8 mm long, with 4-5 fertile florets and aborted florets at the tip, laterally condensed, separated at maturity; rachilla geniculated at the base of each floret; pedicels 0.7-1.6 mm long. Glumes unequal, shorter than

Table 3. Details regarding karyotyps of *Vulpia unilateralis* and *Lolium subulatum*. Values are provided as average. All of the chromosomes were metacentric except one chromosome of *L. subulatum* (chromosome no. 1 in Table) was sub-metacentric.

Chromosome number	TL ( $\mu$ )	L ( $\mu$ )	S ( $\mu$ )	L/S			
<i>Vulpia unilateralis</i>							
1	5.88	3.337	2.540	1.32			
2	5.98	3.589	2.381	1.51			
3	6.2	3.254	2.937	1.11			
4	6.37	3.348	3.016	1.12			
5	7.5	4.016	3.492	1.15			
6	7.15	3.734	3.409	1.10			
7	8.8	4.442	4.312	1.04			
<i>Lolium subulatum</i>							
1	3.4	2.193	1.172	1.87			
2	3.4	1.875	1.484	1.27			
3	4	2.109	1.875	1.12			
4	4.3	2.422	1.875	1.30			
5	4.3	2.656	1.641	1.60			
6	4.2	2.344	1.875	1.25			
7	5.006	2.975	2.109	1.40			
Species	2n	MCL $\pm$ SE	C.V	max TL	min TL	<b>L</b>	<b>S</b>
<i>V. unilateralis</i>	14	7.4 $\pm$ 2.05	0.3	8.95	6.4	4.1	3.22
<i>L. subulatum</i>	14	5.25 $\pm$ 1.65	0.32	6.4	4.09	2.96	2.28

spikelet; upper glume lanceolate, 3-5 mm long, 1.25 – 2 times longer than the lower glume, acute, as long as adjacent lemma, coriaceous, killed, nerves 1-3; lower glume lanceolate, 1.5-3.5 mm long, coriaceous, killed, 3 nerved. Lemma 3-5 mm long, with awn as long as or longer than lemma, sometimes  $\pm$  unawned, glabrous to pubescent.

**Distribution.** Mediterranean region, Europe, Caucasus, Southwest and Central Asia.

**Distribution in Iran.** Southeast, West, Northwest and Center (see Table 1 and Fig. 1).

***Lolium subulatum*** (Banks & Soland) Eig, J. Bot. (London) 75:189 (1937). Fig. 5.

Syn: *Triticum subulatum* Banks & Sol. In Russell & Aleppo ed. 2 :2:244(1794); *N. subulatus* (Banks & Sol.) Bor in Danks Biol. Skr. 14(4); 67 (1965). Ic; Fl. Iraq 9; t. 34 (1968). This species was treated as *N. subulatus* in Flora Iranica (Bor 1970).

Herbaceous, annual. Stems 10-20 cm high, erect. Leaf sheaths inflated; ligules hyaline, 0.5-1 mm, fimbriate to jagged or lacinate; blades partly conduplicate, 1-3 cm long, 0.5 mm wide. Inflorescence simple, unilateral,

straight or rigidly curved. Spikelets 3-6.2 mm long, partly overlapping the next higher spikelet at the same side, arranged on two sides of the rachis, fertile or sterile; fertile spikelets with 3-7 fertile florets and reduced florets at the end; rachilla brittle between fertile florets; pedicel absent or to 0.4 mm long.

Glumes similar, persistent; lower glume lanceolate-attenuate, 2.6-5.1 mm long, about  $\frac{1}{4}$  shorter than upper glume, displaced from side of spikelet to lie parallel to rachilla; upper glume lanceolate, 3-6.2 mm long, as long as adjacent lemma, not keeled, with 1-3 nerves. Lemma elliptic, 2-3 mm long, coriaceous, with 5 nerves, lateral nerves are not well visible, glabrous to scabrid, awnless or with awn to 1.5 mm long. Anthers 0.5-1 mm long, slightly exerted at anthesis. Caryopsis 1.5-2 mm long.

**Distribution.** Middle East, Iran, Afghanistan and Pakistan.

**Distribution in Iran.** This species can be found almost in all regions of Iran (see Table 1 and Fig. 1)



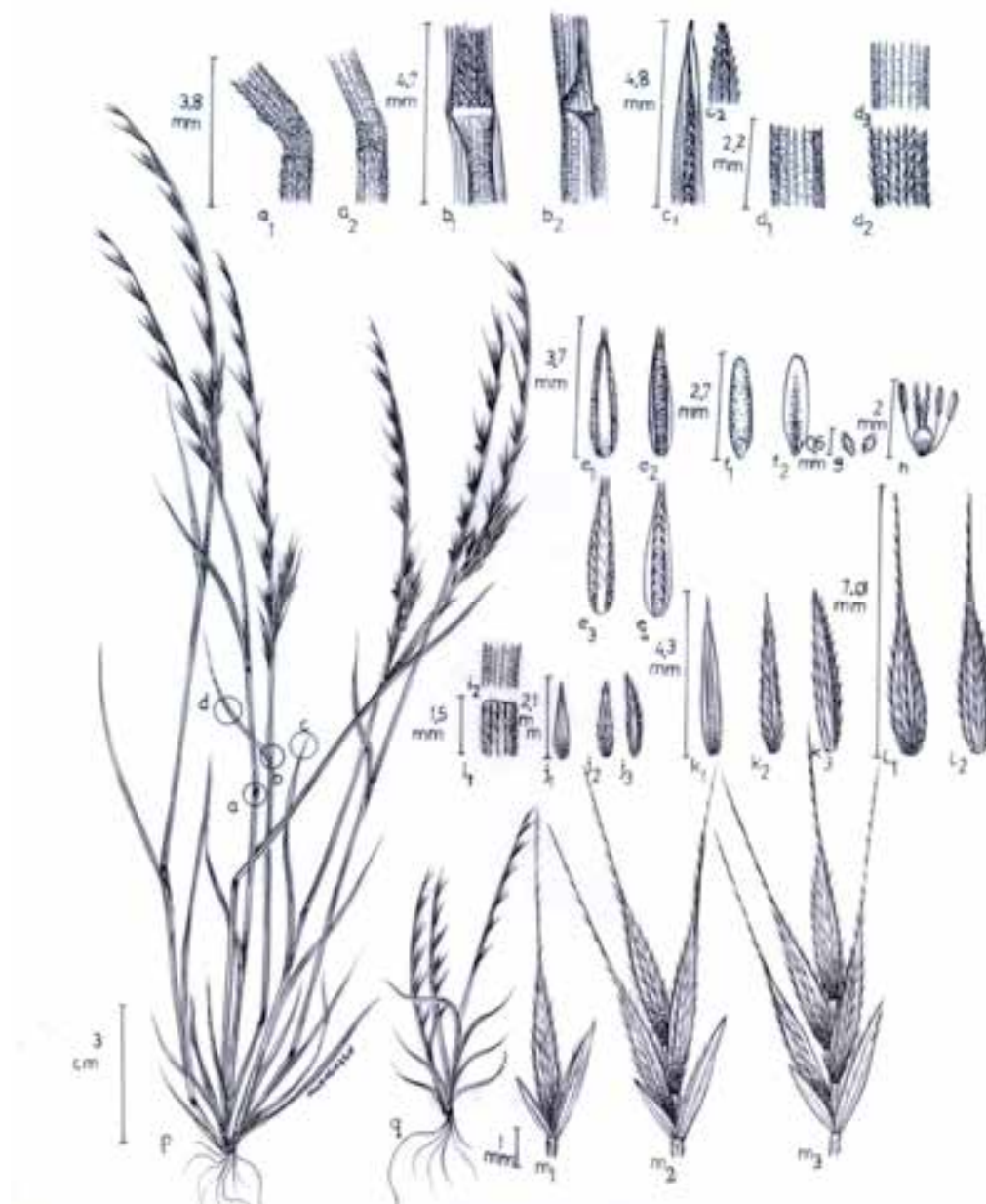


Fig. 4. *Vulpia unilateralis*. p,q: plant habit, a1,2: node, b1,2: ligule, c1,2: adaxial surface of palea, d1-3: lemma and palea, f1,2: seed, g: lodicule, h: anthers and pistil, i1,2 : rachilla, i1-3 : lower glume, k1-3: upper glume, l1,2: florete, m1-3: spikelet.

Stace (1978) transferred this species from genus *Nardurus* s. l. to the monotypic genus *Loliulum*. He has noted that this genus is superficially resemblance to *Nardurus maritimus* but with subequal glumes; obtuse to shortly acuminate, rather coriaceous lemmas; a caryopsis slightly adherent to the palea and with a short, linear hilum; and an abaxial leaf epidermis with straight-walled long-cells which are not parallel sided.

In this study, many of these characters without remarkable differences were observed in the *Vulpia* species. The abaxial leaf epidermis of *L. unilateralis* and the studied species of *Vulpia* had similar semiparallel-sided undulate-walled long-cells (Fig 6). Therefore, we propose to transfer this species to the genus *Vulpia* in a new subgenus.

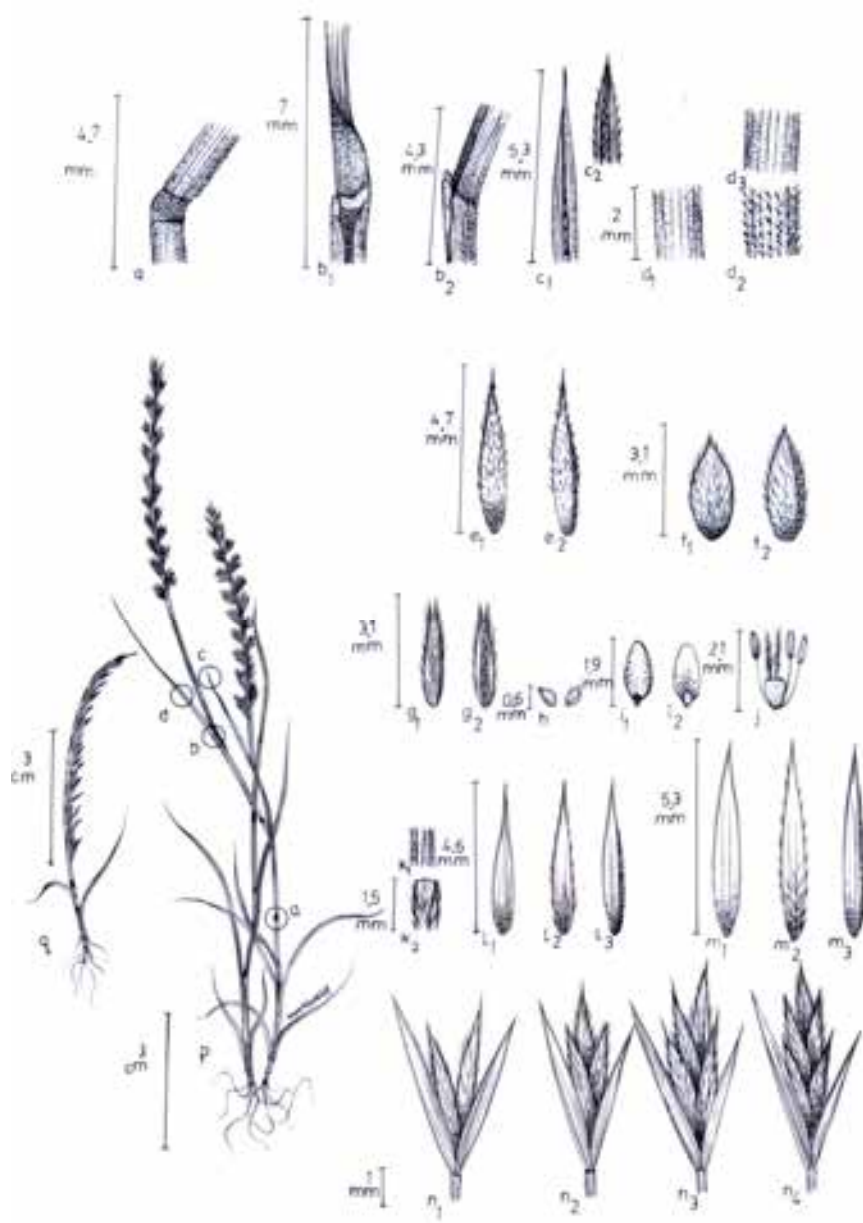
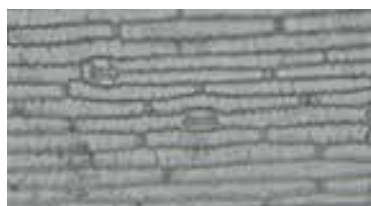


Fig 5. *Lolium subulatum*. p,q: plant habit, a: node, b1,2: ligule, c1,2: adaxial surface of lemma, d1-3: stem, e1,2: abaxial surface of lemma, f1,2: abaxial surface of lemma, g1,2: palea, h: lodicule, i1,2: seed, j: anthers and pistil, k1,2: spikelet stalk, l1-3: lower glume, m1-3: upper glume, n1-4: spikelet.



*Vulpia persica*



*Vulpia unilateralis*



*Lolium subulatum*

Fig 6. Abaxial leaf epidermis with long, semiparallel-sided and undulate-walled cells.

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