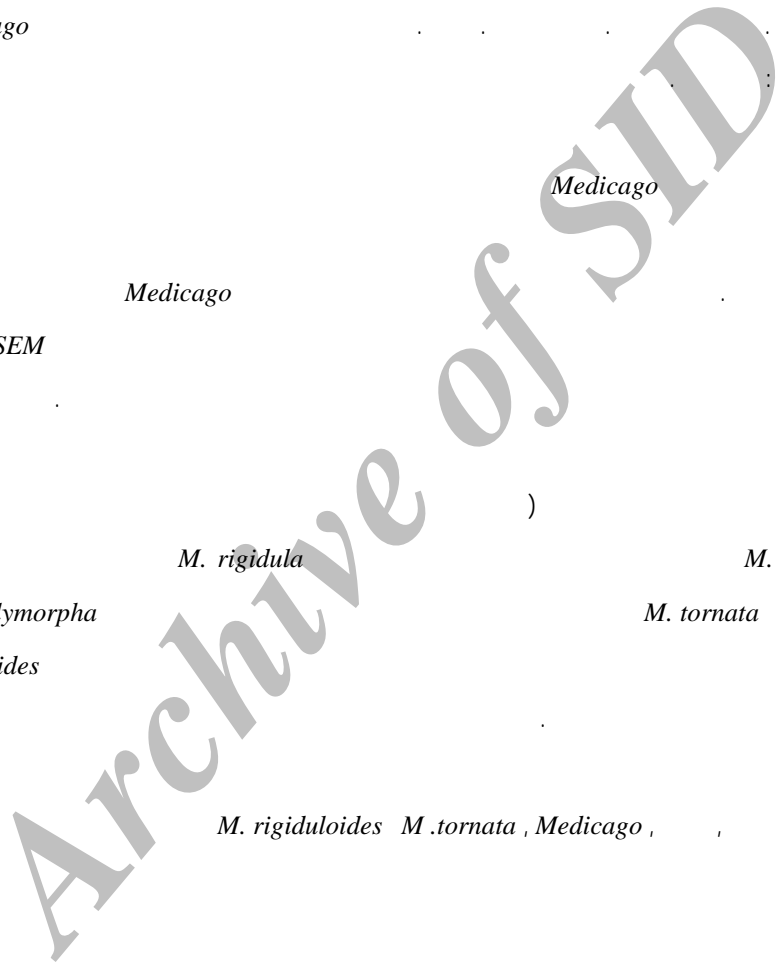


Medicago
Morphological studies of pollen grains of *Medicago* species in Iran

Medicago ()
Medicago
SEM
()
M. rigidula *M. rigiduloides*
M. polymorpha *M. tornata*
M. rigiduloides *M. tornata*
M. rigiduloides *M. tornata* , *Medicago* , :



()

(*Medicago*)

(Moore *et al.*, 1991)

(Small, 1989)

Lupularia Spirocarpos Medicago

Hymenocarpos Orbiculares

(Trizoncolporate)

(Heyn, 1963)

(Moore *et al.*, 1991)

Medicago

(Elliptic)

(Obtuse –Triangular)

(Mehregan *et al.*, 2002)

(Truncated-Triangular)

(Verrucate)

(Reticulate)

(Parsa, 1948)

(Mehregan *et al.*, 2002)

(Pori)

(Heyn, 1984)

(Moossavi, 1977)

(Apocolpium)

(Parsa, 1948; Moossavi, 1977; Heyn, 1984)

M. radiata

Trigonella radiata

(Small *et al.*, 1981)

(Parsa, 1948)

Trigonellinae

M. sativa

Medicago

M. caucasica M. sativa

M. kopetdaghi M. grandiflora

(Vassilczenkov, 1984)

(Assadi, 1989)

(Mozaffarian, 1988)

Medicago

(Moore *et al.*, 1981)

Medicago

(Mehregan *et al.*, 2002)

M. M. polymorpha M. arabica

M. lupulina minima

(Trifolium type)

M. laciniata M. rigiduloides M. rigidula

(Moore *et al.*, 1991)

M. sauvagei

(Mariani & Tavoletti, 1993)

M. noeana Boiss *M. scutellata* (L.) Mill. Gard.
M. truncatula Gaetn. *M. minima* (L.) Bartalini.
M. coronata(L.) Bartalini. *M. littoralis* Rhode
M. laciniata(L.) Mill. Gard. *M. radiata* L.
M. ciliaris (L.) Krocke. *M. arabica* (L.) Huds.
M. constricta *M. polymorpha* L. *M. lupulina* L.
M. orbicularis (L.) *M. rigidula* (L.) All. Durieu.
M. turbinata (L.) All. *M. sauvagei* Negre Bartalini
M. tornata (L.) Mill. *M. aculeata* Gaetn
M. syriaca (E. Small) *M. rigiduloides* (E. Small)

M. scutellata *M. rugosa*

(n =)

M. sativa (n =)

(n = x =)

()

M. rigidula .(Mariani and Tavoletti, 1993)

M. rigiduloides

.(Small , 1990)

Hyoscyamus L.

.()

()

Nepeta L.

Diplotaenia Bioss.

()

()

T. lasiopetalum

Terrataenium

T. nephrophyllum

Putter Coater

(*Medicago*)

x

(E)

(P)

(P/E)

M. rugosa Desr. *M. sativa* L.

Medicago

Table 1. Studied *Medicago* species and their habitats

No.	Species	Habitat
1	<i>M. laciniata</i>	† Khozestan: Seraahi Omidieh-Aghajari, 100m, Ghanavati 6228†
2	<i>M. minima</i>	Fars: Firozabaad, Cheshmeh Shah Bahram Kowar, 1700 m, Ghanavati and Safaie 6047
3	<i>M. coronata</i>	Khozestan: Omidieh, Asiab, 100m, Ghanavati 6468
4	<i>M. arabica</i>	Golestan: Agh-Ghalaa, Marzankalate, 80m, Ghanavati and Mokhtarpor 6206
5	<i>M. polymorpha</i>	Khozestan: Behbahan, Maroon's river side, 300m, Ghanavati 6234
6	<i>M. sauvagei</i>	Khozestan: Seraahi Ahvaz-Ramhormoz, 20m, Ghanavati 6333
7	<i>M. truncatula</i>	Fars: kazeron, Chenar Shahijan, 810m, Ghanavati and Safaie 6127
8	<i>M. turbinata</i>	Bosheher: Tangestan, Ahrem, 60m, Mivehchi 6152
9	<i>M. littoralis</i>	Golestan: Gonbad, Dareh Besh Aylan, 140m, Ghanavati and Mokhtarpor
10	<i>M. aculeata</i>	Kermanshah: Sarpol-e-zahab-Gilan-e-gharb, Sarab-e-garm, 700m, Ghanavati and Mirakhorli 6139
11	<i>M. constricta</i>	Kermanshah: Sarpol-e-zahab-Gilan-e-gharb, Sarab-e-garm, 700m, Ghanavati and Mirakhorli 6131
12	<i>M. rigidula</i>	Azarbaijan Gharbi: Kalibar, Peygham-Mahmod Abaad, 1470m, Ghanavati and Kanani 6199
13	<i>M. tornata</i>	Kermanshah: Biston, Najivaran, 1420m, Ghanavati and mirakhorli 6111
14	<i>M. rigiduloides</i>	Kermanshah: Islam Abaad-e-Gharb, Jozeh Anjirak, Teraazak Abdollah, 1500, Mirakhorli 6144
15	<i>M. noeana</i>	Azarbaijan Gharbi: Oshnavieh, Dareh Ghasemlo, 1500m, Ghanavati and Salimpour 6171
16	<i>M. rogusa</i>	Khozestan: Ahvaz, Hamidieh, 20m, Ghanavati 6462
17	<i>M. scutellata</i>	Bosheher: Dashtestaan, Tang-e-zard, 460m, Mivehchi 6307
18	<i>M. ciliaris</i>	Khozestan: Behbahan, Maroon's river side, 300m, Ghanavati 6343
19	<i>M. radiata</i>	Lorestan: Dorood, Dareh-e- espir, 1600m, Ghanavati and Dadfar 6087
20	<i>M. orbicularis</i>	Fars: Dasht-e- Arjan, 1910m, Ghanavati and Safaie 6018
21	<i>M. syriaca</i>	Loerstan: Khoramabaad, 1000m, Mehregan, TARI
22	<i>M. lupulina</i>	Azarbaijan Gharbi: Takab, Takhtesol iman, Lake side, 2200m, GHanavati and Hasanzadeh 6186
23	<i>M. sativa</i>	Golestan: Chaharbaagh, 1780m, Mokhtarpour 6450

†Specimen No. in National Plant Gene Bank of Iran

†

(Reticulate)

M. radiata

(a)

(Operculum)

(Mesocolpia)

/ μm

/ P/E

/ μm

/ μm

(Opercule)

(Rectangular)

()

M. tornata

M. orbicularis

(b)

(Obtuse-Triangular)

(Circular)

(Quadrangular)

()

/ μm

/ P/E

/ μm

M. polymorpha

M. noeana

() / μm

M. noeana

(Rugulate)

(c)

(Scrobiculate)

(Perforate)

(Faveolate)

/ μm

/ μm

M. lupulina

/ μm

/ P/E

/ μm

M. rugosa

M. polymorpha

/ μm

() / μm

M. noeana

μm

M. sauvagei

M. noeana

(d)

Table 2. Means of Polar and equatorial axes length, P/E ratio and fature length in *Medicago* species.

Species	Polar axis lengh (μm)	Equatorial axis lenght (μm)	Fature length (μm)	P/E ratio
<i>M. radiata</i>	24.26 \pm 0.33 [†]	35.33 \pm 0.48	21.72 \pm 0.29	0.68 \pm 0.0092
<i>M. orbicularis</i>	26.06 \pm 0.35	36.16 \pm 0.49	30.04 \pm 0.41	0.65 \pm 0.0088
<i>M. noeana</i>	32.42 \pm 0.44	44.03 \pm 0.59	35.35 \pm 0.48	0.73 \pm 0.0099
<i>M. sauvagei</i>	20.20 \pm 0.27	35.50 \pm 0.48	26.50 \pm 0.36	0.64 \pm 0.0086
<i>M. syriaca</i>	30.50 \pm 0.41	29.50 \pm 0.40	19.50 \pm 0.26	1.05 \pm 0.0142
<i>M. scutellata</i>	31.61 \pm 0.43	29.28 \pm 0.40	19.92 \pm 0.27	1.07 \pm 0.0144
<i>M. rogusa</i>	27.26 \pm 0.37	33.53 \pm 0.45	31.50 \pm 0.43	0.89 \pm 0.0120
<i>M. polymorpha</i>	19.49 \pm 0.26	19.79 \pm 0.27	16.61 \pm 0.22	0.97 \pm 0.0131
<i>M. arabica</i>	28.40 \pm 0.38	28.85 \pm 0.39	36.66 \pm 0.49	0.99 \pm 0.0134
<i>M. rigidula</i>	31.66 \pm 0.43	35.75 \pm 0.48	20.41 \pm 0.28	0.84 \pm 0.0113
<i>M. minima</i>	23.63 \pm 0.32	34.13 \pm 0.46	27.12 \pm 0.37	0.71 \pm 0.0096
<i>M. rigiduloides</i>	28.50 \pm 0.38	29.10 \pm 0.39	35.50 \pm 0.48	0.98 \pm 0.0132
<i>M. truncatula</i>	30.90 \pm 0.42	38.88 \pm 0.52	23.36 \pm 0.32	0.80 \pm 0.0108
<i>M. turbinata</i>	26.66 \pm 0.36	35.92 \pm 0.48	29.24 \pm 0.39	0.74 \pm 0.0100
<i>M. aculeata</i>	27.57 \pm 0.37	37.57 \pm 0.51	26.81 \pm 0.36	0.74 \pm 0.0100
<i>M. littoralis</i>	30.90 \pm 0.42	33.02 \pm 0.45	20.50 \pm 0.28	0.94 \pm 0.0127
<i>M. sativa</i>	27.04 \pm 0.37	33.78 \pm 0.46	28.51 \pm 0.38	0.82 \pm 0.0111
<i>M. laciniata</i>	23.02 \pm 0.31	35.37 \pm 0.48	27.88 \pm 0.38	0.65 \pm 0.0088
<i>M. constricta</i>	22.82 \pm 0.31	26.86 \pm 0.36	22.52 \pm 0.30	0.86 \pm 0.0116
<i>M. lupulina</i>	17.57 \pm 0.24	29.18 \pm 0.39	26.51 \pm 0.36	0.60 \pm 0.0081
<i>M. ciliaris</i>	31.61 \pm 0.43	32.31 \pm 0.44	20.08 \pm 0.27	0.97 \pm 0.0131
<i>M. coronata</i>	20.90 \pm 0.28	35.25 \pm 0.48	29.23 \pm 0.39	0.58 \pm 0.0078
<i>M. tornata</i>	34.33 \pm 0.46	35.04 \pm 0.47	19.99 \pm 0.27	0.92 \pm 0.0124

†, Mean of 10 samples

\pm SE

†

\pm

, / μm

/ P/E

() / μm

:

: *M. scutellata*

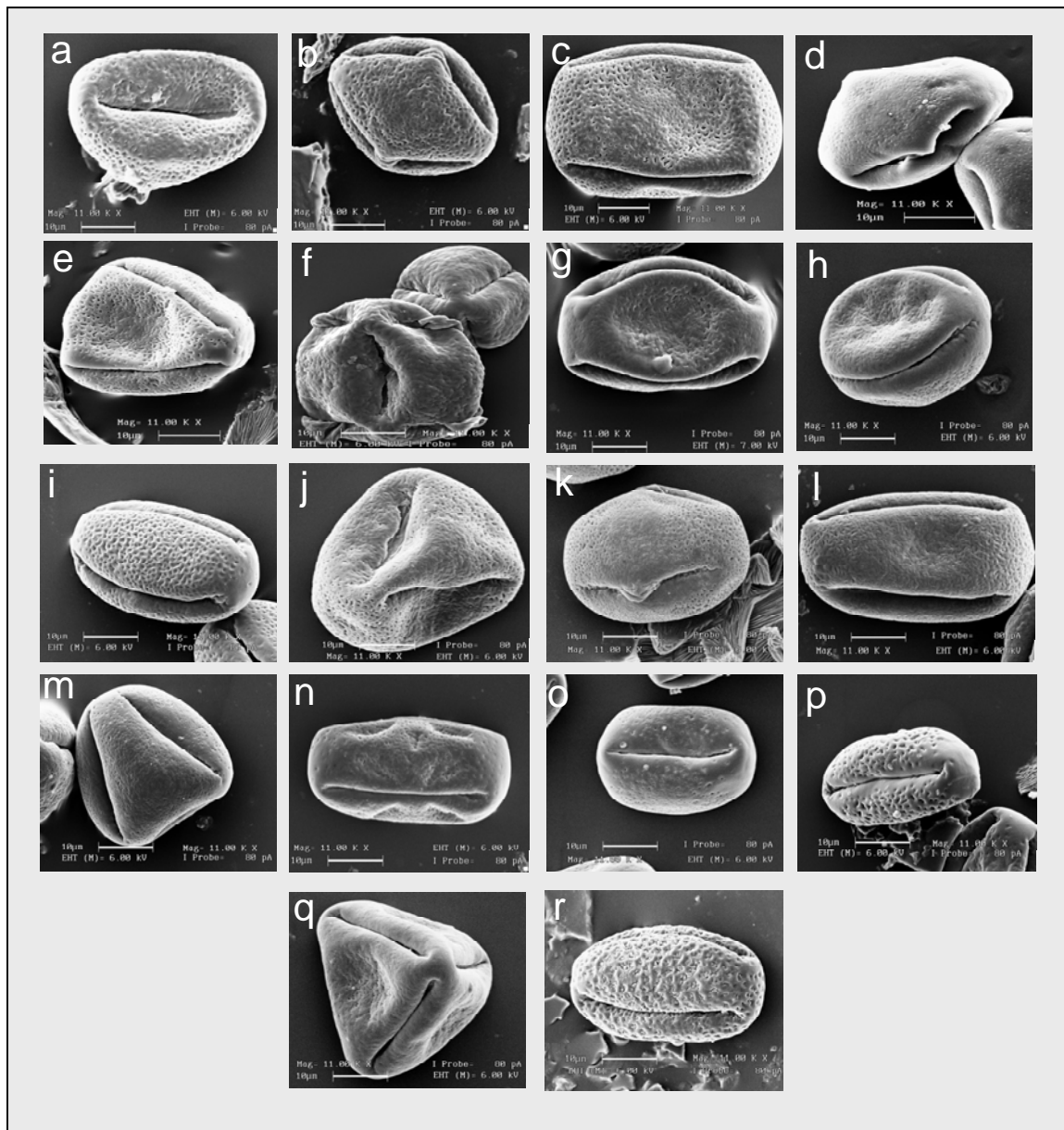
M.

: *M. syriaca*

(f) (Obulate)

(e)

syriaca



,(b) *M. orbicularis* ,(a) *M. radiata* :

,(h) *M. arabica* ,(g) *M. rugosa* ,(f) *M. scutellata* ,(e) *M. syriaca* ,(d) *M. sauvagei* ,(c) *M. noeana* ,(n) *M. laciniata* ,(m) *M. sativa* ,(l) *M. aculeate* ,(k) *M. turbinata* ,(j) *M. truncatula* ,(i) *M. minima* . (r) *M. constricta* (q) *M. ciliaris* ,(p) *M. lupulina* ,(o) *M. coronata*

Fig. 1. Photograph of pollen grains of different *Medicago* species including :*M. radiata* (a), *M. orbicularis* (b), *M. noeana* (c), *M. sauvagei* (d), *M. syriaca* (e), *M. scutellata* (f), *M. rugosa* (g), *M. arabica* (h), *M. minima* (i), *M. truncatula* (j), *M. turbinata* (k), *M. aculeate* (l), *M. sativa* (m), *M. laciniata* (n), *M. coronata* (o), *M. lupulina* (p), *M. ciliaris* (q) and *M. constricta* (r).

(c)

μm

P/E

μm

μm

() μm

P/E

μm

: *M. rugosa*

() μm

(g)

: *M. minima*

(i)

μm

P/E

μm

μm

μm

μm

P/E

()

() μm

: *M. polymorpha*

: *M. rigiduloides*

(d)

(Obtuse-Quadrangular)

()

(d)

μm

μm

μm

μm

μm

P/E

P/E

()

() μm

: *M. truncatula*

: *M. arabica*

(j)

(h) (Circular)

μm

μm

μm

P/E

μm

P/E

() μm

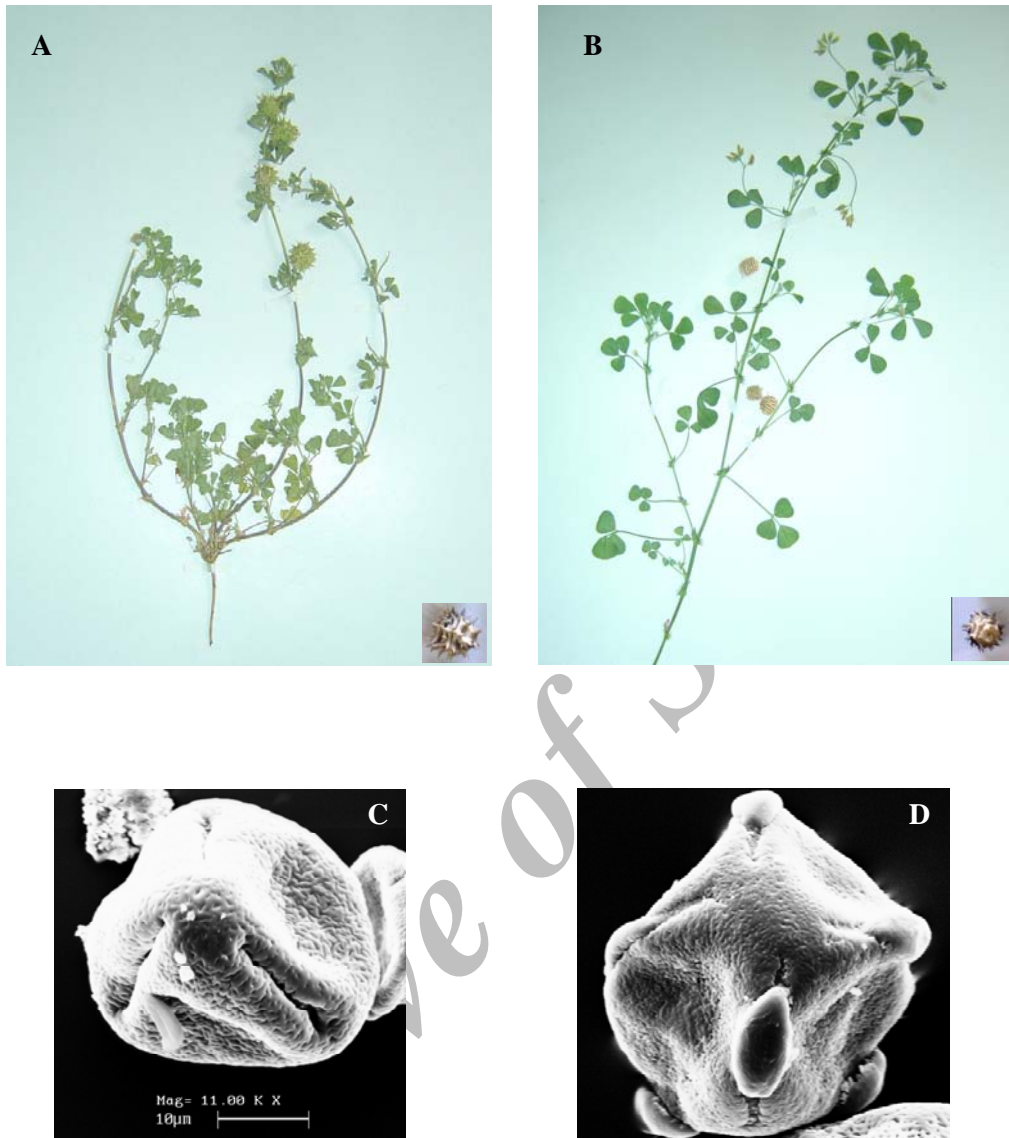
μm

: *M. turbinata*

()

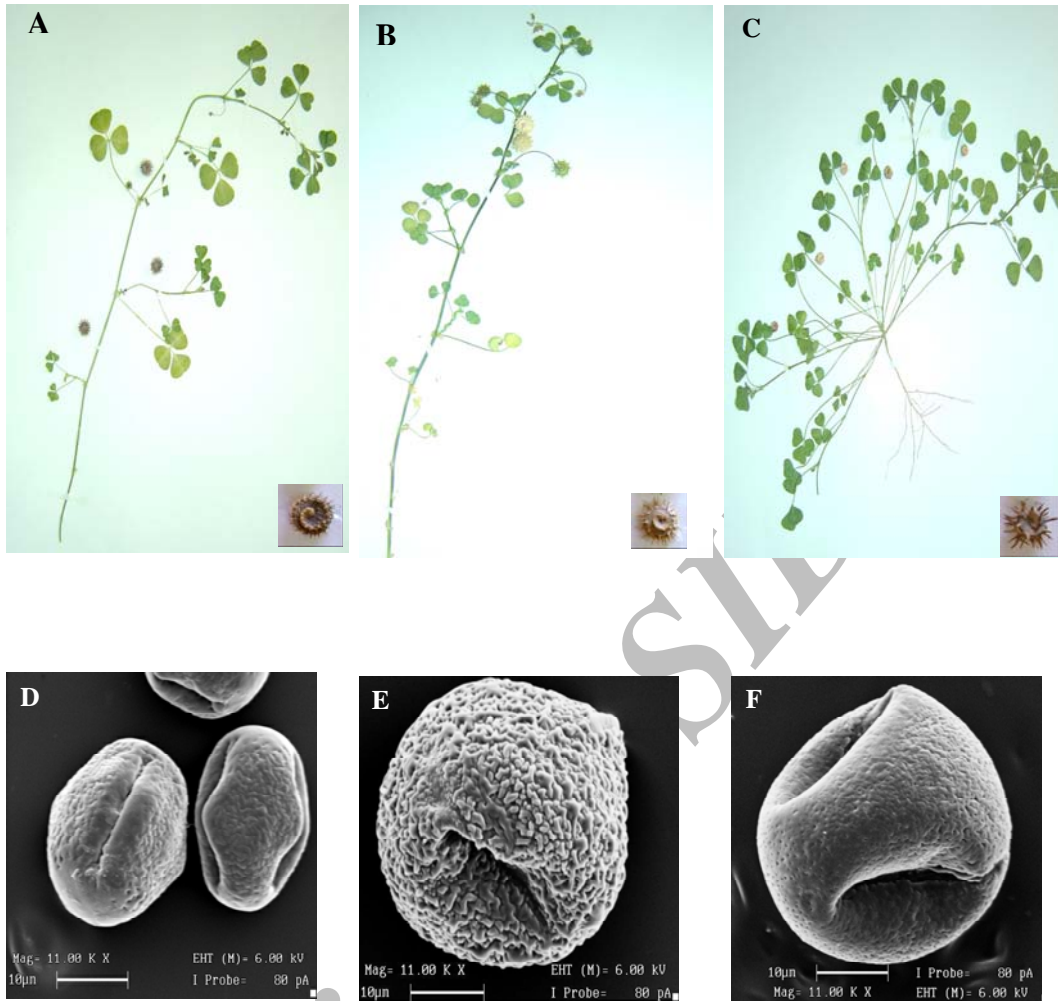
(k)

: *M. rigidula*



(B A) *M. rigiduloides* *M. rigidula*
 (D C)

Fig. 2. Plants and seeds of typical samples of *M. rigidula* and *M. rigiduloides* (A and B respectively) and their pollen grains (C and D respectively).



(C, B, A) *M. littoralis*, *M. tornata*, *M. polymorpha*
 (F, E, D)

Fig. 3. Plants and seeds of typical samples of *M. polymorpha*, *M. tornata* and *M. littoralis* (A, B and C respectively) and their pollens (D, E and F respectively).

μm / μm , / μm . / $\frac{P}{E}$ / μm
 . / $\frac{P}{E}$ () / μm : ***M. aculeata***
 : ***M. coronata*** (1) -

(o) -

(Perforale)
 μm / μm , / μm , / μm
 , / $\frac{P}{E}$, / μm / $\frac{P}{E}$, / μm
 .() / μm .() / μm : ***M. littoralis***
 : ***M. lupulina*** (p)

(f)

μm / μm , / μm , / μm
 . / $\frac{P}{E}$ / μm . / $\frac{P}{E}$ / μm
 .() / μm .() / μm : ***M. ciliaris*** : ***M. sativa***
 (q) (m)

μm / μm , / μm , / μm
 . / $\frac{P}{E}$ / μm . / $\frac{P}{E}$ / μm
 .() / μm .() / μm : ***M. constricta***

(r) -

: ***M. laciniata***

(n) -

M. rigidula
M. rigiduloides

(Small, 1990)

M. rigiduloides *M. rigidula*

M. rigiduloides

M. rigidula

M. rigidula

M. rigiduloides

M. polymorpha

M. tornata

M. littoratis

()

Nepeta L.

()

Diplotaenia Bioss.

Tetrataenium

()

T. nephrophyllum

T. lasiopetalum

M. polymorpha

M. tornata

Medicago

" "

/ μm

M. rigidula

M. rigiduloides

() / μm

P/E

/ μm

Verrucate

: *M. tornata*

(e)

/ μm

P/E

/ μm

/ μm

M. rigidula

()

Medicago

(P)

P/E

(E)

M. sauvagei

M. laciniata

M. minima

M. sauvagei

M. laciniata

M. minima

M. rigidula

M. rigiduloides

M. aculeata

M. rigiduloides

()

M. aculeata

/

M. constricta

n = ()

M. rigidula

M. rigiduloides

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Morphological studies of pollen grains of *Medicago* species in Iran

Ghanavati F¹., J. Mozaffari²., A. A. Masoumi³., Sh. Kazempour⁴

ABSTRACT

Ghanavati F., J. Mozaffari., A. A. Masoumi., Sh. Kazempour. 2007. Morphological studies of pollen grains of *Medicago* species in Iran. Iranian Journal of Crop Sciences. 9(2):184-199.

With more than 23 species of *Medicago*, Iran is one of the origins and centers of diversity of this genus. Due to close similarity in sexual organs and pod-characteristics, taxonomical classification of these species based on morphological characteristics is difficult. Scanning Electron Microscopy (SEM) was used to study the major characteristics of pollen grain among Iranian *Medicago* species. Pollen grains were mostly tricolpate, but quadricolpate or hexacolpate pollen grains were also observed in one species. The equatorial view was elliptic to rectangular or spherical shapes and the polar view was obtuse-triangular, truncate-triangular or square tips. Majority of species showed reticulate (perforate, faveolate, regulate and, scrobiculate) and verrucate exine surface. *M. rigiduloides* with quadric or hexic colpate pollen grain was barely distinguishable from *M. rigidula* with tricolpate pollen exine surface. On the other hand, *M. tornata* with its spherical pollen and verrucate exin surface was obviously different from *M. polymorpha* with rectangular pollen grain and reticulate exine surface. This is the first report of *M. rigiduloides* and *M. tornata* from Iran.

Key words: Pollen grain, *Medicago*, *M. tornata*, *M. rigiduloides*, Iran

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1- Assistant Prof., Seed and Plant Improvement Institute, Karaj, Iran (Corresponding author)

2- Associate Prof., Seed and Plant Improvement Institute, Karaj, Iran

3- Prof., Forest and Rangeland Research Institute, Tehran, Iran

4- Assistant Prof., Biology Group, Faculty of Science, Tarbiat Moddares University, Tehran, Iran