

A TAXONOMIC REVISION OF THE GENUS *MEDICAGO* L. (FABACEAE) IN IRAN

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Taxonomic aspects of the genus *Medicago* L. in Iran were studied. Among the 2500 herbarium sheets and dried fruit samples of 150 populations, 22 species and subspecies were identified. New subsection *Astrocalyx* I. Mehregan (from the section *Spirocarpos* Seringe in DC.) and new combination, *M. rigidula* subsp. *sinskieae* (Uljanova) I. Mehregan & M. R. Rahiminejad are introduced. Also, two species and one subspecies are mentioned as new records from Iran.

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Key words. Taxonomy, *Medicago*, Iran, New record, New combination.

آرایه شناسی جنس یونجه (*Medicago* L.) در ایران

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جنس یونجه (*Medicago* L.) از نظر آرایه شناسی مورد بررسی قرار گرفت. در بین نمونه‌های مطالعه شده شامل ۲۵۰۰ نمونه هرباریومی و میوه ۱۵۰ جمعیت تعداد ۲۲ گونه و زیرگونه از ایران تشخیص داده شد. زیربخش *Astrocalyx* از بخش *Spirocarpos* به عنوان زیربخش جدیدی معرفی می‌گردد. ترکیب جدید *Medicago rigidula* subsp. *sinskieae* معرفی و ۲ گونه و یک زیرگونه برای اولین بار از ایران گزارش می‌شود.

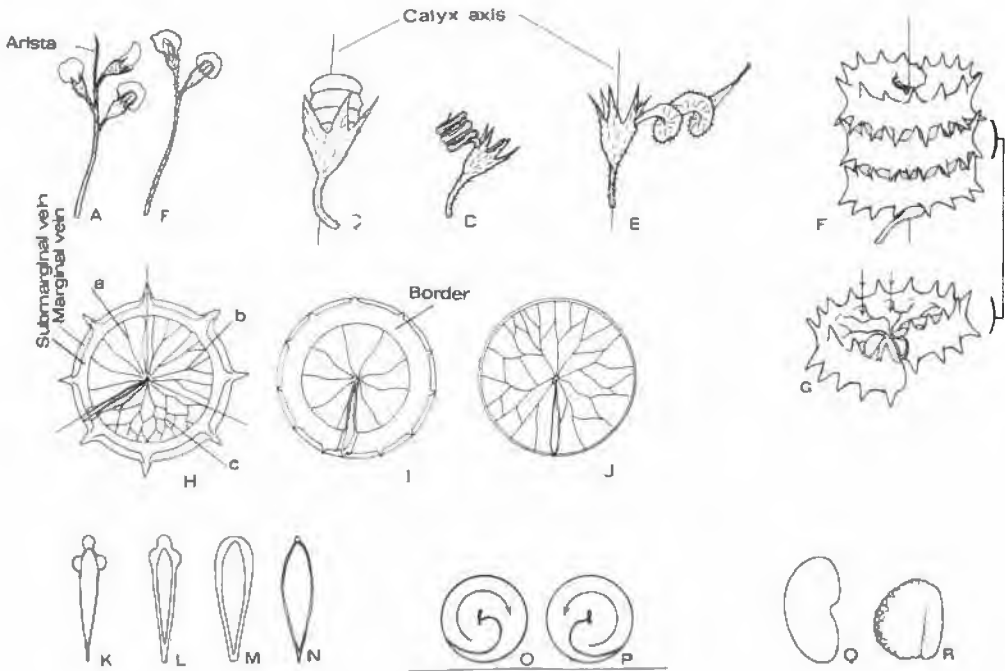


Fig. 1. Main taxonomic features of the genus *Medicago*. A. Aristate inflorescence. B. Exaristate inflorescence. C-D. Position of young pod to calyx; C. Young pod contorted and in calyx axis; D. Young pod contorted and out of calyx axis; E. Young pod in loose spiral and out of calyx axis. F. A schematic pod with 3 coils (side view) G. One coil of pod. H. -J. Venation on surface of one coil; H. Coil with marginal and submarginal veins (a. radial veins simple; b. radial veins branched; c. radial veins anastomose); I. Coil with a veinless border near submarginal vein, J. Coil without submarginal vein. K-N. Cross section of coils; K. Coil thin-walled with marginal and submarginal veins; L. Coil thick-walled with marginal and submarginal veins; M. Coil thick-walled with mixture of marginal and submarginal veins; N. Coil without submarginal vein. O. Coils clockwise. P. Coils anticlockwise. Q-R. Ratio of radicle to cotyledons in length. Q. Radicle half as long as cotyledons; R. Radicle as long as cotyledons.

Selected specimens. N: Domanchik 31364(TARI); NW: Assadi & Mozaffarian 29897(TARI); W: Pabot 29023(TARI); SW: Mozaffarian 45956 (TARI); S: Barkhordari 27807(IRAN); C: Pabot 27836(IRAN); NE:

Assadi & Mozaffarian 36127(TARI); SE: Edmondson & Miller 1621(TARI). 300-3000m. --subsp. *× varia* (Martyn) Arcangeli, Comp. Fl. Ital. 160 (1882). [Syn.: *M. × varia* Martyn; *M. hemicycla* Grossh.]

Table 1. Qualitative and quantitative observations of some characters in the studied species of *Medicago*.

	Indumentum on vegetative organs				Leaflets		Inflorescence	
	Leght of longest stem(cm)	Simple hairs	Multicellular Gland-tipped hairs	Multicellular non gland-tipped hairs	Shape	Size (mm)	Number of flowers	Length of flower (mm)
<i>M. sativa</i>	10-90	±	-	-	Oblong- obovate to linear	4-30×2-11	5-40	5-12
<i>M. rigidula</i>	5-55	+	-/+	-	Cuneate to broadly- obovate	3-12 × 3-9	1-5	4-8
<i>M. constriata</i>	5-40	+	-	-	Cuneate to obovate-orbicular	3-9×2.5-8	1-3	3.5-5
<i>M. sinskiae</i>	10-40	+	-	-	Cuneate to obovate-orbicular	3-8×3-7	1-3	4-5
<i>M. doliaata</i>	5-15	+	-	-	Cuneate to obovate	6-11×5-9	1	4-5
<i>M. littoralis</i>	5-40	+/-	-	-	Cuneate to broadly - obovate	4.5-10(15) ×3-7(12)	1-3	3-7
<i>M. truncatula</i>	25-60	+/-	-	-	Obovate to broadly - obovate	8-20×5-15	1-3	5-7
<i>M. turbinata</i>	10-65	+	-	-	Obovate to rhomboid or oblanceolate	12-30×6-15	2-8	4.5-6.5
<i>M. syriaca</i>	15-60	-	-	-	Obovate to broadly elliptic	9-20×6-17	1-4	3.5-5
<i>M. noeana</i>	10-45	+	-	-	Obovate-cuneate to obovate	8-15×4-8	1-4	5-6
<i>M. rugosa</i>	20-30	±	+/-	-	Obovate-cuneate to obovate (Obovate-obcordate)	10-18×7-14	2-7	3-4
<i>M. scutellata</i>	20-60	±	+	-	Obovate to broadly oblanceolate	10-27×5-15	1-3	6-9
<i>M. ciliaris</i>	40-55	±	-	-	Obovate-cuneate to obovate	11-25×7-18	1-4	5-7
<i>M. arabica</i>	15-60	-	-	±	Cuneate to obcordate	9-25×8-24	1-5	3-6
<i>M. polymorpha</i>	10-60	-	-	-	Cuneate to obcordate	8-25×7-23	1-10	3-6
<i>M. laciniata</i>	5-40	-/-	-	-	Cuneate to obovate (laciniate)	3-12×2-10	1-3	3-6
<i>M. minima</i>	5-55	+	-(+)	-	Obovate to narrow obovate	2.5-14×2-10	2-8	2.5-5
<i>M. coronata</i>	5-30	+	-/+	-	Cuneate to obcordate	4-12×3-10	3-15	1.5-3
<i>M. lupulina</i>	5-90	+	-/-	-	Obovate to obcordate	5-23×4-15	10-50	2-4
<i>M. orbicularis</i>	10-75	-	-	-	Cuneate to broadly -obovate (obovate rhomboid)	6-17×5-14	1-2(5)	4-5.5
<i>M. radiata</i>	10-25	+	-	-	Obovate to oblong	4-15×3-11	1-2(5)	4-6

Table 1. continued

	Fruit		Indumentum			Venation		Spines		Seed
	Simple hairs	- absent (very lax); ± medium	Multicellular hairs	Multicellular non gland-tipped hairs	Number of coils	Diameter of broadest coil (mm)	Submarginal vein	Type of radial veins	Length of spines (mm)	Size (mm)
<i>M. sativa</i>	±/-	-	-	-	1-4	3-8	-	Reticulate	-	1.2-5 × 1-1.5
<i>M. rigidula</i>	±/-	+/-	-	-	3-9	4-10	+	Anastomosing outward	0-3	2.5-4 × 1.5-2.5
<i>M. constricta</i>	-/+	-/+	-	-	4.5-8	5-7	+	Simple or anastomosing outward	0-4	3-4 × 1.5-2.5
<i>M. sinskiae</i>	+/-	+	-	-	3-4.5	5.5-8	+	Anastomosing outward	5-3.5	3-4 × 1.7-2.5
<i>M. doliaata</i>	±	+	-	-	4.5-6	6-8	+	Anastomosing outward	1-2	3.5 × 2-2.5
<i>M. littoralis</i>	-	-	-	-	3-6	4-6	+	Simple or furcated outward	5-4.5	2.5-3 × 1-1.5
<i>M. truncatula</i>	+/-	-	-	-	3.5-7	4.5-7.5	+	Simple or furcated outward	5-4.5	2.5-3.5 × 1-1.8
<i>M. turbinata</i>	-	-	-	-	3-6	5-7	+	Simple, rarely furcated outward	0-1	3-4.5 × 1.7-2.5
<i>M. syriaca</i>	-	-	-	-	3-6	4.5-5	+	Furcated outward	5-1.5	2-3.5 × 1.5-2
<i>M. noeana</i>	-	-	-	-	2-4.5	4.5-7	+	Simple or furcated	-	2.7-3.5 × 1.5-2
<i>M. rigosa</i>	±	+	-	-	2.5-4	5-10	-	Reticulate	-	3-4 × 2-2.5
<i>M. scutellata</i>	±	+	-	-	5-8	9-17	-	Reticulate	-	4.7 × 2.5-4
<i>M. ciliaris</i>	-	-/+	+	+	6-9	12-14	-	Reticulate	2-4	3-4 × 2-2.5
<i>M. arabica</i>	-	-	-	-	4-6	4.5-7	+	Strongly reticulated near submarginal vein	2-4	2.5-3 × 1-1.5
<i>M. polymorpha</i>	-	-	-	-	1.5-4	3.5-9	+	Reticulate	0-6	2-4 × 1-2
<i>M. laciniata</i>	±/-	-	-	-	2.5-7	2.5-5.5	+	simple	1-6	1.5-2.5 × 7-1.3
<i>M. minima</i>	±	-	-	-	1.5-5	2-5	+	Simple or 2-furcated	5-4.5	1.5-2.5 × 1.1-1.5
<i>M. coronata</i>	±	-/+	-	-	1.5-3	1.5-4	+	Simple or 2-furcated	5-1.5	2-2.5 × 1
<i>M. lupulina</i>	±	-/+	-	-	-	1-2.5	-	Reticulate	-	1.2-1.5 × 1-1.3
<i>M. orbicularis</i>	-	-	-	-	4-7	9-17	-	Reticulate	-	2-3 × 2-3
<i>M. radiata</i>	-/+	-	-	-	5-1.3	12-20	-	Reticulate	1-3	2.5-3 × 2-2.5

Table 2. Comparison between some characters of European, Asian and Iranian populations of *M. rigidula* s. l. (including *M. rigiduloides*)

	Europe (Small & al. 1990)	Asia (Small & al. 1990)	Iran (observed by authors)
Ends of pod (truncate – round)	more truncate	more round	truncate to round
Number of coils	mean 4.5	mean 5.5	3.5 - 9
Length of longest spines (mm)	mean 2.4	mean 1.4	0 – 3
Shape of spine	more hooked	more straight	straight to curved
Base of spines	more thin	more thick	thin to thick
Groove adjacent to marginal vein	more absent	more present	absent or present
Angle of spine to axis of pod	mean 109.8	mean 121.7	90 – 180
length of arista in inflorescence (mm)	mean 1.7	mean 2.9	2 – 6 mm

Rare medics in Iran, only recorded in NW.

Specimen seen. NW: Assadi & Olfat 68664 (TARI). 1700-2000 m.

II. Section *Spirocarpos* Seringe in DC.

i. Subsection *Pachyspirae* (Urb.) Heyn, l. c. 25 (1963).

2. *M. rigidula* (L.) All., Fl. Pedem. 1: 316 (1785). s.l.

Very variable species especially in pods. Pods very variable in form, size, number and appression of coils, form and size of spines, edge of coils and indumentum (Fig. 2, A-G). These notes also were mentioned recently by Heyn (1963). The forms cannot easily be divided into separate categories. Using 30 characters, Small & al. (1990a), compared Asian and European populations of *M. rigidula*. They found that Asian populations differed meaningfully from European populations on eight characters (seven of them were from pod characters). Small (1990) separated *M. rigiduloides* from *M. rigidula* based on previous work (Small & al. 1990a). We compared our observations of Iranian materials with the results of Small & al. (1990), and found that Iranian materials comprise both characters of Asian and European populations of the *M. rigidula* s.l. (table 2).

In addition, they made the *M. rigidula* var. *submitis* (Boiss.) Heyn, as the synonym of *M. rigiduloides*, while, the results of Heyn (1984) and this study show that all four varieties of *M. rigidula* (including type variety) occur in Iran. In fact, the study of Small & al. (1990a) represents a clinal variation in *M. rigidula* from Europe toward Asia. This kind of variation (particularly in number of coils, length and shape of spines, angle of spines to pod axis and even size of pods), is a common aspect of most species with spiny pods, and can be seen even in only one population of them (Fig. 2, F, G, I & J). Regarding this, distinction of Asian populations of *M. rigidula* and placing them in *M. rigiduloides*, does not seem to be logical, the latter species is not accepted in this study.

Based on their vegetative characters. *M. rigidula*, *M. constricta* and *M. sinskiae* are not distinguished. In addition, a continuous variation and intermediate states were observed in pod and leaf characters of the above species (Fig. 2, E & G). This is in accordance with Heyn (1963 and 1984), who reported a similarities of pod characters between *M. constricta* and part of *M. rigidula*. Also, stem and petiole anatomy of these two species are very similar (unpublished data). It

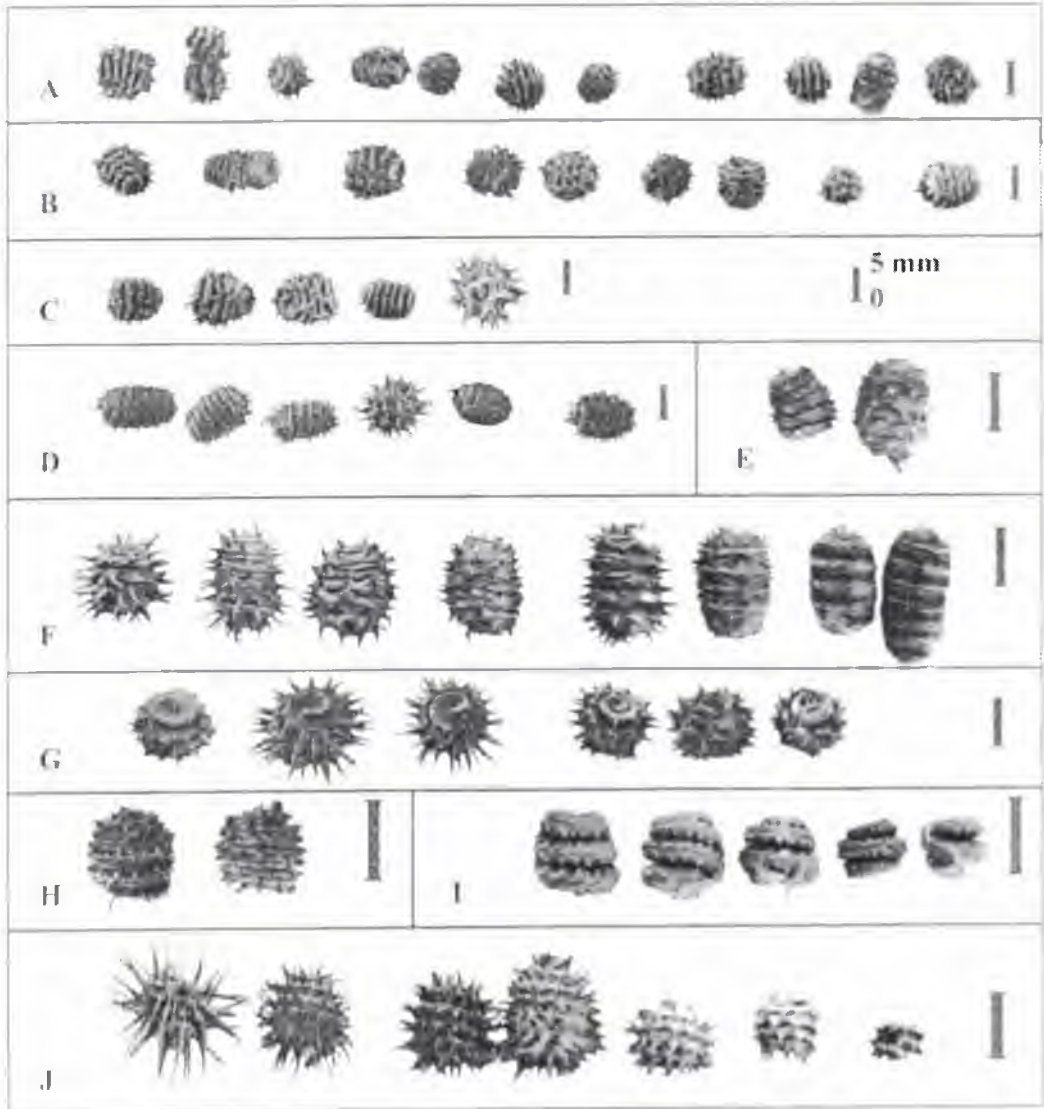


Fig. 2. Variation in pods of *Medicago* species. A-C. Different specimens of *M. rigidula*; D. Different specimens of *M. constricta*; E. Intermediate forms between *M. rigidula* and *M. constricta*; F. Variation in one population of *M. constricta*; G. Variation from *M. sinskiae* (3 pods, left) to *M. rigidula* (3 pods, right); H. Pods of *M. turbinata* (left) and *M. syriaca* (right); I. Variation in *M. noeana*; J. Variation in *M. laciniata*.

Table 3. Type of hairs in three species *M. rigidula*, *M. sinskiae* and *M. constricta*.

Species	<i>M. rigidula</i>	<i>M. sinskiae</i>	<i>M. constricta</i>
Type of hairs			
Long glandular hairs	present/absent	absent	Absent
Short glandular hairs	present/absent	present	present/absent
Simple hairs	present/absent	present/absent	present/absent
Without hairs (glabrous)	present/absent	absent	present/absent

supports opinion of Ponert (1973) about *M. constricta*.

Uljanova (1964), suggested a high similarity between *M. sinskiae* and *M. agrestis* (a synonym for *M. rigidula*). Small and Brookes (1991) have pointed out that *M. sinskiae* is likely a derived line from *M. rigidula*-*M. rigiduloides* complex. Regarding the chromosome numbers $n=7$ & 8 of *M. rigidula* s.l. (Heyn 1963 and Small et al. 1990a), and $n=8$ for *M. sinskiae* (Small and Brookes 1991) and disjunction distribution for the latter (West of Iran & South of Turkmenistan), *M. sinskiae* may be a polyphyletic taxon. Fig. 2, G shows continuous pod variation from *M. rigidula* toward *M. sinskiae*. It is also of important interest that the pod indumentum of *M. sinskiae* and that of some populations of *M. constricta* is similar (table 3). Based on the results of this study, it can be concluded that *M. sinskiae* and *M. constricta* are not separated enough to be regarded as two distinct species. They are taxonomically treated as two subspecies of *M. rigidula*.

1. Pods densely covered by long gland-tipped hairs and usually some simple hairs, rarely subglabrous or glabrous (if so, then some gaps between coils) subsp. *rigidula*
- Pods glabrescent or glabrous (if so, then no gaps between coils), or covered by lax simple hairs mixed with very short gland-tipped hairs, rarely only very short gland-tipped hairs occur 2
2. Pods discoid or shortly cylindrical, with 3-4.5 coils subsp. *sinskiae*

Pods spherical to oval or oblong, with 4.5-8 coils subsp. *constricta*
-subsp. *rigidula* [Syn.: *M. polymorpha* L. χ *rigidula* & μ *muricata* L.; *M. gerardii* Wald. & Kit. ex Willd.; *M. rigidula* subsp. *cinerescens* (Jord.) Ponert & subsp. *agrestis* (Burniat) Ponert; *M. rigiduloides* E. Small].

Very variable species in pod characters.

Selected specimens. N: Runemark & Mozaffarian 28188(TARI); NW: Moussavi & al. 27778(IRAN); W: Assadi 60391(TARI); SW: Foroughi 3207(TARI); S: Assadi & Sardabi 41617(TARI); C: Eetemadi & Movaheddian 8511(IC); NE: Assadi & Massoumi 55697(TARI). 20-3200m.

M. rigidula (L.) All. subsp. *sinskiae* (Uljanova) l. Mehregan & M. R. Rahiminejad, **stat. et comb. nov.** [Syn.: *M. sinskiae* Uljanova], Novit. Syst. Pl. Vas. Acad. Sc. URSS 1964: 175 (1964).

New record for Iran. Only spineless forms of this subspecies had been recorded from Turkmenistan (Uljanova 1964; Small & Brookes 1991). In our area, length of spines can be raised up to 3.5 mm and they are usually hooked at the apex.

W: Reihani 25165 (TARI, spineless), Mehregan 2.10 (TARI, spinose).

- subsp. *constricta* (Dur.) Ponert, Fedd. Rep. 83: 617- 644 (1973). [Syn. *M. constricta* Dur.; *M. globosa* sensu Urb.].

Variable subspecies in occurrence and shape of spines, venation on surface of coils and shape of seeds. [Fig. 2, D & F and Fig. 3, A&B].

Selected specimens. W: Reihani 25168(TARI); SW: Mehregan 7101(IUH).

3. *M. doliata* Carmign. In Giorn. Pisano 12/1 (1810). [Syn. *M. aculeata* Gaertn.]

New record for Iran.

Specimens seen. SW: Mehregan 2.13 & 2.14 (TARI).

4. *M. littoralis* Rohde ex Lois., Not. Fl. France. 118 (1810).

Variable species in vegetative and reproductive parts, and occurs in different parts of Iran. Specimens vary in size and shape of leaves, number of coils, size and shape of spines. Heyn (1984) mentioned presence of this species in Iran doubtfully. [Fig. 3, C&D].

Selected specimens N: Sharif 27600 (IRAN); S: Massoumi & Abuhamez 51924 (TARI), Pabot 29012(TARI). 0-250m.

5. *M. truncatula* Gaertn., De Fruct. et Sem. 2: 350 (1791). [Syn.: *M. tribuloides* Desr.]

Parsa (1948) reported this species sub *M. tribuloides*. Very similar to *M. littoralis*, distinguishable from it by distinct forrow between marginal and submarginal veins. Pods may be hairy (simple hairs) or quite glabrous. [Fig. 3, E & I].

Selected specimens. SW: Anonym 97(TARI); S: Mozaffarian 52122 (TARI).50-950m.

6. *M. turbinata* (L.) All., Fl. Pedem. 1: 315 (1785). [Syn.: *M. polymorpha* L. δ *turbinata* L.; *M. tuberculata* Willd.].

Very distinct species usually seen in local populations. [Fig. 2, H].

Selected specimens. W: Hatami 2270 (TARI); SW: Assadi & Abuhamez 38696 (TARI); S: Mozaffarian 49974 (TARI). 20-900m.

7. *M. syriaca* E. Small, Can. J. Bot. 68: 1473-78 (1990).

New record from SW. Iran Its pods are almost similar to *M. turbinata* in shape. The only record of out of Iran is type locality in Syria (Small 1990). Well distributed in SW Iran. [Fig. 2, H].

Specimens seen. SW: Mehregan 2.15 & 2.17(TARI); Telvari 372 (TARI). 20-800m.

ii. Subsection **Astrocalyx** I. Mehregan, **subject. nov.**

Herbae annuae. Calyx in basi leguminis maturities distincte accrescenti, membranaceus, astroformis. Leguminis spirae crassiusculae, nec spinosae, nec pubescentes; superficies radialiter semel vel furcate venosae, nec anastomosae; marginum plicum elevatae obliquae, versus venas submarginales sensim crassiores. Monotypic. (Typus. *Medicago noeana* Boiss.)

8. *M. noeana* Boiss., Diagn. Pl. Or. Nov. Ser. 2, 2: 10 (1856).

Range of the variation in this species is very limited. [Fig. 2, I].

Selected specimens. NW: Forghandoust 36205(TARI); W: Anonym 43467 (TARI), Hamzee 946(TARI). 1200-2000m.

Morphological observations of this study did not show a close relationship between *M. noeana* and the rest of the subsection *Rotatae*. Using cluster analysis, based on 79 characters, a close relationship between *M. noeana* and the subsection *Pachyspirae*, and its distance from the subsection *Rotatae* was shown (Mehregan & al. 2001). Anatomical studies on the genus (unpublished data) confirmed distinction of *M. noeana* from both subsections *Rotatae* and *Pachyspirae*. Anatomical studies on *Medicago* spp. in Iran showed that number of vascular bundles in the subsections *Rotatae* and *Pachyspirae* are often 12 and 11 respectively, while, that of *M. noeana* is usually 14.

Heyn (1963), based on several important characters (Table 4), divided the section *Spirocarpos* into 4 subsections, which was more or less accepted by Small and Jomphe (1989).

It can be concluded from the table 4, that except for the subsection *Rotatae*, other

subsections belonging to the section *Spirocarpos* are almost fixed on their state of characters.

Distribution of some of the most significant characters among the species belonging to the subsection *Rotatae*, indicates that *M. rugosa*, *M. scutellata* and *M. blancheana* have many character states in common. Permanent multicellular gland-tipped hairs on the vegetative organs, to be unique trait for the subsection *Rotatae*. Occasional presence of glandular hairs, might be a defense role against herbivores (Small 1985b, Goertzen and Small 1993). Presence or absence of submarginal vein, is also an important character which was used as a diagnostic character at the subgenus level by Tutin (1968). Based on the gland-tipped hairs on the vegetative organs, pod indumentum, shape of calyx in mature pod, presence of the submarginal vein and venation of pod surface, *M. noeana* is quite distinct species from the above three species. In addition, *M. noeana* is distinguishable from *M. rotata*, based on presence of the spines on the pod, shape of calyx in mature pod and venation of pod surface pods.

M. shepardii Post (a limited endemic to S. Turkey), that has been transferred to the subsection *Rotatae* (Small and Jomphe 1989), is indeed a closely relative of *M. rotata*.

Despite apparent distance between *M. blancheana* and *M. rotata*, these two species are in fact closely related making a pair-species complex; an idea that was suggested by Small (1984). As a result, it can be concluded that *M. noeana* is distinguishable from all species of the subsection *Rotatae* in its shape of calyx in mature pod and venation of pod surface and separated from all species of the subsection *Pachyspirae* based on the shape of calyx in mature pod and specific model in edge of coils. The star-like and expanded calyx on the pod's base at maturity is a unique character which is observed exclusively in *M. noeana*.

Tab 4. : Comparison between important characters in the subsections of the section *Spirocarpos* (from Heyn 1963, Small and Jomphe 1989) with *M. noeana* (*except *M. shepardii* with contorted-outside young pods).

	Pod hardness	Coil appression	Spine type	Submarginal vein	Seed colour	Position of young fruit to calyx	Glandular hairs on vegetative parts
Subsection <i>Leptospirae</i>	soft	appressed	flexible	present	yellow to brown	contorted-outside	occasional
Subsection <i>Interetiae</i>	soft	non appressed	flexible	absent	dark	non contorted-outside	absent
Subsection <i>Rotatae</i>	soft/hard	appressed/ non appressed	irregular and short/ absent	present/ absent	yellow to brown	contorted-outside, non contorted-outside,	often permanent
Subsection <i>Pachyspirae</i>	hard	appressed	inflexible	present	yellow to brown	contorted-inside* contorted-inside	occasional
<i>M. noeana</i>	hard	appressed	absent	present	yellow to brown	contorted-inside	absent

Based on the above discussion, it can be concluded that *M. noeana* belongs to a distinct subsection

iii. Subsection *Rotatae* (Urb.) Heyn, l. c. 24 (1963).

9. *M. rugosa* Desr., Lam. Encycl. Meth. Bot. 3: 632 (1792).

Very rare in Iran, only collected from Ahvaz. First were recorded by Mozaffarian (1988).

Specimens seen. SW: Hoveizeh 54(TARI). 30m.

10. *M. scutellata* (L.) Mill., Gard. Dict. Ed. 8 no. 2 (1768). [Syn.: *M. polymorpha* L. β *scutellata* L.].

In fact, spontaneous and subspontaneous specimens of *M. scutellata* are originally escaped from the fields.

Selected specimens. N: Moussavi & Ghaedi 8757(IC); W: Ebrahimi 27840 (IRAN); SW: Mehregan 99064 (SBU). 50-800m.

iv. Subsection *Intertextae* (Urb.) Heyn, l.c. 26 (1963).

11. *M. ciliaris* Krucker, Fl. Siles. 2, 2: 244 (1790). [Syn. *M. polymorpha* L. θ *ciliaris* L.; *M. intertextae* (L.) Mill. var. *ciliaris* (L.) Heyn.]

Rare species in Iran. First was reported by Mozaffarian (1988).

Specimens seen. SW: Mozaffarian 58837 (TARI); Dastgheib, without number (IRAN).300-800m.

v. Subsection *Leptospirae* (Urb.) Heyn, l.c. 25 (1963).

12. *M. arabica* (L.) Huds., Fl. Angl. 288 (1762). [Syn. : *M. polymorpha* L. ϵ *arabica* L.; *M. maculata* Willd.].

Selected specimens. N: Mehregan 29128(IRAN); Mozaffarian & Nowrouzi 34845(TARI).600-1300m.

13. *M. polymorpha* L., Sp. Pl. 779 (1753). [Syn.: *M. nigra* Krock; *M. hispida* J. Gaertn.; *M. denticulata* Willd.].

Very common species in N, W, SW, S & SE.

Selected specimens. N: Sabeti 6304(TARI); NW: Mehregan population no. 19(SUH); W: Sharif 27719(IRAN); SW: 38640 Assadi & Abouhamzeh (TARI); S: Pabot 29009 (TARI); SE: Runemark et al. 22353 (TARI).

14. *M. laciniata* (L.) Mill., Gard. Dict. Ed.8 no. 5 (1768). [Syn.: *M. polymorpha* L. v *laciniata* L.; *M. laciniata* (L.) Mill. β *brachyacantha* Boiss.; *M. aschersoniana* Urb.].

Species very common in SW, S & SE. From West to East, usually size of pods, length of spines and ratio of peduncle to subtending petiole are reduced. [Fig. 2, J and Fig. 3, F&H].

Selected specimens. W: Foroughi 3254(TARI); SW: Pabot 29029(TARI); S: Mozaffarian 63558 (TARI); SE: Mozaffarian 43058(TARI).0-2000m.

15. *M. minima* (L.) Bart., Cat. Piant. Siena 61 (1776).[Syn.: *M. polymorpha* L. λ *minima* L.; *M. polymorpha* L. ι *hirsuta* L.].

Very common in N, NW, W, SW and parts of S.

Selected specimens. N: Gauba 27646 (IRAN); NW: Pabot 27674(IRAN); W: Iranshahr 27659(IRAN); SW: Zayri 27649 (IRAN); S: Runemark & Mozaffarian 27176(TARI); C: Iranshahr 27656 (IRAN).-20-2200m.

16. *M. coronata* (L.) Bart., Cat. Piant. Siena 61 (1776). [Syn.: *M. polymorpha* L. η *coronata* L.].

Rarely, specimens with just gland-tipped hairs can be seen.

Selected specimens. W: Reihani 25145 (TARI); SW: Assadi & Abuhamzeh 38966(TARI); S: Assadi & Sardabi 41746(TARI); C: Nowrouzi 4492(IC); SE: Rechingner et al. 27545(IRAN). 300-2000m.

III. Section *Lupularia* Seringe in DC.

17. *M. lupulina* L., Sp. Pl. 779 (1753).

Common species in high altitudes especially in wet conditions.

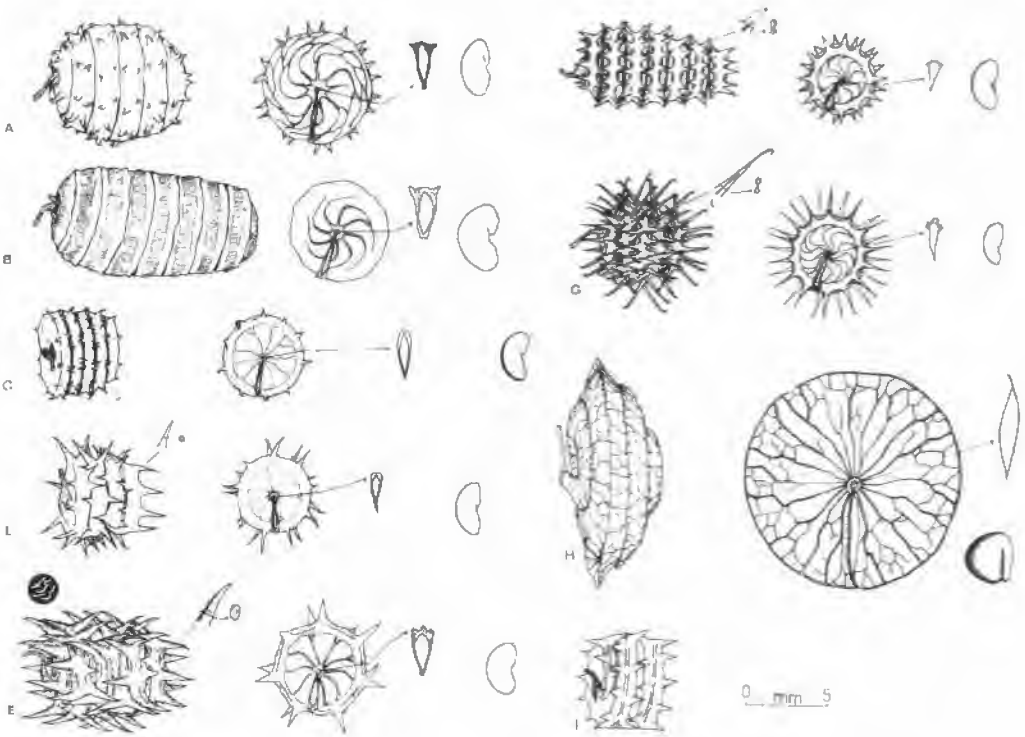


Fig. 3. *Medicago* fruits and seeds. A & B. *M. constricta*; C&D. *M. littoralis*; E&I. *M. truncatula*; F&G. *M. laciniata*; H. *M. orbicularis*.

Selected specimens. N: Rentz & Iranshahr 27638 (TARI); NW: Assadi & al. 68497 (TARI); W: Pabot 29027 (TARI); S: Mozaffarian 44768 (TARI); C: Janighorban & Shams 11505 (ICH); NE: Mozaffarian 48841 (TARI); SE: Mozaffarian 53253 (TARI).500-3500m.

IV. Section *Orbiculares* Urb.

18. *M. orbicularis* (L.) Bart., Cat. Piant. Siena: 60 (1776). [Syn.: *M. polymorpha* L. α *orbicularis* L.].

Common species in N, W & SW. [Fig. 3, H].

Selected specimens. N: Sabeti 6302(TARI); NW: Assadi & Massoumi 20387(TARI); W: Haatami 2006(TARI); SW: Assadi & Abuhamzeh 38631 (TARI); S: Mozaffarian 63682 (TARI); C: Manouchehri 27705 (IRAN); NE: Anonym 27702(TARI).20-2000 m.

V. Section *Hymenocarpos* Seringe in DC. [Syn.: Section *Medicago* sensu Heyn].

19. *M. radiata* L., Sp. Pl. 778 (1753). [Syn.: *Pocockia radiata* (L.) Trautv.; *Trigonella radiata* (L.) Boiss.].

Specimens seen. N: Assadi & Massoumi 55424 (TARI); NW: Massoumi & Abuhamzeh 57008 (TARI); W: Sharafi 32279 (TARI); SW: Mozaffarian 62525 (TARI); S: Assadi & Sardabi 41503 (TARI); C: Nowrouzi 4499(IC); NE: Pabot 29093 (IRAN); SE: 27760 (IRAN). 20-2600m.

Key to the species

1- Pod achene-like, with one seed

M. lupulina

- Pod contorted, reniform or falcate, often with more than one seed 2

2- Perennial. Flowers often blue 1. *M. sativa*

- Annual. Flowers always yellow 3
3- Pod without a submarginal vein parallel to the marginal vein (better observation in young pods) 4

- Pod with a submarginal vein parallel to the marginal vein 8

4- Surface of seeds smooth. Radicle about half as long as cotyledons 5

- Surface of seeds warty or rugose. Radicle as long as cotyledons 7

5- Margin of coils spiny. Seeds dark

11. *M. ciliaris*

- Margin of coils not spiny. Seeds yellow to brown 6

6- Pod somewhat spherical; coils pelviform-imbriate 10. *M. scutellata*

- Pod discoid; coils flat 9. *M. rugosa*

7- Pod with 0.5 - 1.5 coils. Surface of seeds rugose 19. *M. radiata*

- Pod with more than 3 coils. Surface of seeds warty 18. *M. orbicularis*

8- Upper surface of leaflets glabrous or subglabrous 9

- Upper surface of leaflets manifestly hairy 12

9- Margin of coils with 4 ridges and 3 grooves alternating; lateral grooves between marginal and submarginal veins, deeper than central which is on the marginal vein. Multicellular-eglandulose hairs present on the plant (at least peduncle)

12. *M. arabica*

- Margin of coils without a groove on marginal vein, with two grooves between marginal and submarginal veins. Multicellular-eglandulose hairs absent 10

10- Radial veins ending to a veinless and slightly elevated border adjacent to the submarginal vein; border about 0.2 – 0.3 as wide as the radius of coil. Lower surface of leaflets usually asymmetric, pubescence

7. *M. syriaca*

- Radial veins directly ending to the submarginal vein; veinless border absent. Lower surface of leaflets symmetrically pubescence or glabrous 11

11- Radial veins numerous, toward the margin of coil or at least near it strongly elevated and clearly anastomosing 13. *M. polymorpha*

- Radial veins simple or 2-furcated, never anastomosing 14. *M. laciniata*
- 12- Margin of coils with oblique elevations becoming thicker from marginal vein toward the submarginal vein. Calyx in mature pods star-like and expanded on the base of pod 8. *M. noeana*
- Margin of coil without oblique elevations. Calyx in mature pods not expanded and not star-like 13
- 13- Very young pods (immediately after petals falling) in calyx axis; mature pods usually thick-walled and quite hard; coils inflexible 14
- Very young pods out of calyx axis, protruding sideways from calyx; mature pods usually thin-walled and soft; Coils flexible 19
- 14- Radial veins straight or slightly curved, ending to a veinless and slightly elevated border adjacent the submarginal vein; border about one third as wide as the radius of coil. Subtending leaves of upper peduncles usually with rhomboid leaflets 6. *M. turbinata*
- Radial veins straight to strongly curved, ending to a submarginal vein (if no, radial veins strongly curved and at the end are obscure). Subtending leaves of upper peduncles usually without rhomboid leaflets 15
- 15- Gland-tipped hairs present on the pods (sometimes very short) 16
- Gland-tipped hairs on the pods absent 17
- 16- Coils usually clockwise. Radial veins strongly anastomosing near the submarginal vein 3. *M. doliata*
- Coils anticlockwise. Radial veins weakly anastomosing near the submarginal vein 2. *M. rigidula*
- 17- Radial veins strongly curved, usually anastomosing toward the margin of coils. Ends of pod rounded or truncate. Coils (in mature pods) strongly appressed to each other or with some gaps between themselves 2. *M. rigidula*

- Radial veins straight or slightly curved, not anastomose. Ends of pods truncate. Coils strongly appressed to each other 18
- 18- Margin of coils with two distinct grooves between marginal and submarginal veins. Surface of pods with simple hairs or sometimes smooth 5. *M. truncatula*
- Margin of coils as a single rounded or subacute edge, without grooves between marginal and submarginal veins. Surface of coils always smooth 4. *M. littoralis*
- 19- Marginal vein flat and truncate. Submarginal veins can not be observed from the side of the pod 16. *M. coronata*
- Marginal vein not flat, round. Submarginal veins can be observed from the side of the pod 15. *M. minima*

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