

## THE GENUS *MEDICAGO* IN IRAN: BIODIVERSITY AND VARIATION CENTERS

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### Abstract

Biodiversity of the genus *Medicago* in Iran was studied. Distribution of two perennial species *M. sativa* and *M. lupulina* mainly conforms to the mountainous regions of Iran. Among the other annual species of this genus, *M. rigidula* has the most similar distribution to the distribution of perennial species in mountainous regions. Most species of *Medicago* (apart from *M. sativa* and *M. lupulina*) are distributed in regions with Mediterranean climates. One major and two minor variation centers for the genus *Medicago* in Iran were identified. The most possible route for species to enter Iran is from the West via North Iraq.

**Keywords:** *Medicago*, biodiversity, Iran, variation center

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## Introduction

Meteorologically, Iran is exposed to four different climatic conditions: (1) cold and humid from NW, (2) warm and humid from SW, (3) cold and dry from NE and (4) warm and dry from SE. In addition, Alborz and Zagros mountains chains act as two great dams against humid flow from W, NW and N. Therefore, the center of Iran has dry conditions with two major deserts: Lut and Kavir (ADLE 1960).

The genus *Medicago* L. is one of the most important members of the flora of Iran. Apart from its importance in taxonomy, study of this genus is very important in agriculture and natural resources sciences. *Medicago* has a Mediterranean origin (HEYN 1963) and the direction of its distribution is from the West to the East. Flora of Palestine has 23 *Medicago* species (ZOHARY 1972) and Flora of Pakistan (east neighbouring country of Iran) has only 8 species (ALI 1977). The main aim of this work is to study the distribution patterns of the genus *Medicago* in Iran.

## Materials and Methods

A total number of 2500 herbarium sheets from the herbaria IRAN\*, TARI\*, TUH\*, SBUH (Herbarium of Shahid Beheshti University), IUH (Herbarium of Isfahan University) and Herbarium of Isfahan Research Center of Natural Resources, were studied. In addition, 150 fruit population samples (each sample including fruits of at least 30 individuals) were collected from the wild all over the country and examined (now, preserved in Herbarium of Shahr-e-Kord University and IUH). Identification of species was done using HEYN(1984, 1963), DAVIS & HEYN (1970), TOWNSEND (1974), SMALL & JOMPHE (1989), SMALL & BROOKES (1991) & SMALL (1990). After identification, for appointment of species biodiversity, the grid system was used, first introduced by P. H. DAVIS for the "Flora of Turkey and the East Aegean Islands", which divides the area into squares on the basis of the equal degrees of latitude and longitude. This method was later used by WAGENITZ (1986) & HEDGE (1986), and a similar method was also used by RECHINGER (1986). Taxonomic and floristic aspects of the genus *Medicago* in Iran have been discussed by MEHREGAN(2001), MEHREGAN *et al.*

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\*According to Index Herbariorum (Holmgren *et al.* (eds.) New York Botanical Garden, 1990).

(2001) and MEHREGAN & RAHIMINEJAD (in press). For comparison between distribution of *Medicago* in Iran, with Turkey and Iraq, needed information were obtained from Flora of Turkey (DAVIS & HEYN 1970) and Flora of Iraq (TOWNSEND 1974). Climatic divisions used in this work are according to ASSADI (1988) and SABETI (1969).

## Results and Discussions

In the study of plant materials, 22 species of the genus *Medicago* were identified (Tab. 1). Distributions of species are shown in Figs.1-12. Two following methods have been used for showing distributions: boundaries for species with extensive distribution and various marks for species with limited distribution or combination of them.

Two prennial species, *M. sativa* L. (alfalfa) and *M. lupulina* L. have a wide distribution mainly in high elevations of Iran (Fig. 1 and 2). These two species are well adapted to those conditions. *M. sativa* in Iran occurs with two levels of ploidy: Diploids ( $2n=16$ ) and tetraploids ( $2n=32$ ). Iran is one of the possible places for the origin of *M. sativa*. Presence of non-cultivated wild ancestor group ( $2n=16$ ) that gave rise by autopolyploidy to the tetraploid members (SMALL & JOMPHE 1989) support the previous opinion. The perennial species *M. ×varia* Martyn is a hybrid between *M. sativa* and *M. falcata* L. According to the presence of *M. falcata* in the Caucasus and Turkey and *M. sativa* in Iran, this occurrence is possible (Fig. 1).

Other species of *Medicago* in Iran are annual. *M. rigidula* (L.) All. is one of the most adapted species to Irano-Touranian region and is more variable in comparison with the other species in Iran (Fig. 3 and 15). Distribution of this species is nearly similar to those of *M. sativa* and *M. lupulina*. These three species have good resistance to the hard and cold conditions of the high mountains in Iran. Studied herbarium specimens of *M. rigidula* belong to altitudes of 20-3200m. By arrows 2-8 (Fig. 13), possible routes of the emigration of *M. rigidula* in Iran from the West is well shown. The very high mountains situated in the Iran-Turkey boundary seems to act as a natural obstacle that prevents movement of species from





Fig. 1



Fig. 2

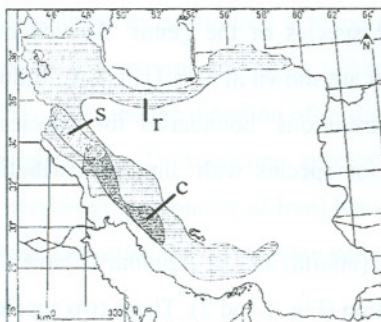


Fig. 3

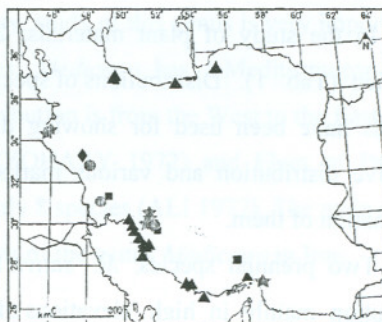


Fig. 4

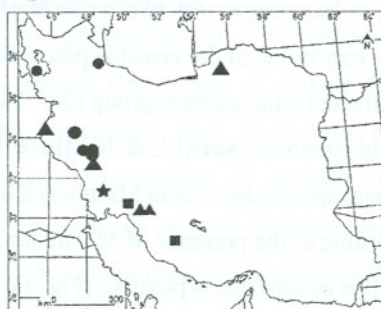


Fig. 5



Fig. 6

Fig. 1. Distribution of *M. sativa* (▨) and *M. x varia* (★) in Iran.

Fig. 2. Distribution of *M. lupulina* in Iran.

Fig. 3. Distribution of *M. rigidula* (r), *M. sinskiae* (s) and *M. constricta* (c) in Iran.

Fig. 4. Distribution of *M. doliata* (◆), *M. littoralis* (▲), *M. truncatula* (■), *M. turbinata* (★) and *M. syriaca* (●) in Iran.

Fig. 5. Distribution of *M. noeana* (●), *M. scutellata* (▲), *M. rugosa* (★) and *M. ciliaris* (■) in Iran.

Fig. 6. Distribution of *M. polymorpha* in Iran.

Turkey into Iran. *M. rigidula* may enter from another possible route, "NW" (not shown) as evidenced by the presence of *M. rigidula* varieties in this region (Azerbaijan), which differ from the other regions in Iran; Some herbarium specimens of *M. rigidula* belong to the var. *cinerscens* (Jord.) Rouy and cannot be seen in W Iran. Two related species of *M. rigidula* i.e. *M. constricta* Dur. (Fig. 15) and *M. sinskiae* Uljanova have limited distribution to Zagrosian regions (Fig. 3). The only record of *M. sinskiae* outside Iran is the report of Uljanova from the type locality, Turkmenistan (SMALL & BROOKES 1991, ULJANOVA 1964). Origin, spreading and disjunction distribution of this species is doubtful. According to SMALL & BROOKES (1991), *M. sinskiae* is a localized endemic derivative of *M. rigidula* s.l. The disjunction distribution of former, support the presence of two possible places for the origin of *M. sinskiae* from *M. rigidula*.

Among species *M. littoralis* Rohde ex Lois., *M. doliata* Carmign, *M. truncatula* Gaertn., *M. turbinata* (L.) All. and *M. syriaca* E. Small, only *M. littoralis* has a disjunction distribution. Other species usually can be found only in Zagrosian and western Saharo-Arabian phytochorions in Iran. Apart from *M. rigidula* and *M. littoralis*, other species of the subsection *pachyspirae* have a limited distribution to a narrow zone from western to southern Iran (Fig. 3, 4 & 15). This species has heavy and thick walled pods that may be one cause of their limited distribution (Fig. 15). *M. syriaca* is an endemic species to SW Asia. The only record of it, outside Iran is from the type locality in Syria (SMALL 1990). It is very likely that *M. syriaca* first originated in Iran and then migrated to the west, a possible route not shown in Fig. 13. *M. doliata* is an omni Mediterranean species and its presence in our area is surprising.

Among the subsection *Rotatae*, *M. noeana* Boiss. has a greater distribution from the others. Arrows 2, 3 and 6 (Fig. 13) show possible movement patterns of this species from the West into Iran. In fact, specimens of *M. scutellata* (L.) Mill., originally escaped from the farms and at the moment many of them have become subsontaneous. *M. rugosa* Desr. has a very limited distribution in Iran (Fig. 5), which seems to be sporadic. Two records of *M. ciliaris* Krucker are from SW Iran (Fig. 5).





Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11

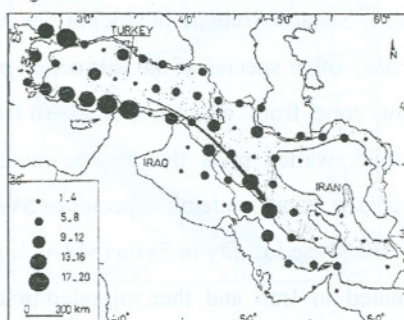


Fig. 12

Fig. 7. Distribution of *M. laciniata* (I) and *M. arabica* (★) in Iran.

Fig. 8. Distribution of *M. minima* in Iran.

Fig. 9. Distribution of *M. coronata* in Iran.

Fig. 10. Distribution of *M. orbicularis* in Iran.

Fig. 11. Distribution of *M. radiata* in Iran.

Fig. 12. Relation between distribution of *Medicago* species to geographical dimensions and elevations (shown by □ texture) in three countries Iran, Iraq and Turkey. Number of species in each 2×2 longitude and altitude shown by black circles. Black arrow shows main possible route of migration of species into Iran

*M. arabica* (L.) Huds. is an Euro-Siberian species (HELLER & HEYN 1990) that can be seen in N Iran in Hyrcanian region. The Hyrcanian region, in fact has the Euro-Siberian climate, and known by same author as a part of it (SABETI 1969). The only way *M. arabica* can enter Iran is from the North, as shown by arrow 1 (Fig. 13).

*M. laciniata* (L.) Mill. is a species well adapted to the Saharo-Sindian region (Fig.7) which has saharian and semi-saharian climates. Arrow 9 shows the only possible way that this species can enter Iran. In *M. laciniata* size, number of coils, and length of spines decreases from west to east, and in SE Iran, the only forms that can be identified are sub var. *brachyacantha* Boiss. . *M. polymorpha* L. can be seen in different parts of Iran. This species is well adapted to the Zagrosian, Saharo-Arabian and Hyrcanian phytochorions (Fig. 6), and usually cannot be seen in Irano-Touranian phytochorion. *M. minima* (L.) Bart. (Fig. 15) has a disjunction distribution in Iran (nearly like *M. polymorpha*) and can be seen in Hyrcanian, Zagrosian and northern, western and southern margins of Irano-Touranian regions (Fig. 8). *M. coronata* (L.) Bart. has a more limited distribution compared with the two earlier species (Fig. 9). Distribution of this species is very similar to *M. minima* (except in N Iran). The only specimens of *M. coronata* in N Iran are from the small city of Manjil. The main cause of the wide distribution of most species of *Medicago* is due to their spines that well attached to carriers (HEYN 1963). This feature can be seen well in the subsection *Leptospirae* with thin-walled and hooked-spiny pods, unlike the subsection *Pachyspirae* (Fig. 15). There is a similar feature seen in *M. radiata* L. (Fig. 15). *M. radiata* has a wide distribution in Iran, including the Irano-Touranian and part of the Saharo-Arabian phytochorions (Fig. 11). *M. orbicularis* (L.) Bart. has a very similar distribution to *M. minima*. (Figs. 8 & 10). Variation centers for the genus *Medicago* can be seen in different parts of Iran. The main variation center with a high concentration of species is in the SW (Fig. 13). This center is situated as a stripe between the Irano-Touranian and Saharo-Arabian regions, most of it known as a part of the Zagrosian phytochorion (ASSADI 1988). Comparing this stripe with the bioclimatic map of Iran shows that this stripe is applicable to regions with a Mediterranean climate (SABETI 1969). There are two



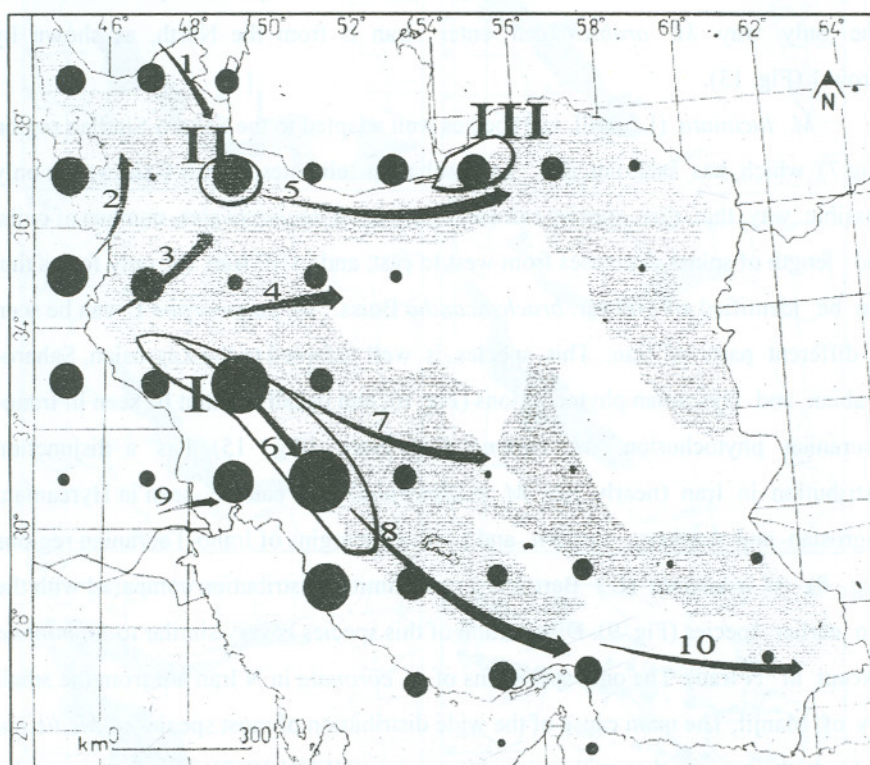


Fig. 13. Most possible routes for migration of *Medicago* species into Iran or their spreads (shown by arrows). Diameters of black circles show the number of species in each  $2 \times 2$  degrees longitude and latitude (smallest=1, biggest = 15). I, II, and III show one main and two minor variation centers, respectively.



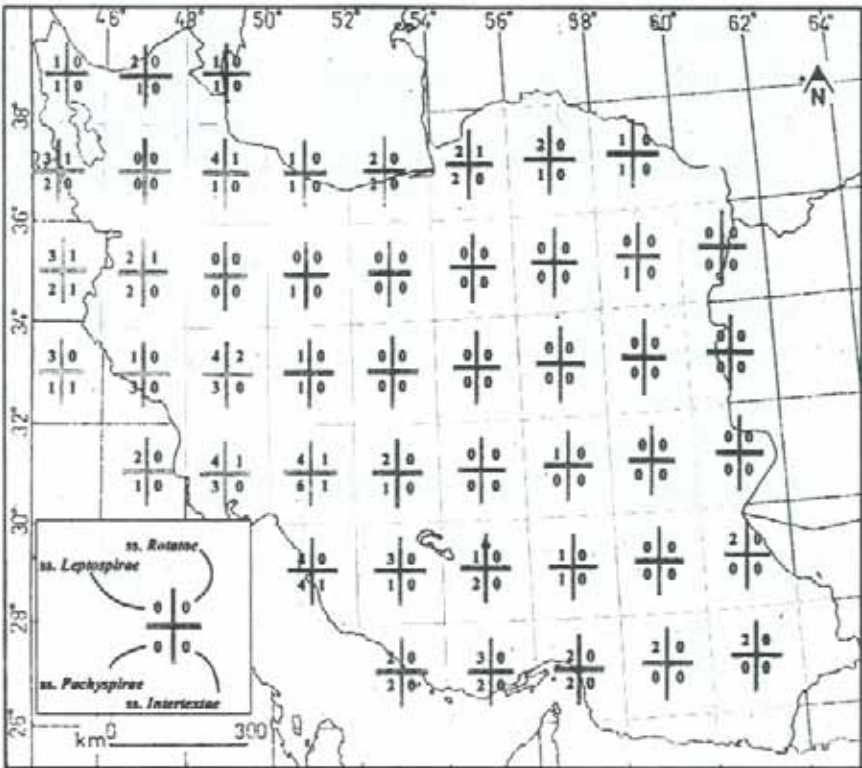


Fig. 14. Number of species belonging to the subsections *Pachyspirae*, *Rotatae*, *Leptospirae* and *Intertextae* from the section *Spirocarpos* in each 2×2 degrees longitude and altitude.

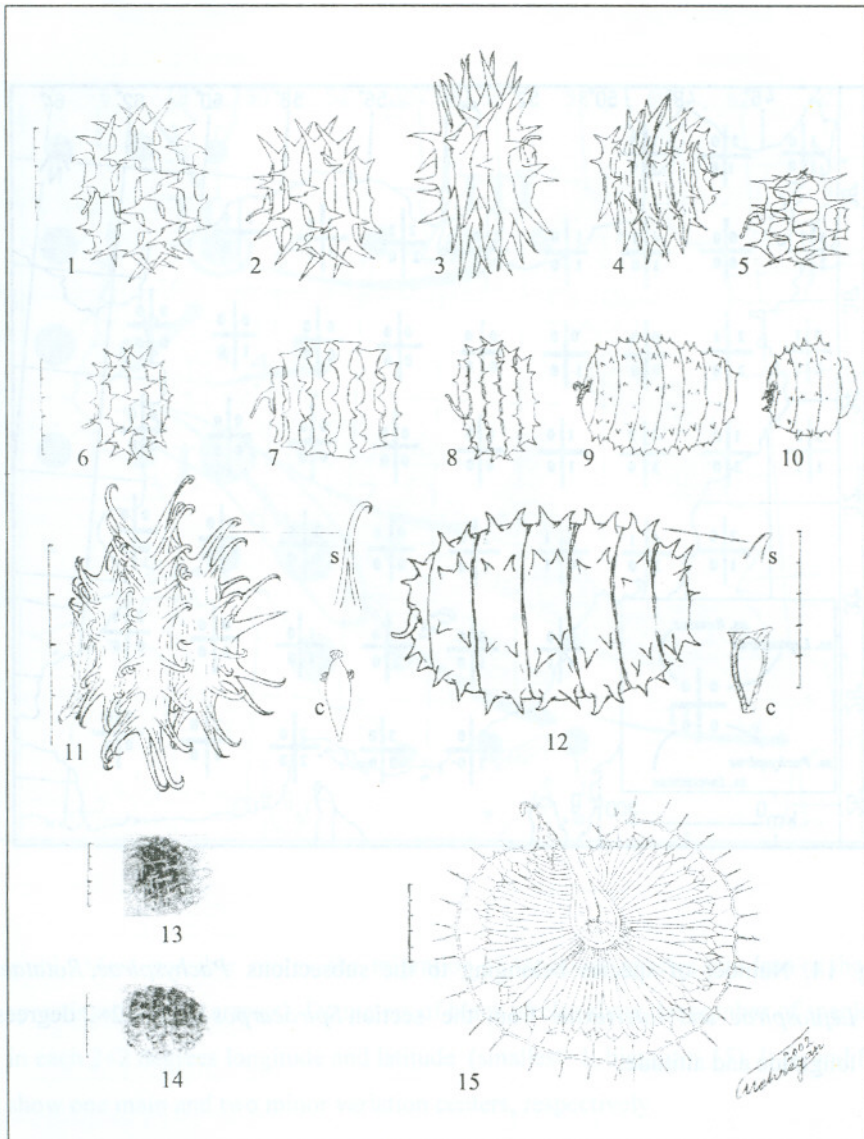


Fig. 15. Pods of *Medicago* spp. (1 - 10) Part of variation in *M. rigidula*; (11 - 14) Comparison between pods of two subsections *Leptospirae* and *Pachyspirae*, (11) *M. minima* (s. spine; c. cross section of one coil with thin walls); (12) *M. constricta* (s. spine; c. cross section of one coil with thick walls); (13) *M. arabica*; (14) *M. turbinata*; (15) *M. radiata*.



Tab. 1. List of infrageneric taxa of the genus *Medicago* in Iran

No.	Section	Subsection	Species
1	<i>Medicago</i>		<i>M. sativa</i> L.
2			<i>M. ×varia</i> Martyn
3	<i>Spirocarpos</i>	<i>Pachyspirae</i> (Urb.)	<i>M. rigidula</i> (L.) All.
	Seringe in DC.	Heyn	
4			<i>M. constricta</i> Dur.
5			<i>M. sinkiae</i> Uljanova
6			<i>M. doliata</i> Carmign
7			<i>M. littoralis</i> Rohde ex Lois.
8			<i>M. truncatula</i> Gaertn.
9			<i>M. turbinata</i> (L.) All.
10			<i>M. syriaca</i> E. Small
11		<i>Rotatae</i> (Urb.) Heyn	<i>M. noeana</i> Boiss.
12			<i>M. rugosa</i> Desr.
13			<i>M. scutellata</i> (L.) Mill.
14		<i>Intertextae</i> (Urb.)	<i>M. ciliaris</i> Krucker
		Heyn	
15		<i>Leptospirae</i> (Urb.)	<i>M. arabica</i> (L.) Huds.
		Heyn	
16			<i>M. polymorpha</i> L.
17			<i>M. laciniata</i> (L.) Mill.
18			<i>M. minima</i> (L.) Bart.
19			<i>M. coronata</i> (L.) Bart.
20	<i>Lupularia</i> Seringe in DC.		<i>M. lupulina</i> L.
21	<i>Orbiculares</i> Urb.		<i>M. orbicularis</i> (L.) Bart.
22	<i>Hymenocarpos</i> Seringe in DC.		<i>M. radiata</i> L.

minor secondary centers for variation of *Medicago* in north Iran (Fig. 13). In first view, presence of these variation centers in N Iran seems doubtful. These two minor centers are situated between Hyrcanian and Irano-Touranian phytocorions; but in fact has Mediterranean climate (Fig. 13, SABETI 1969). Regions with Mediterranean climate in Iran usually are signified by the presence of some Mediterranean elements, such as Olive (*Olea europaea* L.), Cypress (*Cupressus sempervirens* L.), Oleander (*Nerium oleander* L.) and Myrtle (*Myrtus communis* L.) (ASSADI 1988 and SABETI 1969). In fact, the distribution model of the genus *Medicago* in Iran, also supports the Mediterranean origin of this genus.

Distribution of the *Medicago* species and their relation to geographical dimensions in Iran, Turkey and Iraq are shown in Figs. 12-14. High density of *Medicago* is situated in the Coastal Mediterranean (Fig. 12). According to previous discussions and studies of the genus *Medicago* in Iran, Iraq and Turkey (Fig. 12), and with attention to the Mediterranean origin of this genus (HEYN 1963), the main route of *Medicago*'s emigration is from the west to the east via the south margin of Anatolia plateau, north Iraq and west margin of the Iranian plateau (shown by black arrow in Fig. 12). Other possible ways, such as the Iran-Turkey boundaries and the south Iran-Iraq boundaries are rejected because of very high mountains of the former and Saharian or wet conditions of the latter.

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