

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

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In a revision of the genus *Lotus* L. in Iran, the specimens of several herbaria were studied, moreover, the studies were completed in the field. Based on the studies, an identification key to the Iranian species and their selected specimens was prepared. According to the results of this study eight species within the Iranian materials of *Lotus* were recognized. Also the following changes were applied: two varieties of *L. corniculatus* L. (var. *corniculatus* and var. *tenuifolius* L.) were accepted; *L. krylovii* Schischk. & Serg. and *L. tenuis* Waldst. & Kit. ex Willd. as synonyms to *L. corniculatus* L. var. *tenuifolius* L.; three varieties including *L. corniculatus* L. subsp. *corniculatus* var. *kochii* Chrtkova-Zertova, var. *hirsutus* W. D. J. Koch and var. *brachyodon* Boiss. as synonyms of *L. corniculatus* L. var. *corniculatus* L.; *L. michauxianus* Ser. as synonym to *L. gebelia* Vent. Furthermore, no infraspecific taxa were recognized for *L. gebelia* Vent.

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Key words: *Lotus*; *Loteae*; Fabaceae; taxonomy; Iran

بررسی تاکسونومی جنس *Lotus* در ایران

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جهت بررسی تاکسونومی جنس *Lotus* در ایران نمونه‌های گیاهی هرباریوم‌های مختلف ایران مورد مطالعه قرار گرفت و جهت تکمیل مطالعات به رویشگاههای آنها مراجعه گردید. کلید شناسایی گونه‌ها به همراه مشخصات نمونه‌های انتخاب شده از هر تاکسون ارایه گردید. بر اساس نتایج ۸ گونه از جنس *Lotus* در ایران شناسایی گردید و همچنین تغییرات زیر اعمال گردید: دو واریته *var. tenuifolius* L. و *var. corniculatus* L. مترادف گونه *L. corniculatus* L. پذیرفته شد؛ گونه‌های *L. krylovii* Schischk. & Serg. و *L. tenuis* Waldst. & Kit. ex Willd. مترادف گونه *L. corniculatus* L. subsp. *corniculatus* var. *hirsutus* W. D. J. Koch قرار گرفتند؛ واریته‌های *L. corniculatus* var. *tenuifolius* L. و *L. corniculatus* L. subsp. *corniculatus* var. *kochii* Chrtkova-Zertova; J. Koch مترادف با *L. corniculatus* L. var. *corniculatus* قرار گرفتند؛ گونه *L. michauxianus* Ser. مترادف با *L. gebelia* Vent. قرار گرفت. همچنین گونه *L. gebelia* Vent. بدون هرگونه واحد تحت گونه‌ای پذیرفته شد.

INTRODUCTION

The genus *Lotus* L. (tribe *Loteae* DC., family Fabaceae) comprises approximately 183–188 species following Polhill's (1981) circumscription in the world. The main center of speciation of the Old World species (ca. 145 species) is the Mediterranean Region to the Arctic, and extending down the Nile through Ethiopia and East Africa to South Africa, Asia, Australia and

Japan. The New World species (ca. 40 species) have a wide distribution along the Pacific coast, extending from British Columbia to Mexico, Southern California and reaching the eastern United States (Arambarri 2000). The genus *Lotus* has a difficult generic delimitation, mostly due to its high morphological and biogeographical diversity. The history of the classification of the genus has been one of constant

disagreement among taxonomists, who have created subgenera, sections, subsections (Brand 1898 & Gillett 1958), and species groups (Heyn 1970 & Arambarri 1999). The genus *Lotus* is distinguished from other legume genera by the following characters: imparipinnate leaves, usually 5-foliolate. Leaflets entire, two lower ones often different in shape from the others, usually stipule like. Stipules very small or tuberculate, sometimes without stipules and umbellate axillary inflorescences subtended by three leafy bracts (Polhill & Raven 1981, Kirkbride 1999). The number of *Lotus* species growing in Iran varies according to different authors for example Mousavi (1974) reported ten species, Parsa (1948) and Chrtkova-Zertova (1984) nine species.

The aim of this study is to examine morphological characteristics of the species in details and to provide a taxonomic account of the genus in Iran for the project Flora of Iran (Assadi 1978).

MATERIALS AND METHODS

A total of 300 specimens of the genus *Lotus* collected from all around Iran and herbarium sheets from TARI, IRAN, TUH and the other specimens from herbaria in Agricultural and Natural Resources Research Centers in Iran were studied. All vouchers and type specimens are deposited in the herbarium of Agriculture and Natural Resources Research Center of Kermanshah (RANK), TARI, IRAN and some digital herbaria such as C (Museum Botanicum Hauniense, University of Copenhagen; <http://plants.jstor.org>) and CJB (Conservatoire et Jardin botaniques Ville de Geneve; <http://www.ville-ge.ch/musinfo/bd/cjb/chg/>). The morphological characters were studied in the field and the range of variations was measured directly on the specimens. Several references were used, but Flora Iranica (Chrtkova-Zertova 1984) as one of the last revisions of the genus in Iran was used as a base of studies.

RESULTS AND DISCUSSION

Taxonomic treatment

Based on the results of the present study the following characters are of taxonomic values: life cycle; indumentation; petiole of uppermost leaflet; leaflets shape; pedunculation; number of flowers; flowers length; flowers colour; calyx shape; ratio of calyx teeth to the tube. We also concluded that the genus *Lotus* occurs in Iran with a total of eight species and two varieties; a diagnostic key to these taxa has been provided and presented bellow.

Key to the species

1. Flowers with a long peduncle (6-120 mm) 2

- Flowers sessile to subsessile (0.5-1.5 mm) in the leaf axils 7
- 2. Plants perennial 3
- Plants annual or biennial 5
- 3. Flowers 7-14 mm. Leaflets linear-lanceolate, oblanceolate, obovate or ovate *L. corniculatus*
- Flowers 13-23 mm. Leaflets cuneate, rhomboid-obovate and elliptic 4
- 4. Flowers 13-23 mm, variegated white or pale pink or reddish-purple, the tips of the wings with deep crimson-pink *L. gebelia*
- Flowers 17-19 mm, uniformly pale yellow *L. aegaeus*
- 5. Indumentum mostly of appressed, more or less spreading hairs. Uppermost leaflet sessile. Flowers yellow or with red veined 6
- Indumentum sparse, scarcely conspicuous, uppermost leaflet petiolate (1-6 mm). Flowers red *L. laricus*
- 6. Calyx campanulate, calyx teeth longer than tube *L. angustissimus*
- Calyx strongly bilabiate, calyx teeth as long as or shorter than tube *L. halophilus*
- 7. Flowers 1-6. Calyx teeth as long as or shorter than tube *L. schimperii*
- Flowers 1-2. Calyx teeth 2-4 times as long as tube *L. garcinii*

Lotus corniculatus L., Sp. Pl. 2: 775 (1753).

The species is divided into two varieties.

1. Leaflets obovate to ovate, obtuse at the apex *var. corniculatus*
- Leaflets narrowly oblanceolate or linear-oblong, acute to acuminate at the apex *var. tenuifolius*

-var. *corniculatus*

Syn.: *L. corniculatus* L. subsp. *corniculatus* var. *hirsutus* W. D. J. Koch, Syn. Fl. Germ. 178 (1835); *L. corniculatus* L. subsp. *corniculatus* var. *brachyodon* Boiss., Diagn. Pl. Or. Nov. Ser. 2, 2: 21(1856); *L. corniculatus* L. subsp. *corniculatus* var. *kochii* Chrtkova-Zertova, Rozpr. Ceskosl. Akad. Ved, Rada Mat. Priř 83, 4: 36 (1973).

Selected specimens. Mazandaran, the margin of Khazar bank, Nowshahr, -25m, Amini & Jalilian 7001 RANK. - Gilan, Lahijan, 80m, Jalilian & Nemati 6001 RANK. - Gorgan, above Ziarat, 1000m, Assadi & Mozaffarian 41046 TARI; 85 km E Rudbar, 200m, Cronquist & Babakhanloo 10700 TARI. - East Azerbaijan, Sarab, Asb Froushan village, 1880m, Jalilian, Nemati & Qaderi 7013 RANK; Asalem to Khalkhal, 2150m, Wendelbo & Assadi 18427 TARI. - Kurdistan: Baneh, 2000-2200m, Iranshahr & Termeh 12397 IRAN; Kurdistan, road of Saqez to Baneh, Dolatabad village, Salavatabad pass, N. slope of the Khan pass, 2380m, Jalilian, Qaderi & Sanjabi 2015 RANK.. - Kermanshah,

85 Km from Kermanshah to Sonqor, Amroleh Mountain, Jalilian & Qaderi 3040 RANK. - Tehran, Tar lake, Sarbandan, the road of Firooz kuh, 2500m, Amini & Bazargan 19080 TARI.

var. *tenuifolius* L., Sp. Pl. 1: 776 (1753).

Syn.: *L. tenuis* Waldst. & Kit. ex Willd., Enum. Pl. Hort. Berol. 2: 797 (1809); *L. tenuifolius* (L.) Reichenb. Fl. Germ. Exs. 22: 506 (1832); *L. corniculatus* L. subsp. *frondosus* Freyn, Bull. Herb. Boiss. Ser. 2, 4: 44 (1904); *L. corniculatus* L. subsp. *tenuis* (Kit.) Briquet, Prodr. Fl. Corse 2: 335 (1913); *L. krylovii* Schischk. & Serg. in Animadvers. Syst. Herb. Univ. Tomsk. 7-8: 5 (1932); *L. frondosus* (Freyn) Kupr. Fl. URSS. 11: 295 (1945).

Selected specimens. Gorgan, the crossroad of Bandar Gaz, 40 km W. of Gorgan, Velafrā, Jalilian 7006 RANK. - Gilan, Roodbar, 200m, Jalilian & Nemati 7004 RANK; Sefid Rud, Jalilian & Nemati 7001 RANK. -East Azerbaijan. Gori Gol Lake, 1920m, Nemati & Jalilian 7010 RANK; Sarab, Asb Froushan village, 1880m, Qahremani & Imani 6840.- West Azerbaijan, ordo shahi village, near to lake, Shanaki, Heidari & Larti 201. - Khuzestan, Ahvaz, Mollasani, 30m, Nemati & Qaderi 7004 RANK.- Tehran, Karaj, kuh-e Dashteh, 2450m, Foroughi 960 TARI.

Lotus corniculatus is the most variable species and is widespread throughout the Mediterranean basin, the high mountains of eastern sub-Saharan Africa, Europe, southwestern, eastern and middle Asia and the Indian subcontinent (Kirkbride 1999). Chrtkova-Zertova (1984) distinguished three species (*L. tenuis* Waldst. & Kit. ex Willd, *L. krylovii* Schischk. & Serg. and *L. corniculatus* L.) and subspecific taxa in *Lotus corniculatus* L. including *L. corniculatus* L. subsp. *corniculatus* (with varieties including var. *corniculatus*, var. *kochii* Chrtkova-Zertova, var. *hirsutus* W. D. J. Koch and var. *brachyodon* Boiss.) and *L. corniculatus* L. subsp. *frondosus* Freyn based on the ratio of calyx teeth to calyx tube, shape and size of leaflets and color of flowers. Regarding to overlapping characters (the ratio of calyx teeth to calyx tube, size of leaflets and color of flowers), in this study based on leaflets shape, we accepted two varieties including var. *corniculatus* L. and var. *tenuifolius* L. The taxon (*tenuifolius*) was recognized by Linnaeus (1753) as a variety of *L. corniculatus*, subsequently taxonomic botanists have used it as specific rank or as an intraspecific taxon of *L. corniculatus* without establishing a consensus as to its rank. In Flora Europaea (Ball 1968) it was accepted at specific rank as part of the *L. corniculatus* group. In Flora of Turkey (Heyn 1970) and Flora of Iraq (Townsend 1974) it was presented as a variety of *L.*

corniculatus. Brand (1898) cited it in synonymy under *L. corniculatus* var. *tenuifolius* L. in his monograph of Old World *Lotus*.

2. *L. angustissimus* L., Sp. Pl. 1090 (1753).

Syn.: *L. gracilis* Waldst. & Kit., Pl. Rar. Hung. 3: 254 (1809).

Selected specimens. Gorgan, Minudasht, Wheat field, Mazaheri 20248 TARI. - Mazandaran. Nowshahr road to Sisangan National Park, Kohne sara, -20m, Jalilian & Amini 7016 RANK; Chalus, Shirzadi 6019 IRAN; Qaem shahr, Talar, Nemati & Qaderi 5200 RANK. - Gilan, Rasht, Jirandeh, Mirkamali, 6642 IRAN. - Bushehr, Dashtestan, Doroudgah, 55m, Sartavi & Gholamian 53.

L. halophilus Boiss & Sprun., Diagn. Pl. Or. ser. 1, 2: 37 (1843).

Syn.: *Lotus villosus* Forssk., Fl. Aegypt. -Arab 71 (1775) non Burm. f. (1768); *L. pusillus* Viv., Fl. Lyb. Spec. 47 (1824) non Medik (1783).

Selected specimens. Hormozgan: Tonb-e Bozorg and Tonb-e Kuchak, sea level, Assadi & Mozaffarian, 47318, TARI; Bandar Abbas to Minab, Jalabi, 10m, Jalilian, Nemati & Khosravi, 7029 RANK; Bushehr: Lavar village, hills of sand beside to sea, Jalilian & Nemati 7028 RANK; Delvar road, after Ameri, Golkheir village, 20 m, Jalilian & Nemati 7011 RANK. - Khuzistan: Hamidieh, Alvanieh village, Karkkeh Dam, 20m, Mozaffarian 53457 TARI.

L. laricus Rech. f., Aell. & Esfand., Bot. Jahrb. 75: 333 (1951).

Syn.: *L. schimperii* Steud. f. *laricus* (Rech. f., Aell. & Esfand.) Parsa, Fl. Iran. 9: (1966).

Selected specimens. Hormozgan: Bandar Abbas to Minab, Hasan Langi, Shah Moazodin, 10m, Jalilian, Khosravi & Nemati 7030 RANK; Baluchistan: Ziaratgah to Sarbaz, Ershad & Iranshahr 16364 IRAN. The two lower leaflets are usually narrowly ovate and the upper ones usually narrowly obovate. uppermost leaflet is petiolate.

L. schimperii Steud. ex Boiss. Fl. Or. 2 : 170 (1872).

Syn.: *L. ehrenbergii* Schweinf. ex Vierh., Denkschr. K. Akad. Wiss. Wien, Math. - Nat. 71: 41 (1907).

Selected specimens. Hormozgan: Bandar Abbas, 20m, Mozaffarian 58267 TARI; Bandar Abbas to Minab, Jalabi, 10m, Jalilian, Nemati & Khosravi 7023 RANK; Hasan Langi, Shah Moezoddin, 10m, Jalilian, Nemati & Khosravi 7040 RANK; the road of Bandar Moghoyeh to Charak, 12m, Jalilian & Nemati 7025 RANK.

L. garcinii DC., Prodr. 2: 212 (1825).

Syn.: *Aspalathus persica* Burm., Fl. India 155 (1768); *L. stocksii* Boiss., Fl. Or. 2: 174 (1872); *L. pumilus* Parsa, Kew Bull. 2 (1): 21. (1947); *L. sharifii* Rech. f. & Esfand., Bot. Jahrb. Syst. 75 (3): 334-335 (1951).

Selected specimens. Hormozgan: Bandar Abbas, Nakhle Nakhoda, coast of sea, 10m, Mozaffarian 45056 TARI; Bandar Moghuyeh, before Bandar Charak, 12m, Jalilian & Nemati 7027 RANK. - Bushehr: Dashtestan, Brikan village, 20m, Sartavi & Mozaffarian 254. - Baluchistan: Chabahar, Pashad Bandar Beris, 20 m, Mozaffarian 52841 TARI.

L. aegaeus Boiss. Fl. Orient. 2: 167.

Selected specimen. West Azerbaijan: ca 15 km from Piranshahr to Sardasht, 1400m, Maroofi & Karegar 8556 HKS.

Lotus aegaeus is close to *Lotus gebelia*, but differs from it by having uniformly pale yellow flowers. Flowers in *Lotus gebelia* are variegated white or pale pink with the wings with deep crimson-pink (Ball 1968 & Heyn 1970).

L. gebelia Vent., Descr. Pl. Jard. Cels. 57 (1802).

Syn.: *L. michauxianus* Ser. in DC., Prodr. 2: 211 (1825); *L. aleppicus* Boiss., Diagn. ser. 1(9): 33 (1849); *L. gebelia* Vent. var. *villosus* Boiss., Fl. Or. 2: 168 (1872); *L. gebelia* Vent. var. *hirsutissimus* (Ledeb.) Dinsm., Fl. Syr. 1: 357 (1932); *L. gebelia* Vent. var. *lanatus* Chrtkova-Zertova, Folia Geobot. Phytotax. 2: 305 (1967); *L. michauxianus* Ser. var. *glabratus* Chrtkova - Zertova, Folia Geobot. Phytotax. 2: 307 (1967).

Selected specimens. East Azerbaijan: Arasbaran protected area, between Tolo Ali and Veinagh, 1100m, Assadi & Vosoghi 24609 TARI; West Azerbaijan: between Gharah Bagh & Agh Ziarat, Bamaj kuh, 1300-1700m, Alizadeh & Ghasempoor 3359; Naghadeh, 1450m, Forughi 1615 TARI. - Kurdistan: 25 Km SE Sanandaj, above the mountain of Narran village, 2200-2600m, Assadi 60374 TARI. - Kermanshah: the road of Paveh to Desheh, 1300-1600m, Jalilian & Nemati 5558 RANK. - Tehran: the entrance of Karaj to Chalus road,

before the tunnel, 1750m, Jalilian 7025 RANK; Karaj, Kalak, 1700-1800m, Musavi 27451 IRAN; 21 Km. NW of Tehran, the road of Kan to Soleqan, 1600m, Amini & Bazargan 18492 TARI; Dashteh, 1850m, Riazi 6346 TARI.

Digital type specimens: US00090990 (Fauire 110), G00341439 (Ventenat s. n.), WAG0004571 (Kotschy 319).

Heyn (1970) accepted *L. gebelia* Vent. with three varieties that linked by some intermediate characters such as: the ratio of legume to calyx and peduncles to subtending leaf length and leaflets shape. Townsend (1974) and Chrtkova-Zertova (1984) recognized two varieties of *L. gebelia* Vent. based on the presence or absence of indumentum. Chrtkova-Zertova (1984) accepted *L. michauxianus* Ser. for the Flora of Iran that differs from *L. gebelia* Vent. based on leaflets shape, calyx and corolla length and ratio of corolla segments. The illustrations of isotype of *L. michauxianus* Ser. var. *glabratus* (US00090990; <http://plants.jstor.org>) and holotype of *L. gebelia* Vent. var. *gebelia* (G00341439; <http://www.ville-ge.ch/musinfo/bd/cjb/chg/>) and isosytype of *L. gebelia* Vent. var. *villosus* Boiss. (WAG0004571; <http://plants.jstor.org>) were observed. also the location of isotype of *L. michauxianus* Ser. (karaj region) was referred in order to reach detailed illustration about this taxon and specimens were collected and morphological characters studied. Considering the more or less overlapping mentioned characters (table 1), there is a continuous variability of most of the features in Iranian taxa. Therefore *L. michauxianus* Ser. was accepted as a synonym and within the range of *L. gebelia* Vent., as mentioned by Heyn (1970) and Townsend (1974). Furthermore the character of indumentum used by Chrtkova-zertova (1984) and Townsend (1974) and the characters of the ratio of legume to calyx length, the ratio of corolla segments and the ratio of peduncle to subtending leaf used by Heyn (1970) for distinguishing of the varieties of *L. gebelia* were found overlapping in our specimens. Then we accepted *L. gebelia* without any infraspecific taxa.

Table 1. Comparison of important morphological characters in *L. gebelia* and *L. michauxianus*

Taxa	<i>L. michauxianus</i> Ser. (Chrtkova-Zertova, 1984)	Isotype of <i>L. michauxianus</i>	<i>L. gebelia</i> Vent. (Chrtkova-Zertova, 1984)	Holotype of <i>L. gebelia</i>	This study
Leaflet shape	Cuneate	Cuneate, rhomboid, obovate	Rhomboid, obovate-rotundate	Cuneate, rhomboid, obovate, elliptic	Cuneate, rhomboid, obovate
Leaflet tip	Truncate, sinuate, abruptly apiculate	apiculate	apiculate	apiculate	Apiculate or not apiculate, truncate
Calyx length (mm)	8-11	10-11	6-9	8-10	8-10
Corolla length (mm)	15-25	22	13-17	19-20	13-23

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