

1954

Keys to Sweet Clovers (Melilotus)

Duane Isely
Iowa State College

Copyright ©1954 Iowa Academy of Science, Inc.

Follow this and additional works at: <https://scholarworks.uni.edu/pias>

Recommended Citation

Isely, Duane (1954) "Keys to Sweet Clovers (Melilotus)," *Proceedings of the Iowa Academy of Science*, 61(1), 119-131.

Available at: <https://scholarworks.uni.edu/pias/vol61/iss1/13>

This Research is brought to you for free and open access by the Iowa Academy of Science at UNI ScholarWorks. It has been accepted for inclusion in Proceedings of the Iowa Academy of Science by an authorized editor of UNI ScholarWorks. For more information, please contact scholarworks@uni.edu.

Keys to Sweet Clovers (*Melilotus*)¹

By DUANE ISELY

Melilotus is a Eurasian leguminous genus of some twenty species. Two species, *M. albus* and *officinalis*, introduced to the North American continent are now among the most important broad-leaved forages. *M. indicus* is a naturalized common weed in the southwestern United States; *M. altissimus* is locally established in the northeastern states.

During the last two decades, the sweet clovers have been under investigation at several stations with respect to the development, through plant breeding, of new and improved strains. Some of the immediate goals have been increased yield, improved forage quality, and freedom from coumarin. In this connection, investigators have felt it desirable to explore the possible reservoir of genetic material available in the related species. Limited populations of many of these species have now been introduced and are being maintained in plant introduction nurseries. The forage characteristics of these plants as well as their interfertility relationships with the cultivated species are the subjects of study in breeding programs at the present time.

On several occasions, inquiries have been made to the author with respect to sources of botanical information concerning the species of *Melilotus* and with regard to keys allowing verification of identifications. The answer: there is apparently no general treatment of the genus nor identification keys in the English language.² The most recent keys (in Latin) are provided by Schulz (1901) for the species recognized by him.

The objective of the present study has been a survey of the genus, and the treatment of all species in a series of identification keys. For the time being, taxonomic concepts of these species have, with certain specified exceptions, been accepted, "as is." Nomenclature has not been investigated.

MELILOTUS

Melilotus is a relatively small genus of the tribe Trifolieae, comprising (under our interpretation) 20 species. It is perhaps most

¹ Journal Paper No. J-2511 of the Iowa Agric. Expt. Sta. Ames, Iowa. Project No. 1073.

² An unpublished U. S. Department of Agriculture report by Martin (1940) includes keys to a number of the species.

closely related to *Trigonella* and *Medicago* from which it differs, in general appearance, in its elongated racemes, and reduced, 1—2 seeded, largely indehiscent pods.

The members of the genus comprise two relatively distinct groups. Eleven annual species are localized almost entirely with Mediterranean Europe, Asia Minor, and adjacent Africa (except for the now widespread *Melilotus indicus*). The predominantly biennial species occur throughout most of Europe as well as adjacent Asia. One species, *M. suaveolens*, typical of temperate Asia (apparently especially common in China) is rather limited in its European distribution. *Melilotus albus* and *officinalis* are now widely distributed in agricultural regions throughout the world. Schulz (l.c.) suggests that the biennial group may have originated in the arid plains of southwestern Asia, and that their widespread occurrence in Europe was brought about by man.

LITERATURE

In addition to the monographic study by Schulz, cited above, species indigenous to various regions have been treated in floristic studies, e.g. Coste (1901), Gams (1923-24), Hayek (1927), Kuznetsov (1927), Post (1932), and Clapham et.al (1952). The introduced species have received only passing attention from American botanists; they are treated in slightly greater detail by Isely (1951). Chromosome number relationships within the genus are summarized by Fryer (1930) and Senn (1938).

MATERIALS

The keys herein presented are based both on living material and herbarium specimens. Field observations were made on: (1) *Melilotus* accessions of the Regional Plant Introduction Nursery at Ames, (2) Farm Crops department trial plots, and (3) population samples grown from seed obtained from miscellaneous sources. The extensive *Melilotus* collection of the U. S. National Museum was kindly made available to the author for supplementary herbarium studies.

TAXONOMIC INTERPRETATIONS

Most of the species of *Melilotus* seem reasonably distinct. Consequently, published treatments are largely in accord as regards species delimitation.³ However, three "problem areas" require further study for clarification. Interpretations which have been employed in the keys are as follows:

³This is not true of subspecific categories. For instance, it is probable that very few present day taxonomists would accept the numerous subspecific categories of Schulz (l.c.).

(1) *Melilotus altissimus* Thuill. (Incl. *M. paluster* Schultes and *macrorrhizus* [W. K.] Pers.) This is a central European complex which has been variously recognized as 1—3 species. Morphological variation within the group is concerned primarily with trivial characteristics and is scarcely more extensive than in other biennial species. It is, therefore, regarded as a single species.

(2) *Melilotus albus* Desr. (Incl. *M. kotschyi* Schulz and *M. urbanii* Schulz) European material of *M. albus* is polymorphic in comparison to American white sweet clover strains. Possibly our cultivated varieties are primarily descended from a limited number of genetic strains in proportion to those present in the species as a whole. Some of this variability involving, in part, fruit size and shape (possibly to be correlated with the presence of one or two seeds) is difficult of interpretation.

M. kotschyi and *urbanii* of Schulz were described from limited and incomplete material. No definite determination of their relationships can be made without examining Schulz' original material. It appears probable that they fall within the limits of the *M. albus* complex.

(3) *Melilotus sulcatus* Desf., *segetalis* (Brot.) Ser., and *infestus* Guss. These species are small, Mediterranean annuals. They appear to form an intergrading series, the very distinct *M. sulcatus* and *infestus* constituting the extremes, and *M. segetalis*, a heterogeneous series of intermediates. The correlative variability of several flower, fruit, and plant characters suggests a moderately effective barrier to free genic exchange. Possibly, the typical forms are freely interfertile, but maintain a certain degree of morphological identity through partial geographic or ecological isolation, or possibly, genetic factors entirely are involved. An improved understanding of the biological relationships of these species would, obviously, facilitate their interpretation.

For the present, the three principal units comprising this complex are maintained as separate species; however, plants with a blend of *sulcatus-segetalis* or *segetalis-infestus* characters may be identifiable in only a subjective manner.

THE KEYS

The majority of the species of *Melilotus* are similar in habit, general appearance, and flower structure. Their most distinctive differences are in fruit structure. Plants with both flowers and fruit are relatively easy to determine. They may be distinguished if possessing flowers only, but greater consideration must be given to details of flower structure, the stipules, and the leaflets.

Five species of *Melilotus* are white-flowered; the remainder are yellow. This difference in flower color facilitates the easy recognition of superficially similar species. On most herbarium specimens, however, flower color is not identifiable. As a result, several of the common species are often confused, especially if they lack fruits or possess only immature fruits. For example, specimens of *M. albus* are often determined as *officinalis* or *suaveolens* or *vice versa*.

In view of the above problems, four separate keys to the species of *Melilotus* have been prepared. They are: I. Flowers and fruit present—flower color discernible. II. Flowers and fruit present—flower color not discernible. III. Fruits absent (or immature)—flower color discernible. IV. Fruits absent (or immature)—flower color not discernible. Used separately or in combination, these keys should provide a workable classification of the species under a variety of circumstances. If one is working with living, flowering and fruiting material, he would probably find Key 1 the most useful. He would elect to employ Keys II, III, or IV dependent upon the extent to which information concerning his plants was limited.

In Key 1 only, the name of the plant is followed with the most frequently employed synonyms (if any), and a generalized statement concerning its range.

I. FLOWERS AND FRUIT PRESENT—FLOWER COLOR DISCERNIBLE

1. Flowers white or tipped with blue.

2. Keel and wings blue-tipped: fruits with 5—8 longitudinal, broad, corky, ridges. *Melilotus bicolor* Boiss. and Bal. Turkey.

2. Petals entirely white; fruit not longitudinally ridged.

3. Pedicels flexuous, 3—5 mm. in length; flowers small, about 3 mm. in length. *M. wolgicus* Poir. (*M. ruthenicus* [M.B.] Ser.)

Southern Urals to southeastern Russia.

3. Pedicels 1—2 mm. long; flowers 4.5—8 mm. long.

4. Fruits irregular by reticulate-nerved, glabrous; stripules linear-lanceolate, entire. *M. albus* Desr. (*M. vulgaris* Willd., *M.*

leucanthus Koch) Eurasia, east to Tibet and China, south to Afghanistan and Arabia; now widely distributed in temperate, agricultural areas throughout the world.

4. Fruits cross-ribbed with transverse nerves predominating; young fruits hirsute or stipules lacerate.

5. Fruits with several (6—12) irregular, low cross-nerves, not hirsute; stipules lacerate.

M. speciosus Dur. Algeria, Morocco.

5. Fruits with few (3—5), conspicuous nerves (appear like elevated folds of tissue), sparsely hirsute when young; stipules not lacerate.

M. tauricus (M. B.) Ser. About eastern half of Black Sea, possibly south to Iraq.

1. Flowers yellow.

6. Nerves on pod concentrically curved; stipules usually lacerate or strongly toothed.

7. Racemes short, rarely exceeding subtending leaves; fruits acute or acuminate, large, 6—8 mm. long when mature.,

M. messanensis (L.) All. Mediterranean Europe and Africa.

7. Racemes exceeding subtending leaves; fruits obtuse, or inconspicuously apiculate, less than 6 mm. long.

8. Fruit 4—5 mm. long with 3—6 coarse ribs; flowers usually 6—7 mm. long.

M. infestus Guss. Mediterranean Europe and Africa, Asia Minor.

8. Fruit 2.5—3.5 mm. long with 6—9 narrow, more approximate ribs; flowers 2.5—5 mm. long.

9. Flowers 2.5—3.0 mm. long; keel usually exceeding standard; peduncles shorter or somewhat longer than the frequently loosely flowered racemes; leaves obovate to obovate-oblong, finely denticulate.

M. sulcatus Desf. Entire Mediterranean region, introduced farther north.

9. Flowers 3.5—5.0 mm. long; keel usually subequal to standard; peduncles stiff, exceeding the loose or compactly-flowered racemes; leaves obovate, sharply denticulate.

M. segetalis (Brot.) Ser. Mediterranean, primarily western portion (?).

6. Nerves on pod various, not concentrically curved (sometimes slightly so at margin); stipules entire or toothed.

10. Stipules conspicuously lacerate or toothed.

11. Flowers small, 3—4 mm. long; leaves close denticulate, the veinlets strengthened at margin and conspicuously exerted.

M. dentatus (W.K.) Pers. Temperate Eurasia, east to Mongolia.

11. Flowers larger, 6—8 mm. long; leaves nearly entire to irregularly or undulate denticulate, the veinlets scarcely exerted.

12. Pods compressed with transverse nerves; corolla 3 times exceeding calyx.

M. macrocarpus Coss. and Dur. Algeria, Morocco.

12. Pods plump, irregularly reticulate with broad nerves which on immature fruits appear as contiguous fleshy folds of tissue, corolla about twice as long as calyx.

M. italicus (L.) Lam. Mediterranean Europe and Asia Minor.

- 10. Stipules entire, or the lowermost inconspicuously toothed.
- 13. Ovary and young fruits sparsely hirsute.
 - 14. Fruits globose, abruptly beaked when mature; leaves mostly obovate, usually conspicuously cuneate and about 1 cm. long or less, toothed primarily towards apex; plants slender annuals.
M. neapolitanus Ten. (*M. gracilis* DC.)
 Southern Europe and adjacent North Africa; southwestern Asia.
 - 14. Fruits compressed, tapering to a point or short beak; leaves elliptic to oblanceolate (lowermost broader), commonly exceeding 1 cm., frequently strongly toothed about entire margin; plants taller biennials.
 - 15. Petals persistent about young fruits; pods elliptic-oblong, brownish; leaves usually not sharply toothed.
M. hirsutus Lipsky. Southwestern Russia.
 - 15. Petals quickly deciduous; pods broadly ovate, black when mature; leaves often sharply toothed.
M. altissimus Thuill. [Incl. *M. macrorhizus* (W. K.) Pers. and *M. paluster* Schultes]. Primarily central and northern Europe.
- 13. Ovary and young fruits glabrous.
 - 16. Pods cross-ribbed with transverse nerves predominant.
 - 17. Leaves obovate-cuneate, toothed primarily on upper portion of margin; fruits usually about 3 mm. broad; plants annual.
M. elegans Salzm. Mediterranean Europe and Africa, Palestine.
 - 17. Leaves obovate to oblong-elliptic, toothed about most of margin; fruits mostly 2—2.5 mm. broad; plants ordinarily biennial.
M. officinalis (L.) Desr. Europe; adjacent Asia, and introduced in temperate agricultural regions throughout the world.
 - 16. Pods reticulate or irregularly nerved.
 - 18. Racemes few (5-10)—flowered; pedicels filiform, 4—5 mm. long.
M. polonicus (L.) Desr. Urals to southeastern Russia and adjacent Turkestan.
 - 18. Racemes many flowered; pedicels short (1—2 mm. long).
 - 19. Flowers very small, 2—3 mm. long; seeds finely bumpy; plants annual.
M. indicus (L.) All. (*M. parviflorus* Desf.) Entire Mediterranean region, now introduced in warm-temperate agricultural regions throughout the world.
 - 19. Flowers larger, 3—4 mm. long; seeds smooth; plant biennial.
M. suaveolens Ledeb. Siberia to Japan, especially common in temperate China.

II. FLOWERS AND FRUIT PRESENT—FLOWER COLOR NOT DISCERNIBLE

1. Fruits with 5—8 longitudinal, corky ridges; leaflets small, usually less than 1 cm. in length.

Melilotus bicolor Boiss. and Bal.

1. Fruits not longitudinally ridged; leaflets various in size, usually 1 cm. or more in length.
2. Nerves on pod concentrically curved; stipules usually lacerate or strongly toothed.
3. Racemes short, rarely exceeding subtending leaves; fruits acute or acuminate, large, 6—8 mm. long when mature.

M. messanensis (L.) All.

3. Racemes exceeding subtending leaves; fruits obtuse or inconspicuously apiculate, less than 6 mm. long.
4. Fruit 4—5 mm. long with 3—6 coarse ribs; flowers usually 6—7 mm. long.

M. infestus Guss.

4. Fruit 2.5—3.5 mm. long with 6—9 narrow, more approximate ribs; flowers 2.5—5 mm. long.
5. Flowers 2.5—3 mm. long; keel usually exceeding standard; peduncles shorter or somewhat longer than the frequently loosely flowered racemes; leaves obovate to obovate-oblong, finely denticulate.

M. sulcatus Desf.

5. Flowers 3—5 mm. long; keel usually subequal to standard; peduncles stiff, exceeding the loose or compactly-flowered racemes; leaves obovate, sharply denticulate.

M. segetalis (Brot.) Ser.

2. Nerves on pod various, not concentrically curved (sometimes slightly so at margin); stipules entire or toothed.
6. Stipules conspicuously lacerate or toothed.
7. Flowers small, 3—4 mm. long; leaves closely denticulate, the veinlets strengthened at margin and conspicuously exerted.

M. dentatus (W. K.) Pers.

7. Flowers larger, 6—8 mm. long; leaves nearly entire to irregularly or undulate-denticulate, the veinlets scarcely exceeding calyx.
8. Pods compressed with transverse nerves; corolla 3 times exceeding calyx.
9. Wings about as long as standard or slightly shorter.

M. speciosus Dur.

9. Wings much shorter than standard.

M. macrocarpus Coss. and Dur.

8. Pods plump, irregularly reticulate with broad nerves which on immature fruits appear as contiguous, fleshy folds of tissue; corolla about twice as long as calyx.

M. italicus (L.) Lam.

6. Stipules entire, or the lowermost inconspicuously toothed.
10. Ovary and young fruits sparsely hirsute.

11. Fruits globose, divergent or stiffly ascending, conspicuously beaked; leaves cuneate-ovate; toothed primarily at apex; stipules lanceolate; plants slender annuals with ascending branches.
M. neapolitanus Ten.
11. Fruits ovoid or compressed, usually drooping, weakly beaked; leaves and stipules various; plants biennials.
12. Fruits reticulate (frequently appearing irregularly roughened or nearly smooth when young).
13. Petals persistent about young fruits; pods elliptic-oblong, brownish; leaves usually not sharply toothed.
M. hirsutus Lipsky.
13. Petals quickly deciduous; pods broadly ovate, black when mature; leaves often sharply toothed.
M. altissimus Thuill.
12. Fruits coarsely 3—5 ribbed, the elevations (particularly in young fruits) appearing like fleshy folds of tissue.
M. tauricus (M.B.) Ser.
10. Ovary and fruit glabrous.
 14. Pedicels 3—5 mm. long, slender and flexuous.
 15. Racemes few-flowered (5—10); pods oblong, 6—7 mm. in length.
M. polonicus (L.) Desr.
 15. Racemes many-flowered (30—40); pods narrowly ovate, 4—5 mm. long.
M. wolgicus Poir.
 14. Pedicels 1—2.5 mm. long.
 16. Pods cross-ribbed with transverse nerves predominant.
 17. Leaves obovate-cuneate, toothed primarily on upper portion of margin; fruits usually about 3 mm. broad; plants annual.
M. elegans Salzm.
 17. Leaves obovate to oblong-elliptic, toothed about most of margin; fruits mostly 2—2.5 mm. broad; plants ordinarily biennial.
M. officinalis (L.) Desr.
 16. Pods reticulate or irregularly nerved.
 18. Flowers very small and densely crowded, 2—3 mm. long; calyx lobes deltoid, somewhat convexly curved towards apex giving an obtuse appearance; plants annual; seed finely bumpy.
M. indicus (L.) All.
 18. Flowers larger, 3—5 mm. long; calyx lobes deltoid-lanceolate to lanceolate, sharp-pointed; plants biennial; seeds smooth.
 19. Flowers 3—4 mm. long, less than twice as long as calyx; pedicels 1—1.5 mm. long; calyx lobes usually slender and equaling or exceeding tube; leaflets most frequently sharply denticulate.
M. suaveolens Ledeb.

19. Flowers—4-5 mm. long, twice as long as calyx; pedicels about 2 mm. long; calyx lobes and leaflets variable.

M. albus Desr.

III. FRUITS ABSENT (OR IMMATURE)—FLOWER COLOR DISCERNIBLE

1. Flowers white or tipped with blue.

2. Keel and wings blue-tipped; low annuals with small, broadly obovate-cuneate leaflets and few-flowered racemes.

Melilotus bicolor Boiss. and Bal.

2. Petals entirely white; plants various.

3. Stipules lacerate or conspicuously toothed; flowers 7—8 mm. long, the petals about 3 times exceeding calyx.

M. speciosus Dur.

3. Stipules entire; flowers 3—6 mm. long, the petals about twice exceeding the calyx.

4. Ovary and young fruit hirsute; leaflets obovate-cuneate, thick, sharply toothed.

M. tauricus (M.B.) Ser.

4. Ovary glabrous; leaflets various, not as above.

5. Pedicels flexuous, (3) 4-5 mm. long, usually longer than flowers which are 3—4 mm. in length; calyx teeth deltoid, less than $\frac{1}{2}$ as long as tube.

M. wolgicus Poir.

5. Pedicels about 2 mm. long, shorter than flowers which are 4—5.5 (6) mm. in length; calyx teeth lanceolate, $\frac{1}{2}$ —1 times as long as tube.

M. albus Desr.

1. Flowers yellow.

6. Stipules toothed or lacerate—in some species only the basal lobe is conspicuously toothed, the principal, lanceolate limb being entire.

7. Flowering racemes shorter than subtending leaves, mostly 6—10 flowered; leaflets usually strongly cuneate; plants annual with decumbent, basal branches.

M. messanensis (L.) All.

7. Racemes exceeding leaves, usually 15—40 flowered; plants various.

8. Flowers small, 2.5—3.0 mm. long; keel exceeding standard; small diffuse annuals.

M. sulcatus Desf.

8. Flowers larger than above; keel approximating or shorter than standard.

9. Wings much shorter than standard ($\frac{2}{3}$ — $\frac{3}{4}$ as long), usually considerably narrower than other petals.

10. Flowers 6—8 mm. in length—if slightly less with sharply and closely denticulate leaflets (veinlets slightly exerted).

11. Leaflets inconspicuously or undulate toothed; flowers usually 7—8 mm. long, the petals about 3 times exceeding the calyx.

M. macrocarpus Coss. and Dur.

11. Leaflets closely denticulate, the veinlets usually slightly exerted; flowers usually (5.5) 6—7 mm. long, the petals approximately twice as long as calyx.

M. infestus Guss.

10. Flowers 3.5—5 mm. in length; leaves denticulate but veinlets scarcely exerted.

M. segetalis (Brot.) Ser.

9. Wings slightly shorter than standard, not conspicuously narrowed in comparison to other petals.

12. Leaflets obovate-cuneate to oblong-elliptic, closely denticulate, the contiguous veinlets strengthened near margin and sharply exerted; flowers 3—4 mm. long.

M. dentatus (W. K.) Pers.

12. Leaflets broadly obovate (frequently nearly as broad as long), thick, glaucous, subentire to undulate toothed; flowers 6—8 mm. long.

M. italicus (L.) Lam.

6. Stipules, except for lowermost, entire or obscurely denticulate at base.

13. Flowers small, 2—2.5 (3) mm. long; stipules lanceolate, slightly toothed at base; calyx lobes deltoid, the margins slightly convex.

M. indicus (L.) All.

13. Flowers longer, 3—8 mm. long; stipules usually linear-lanceolate, entire; calyx lobes deltoid or lanceolate, the margins straight.

14. Pedicels 3—5 mm. long, flexuous; racemes with 4—10 widely spaced flowers.

M. polonicus (L.) Desr.

14. Pedicels 1—2.5 mm. long; racemes usually with 20 or more flowers (sometimes less in *M. neapolitanus*).

15. Ovary and young fruit glabrous.

16. Stipules lanceolate; leaflets obovate-cuneate, denticulate primarily at apex; plants annual, often small, only 2—4 dm. high.

M. elegans Salzm.

16. Stipules narrowly lanceolate to linear; leaflets obovate to elliptic, often narrowly so, usually denticulate around most of margin; plants bi-annual, often exceeding 1 m.

17. Flowers 5—7 mm. long; pedicels approximately 2 mm. long; calyx rather abruptly, and sometimes assymmetrically narrowed at base, the teeth often considerably shorter than tube; ovary distinctly stalked.

M. officinalis (L.) Desr.

17. Flowers 3—4 mm. long; pedicels mostly somewhat less than 2 mm. in length; calyx gradually narrowed to base, the teeth usually subequal to the tube; ovary narrowed at base.

M. suaveolens Ledeb.

15. Ovary and young fruit hairy.

18. Flowers 5—8 mm. long, usually drooping at anthesis; calyx teeth lanceolate, exceeding 1 mm. in length; leaflets obovate-elliptic, often narrowly so, frequently sharply toothed about entire margin; plants biennial, usually 0.5—1.5 m. high.

19. Leaflets obovate-elliptic; calyx teeth slender, approximating or exceeding tube; ovary closely appressed-pilose; petals persistent about young fruit.

M. hirsutus Lipsky.

19. Leaflets elliptic-oblong, often sharply toothed; calyx teeth lanceolate, usually shorter than tube; ovary appressed-hirsute; petals quickly deciduous.

M. altissimus Thuill.

18. Flowers 4—5 (6) mm. long, usually horizontal or ascending at anthesis; calyx teeth deltoid, less than 1 mm. in length; leaflets cuneate, toothed primarily at apex; plants annual, usually not exceeding 0.5 m.

M. neapolitanus Ten.

IV. FRUITS ABSENT (OR IMMATURE)—FLOWERS PRESENT, COLOR NOT DISCERNIBLE

1. Stipules toothed or lacerate—in some species only the basal lobe is conspicuously toothed, the principal, lanceolate limb being entire; uppermost stipules sometimes nearly entire.

2. Flowering racemes shorter than subtending leaves, mostly 6—10 flowered; leaflets usually strongly cuneate and emarginate; plants annual, ascending or low spreading.

Melilotus messanensis (L.) All.

2. Racemes exceeding leaves, usually 15—40 flowered; leaflets and plants various.

3. Flowers small, 2.5—3.0 mm. long; keel exceeding standard; small, diffuse annuals.

M. sulcatus Desf.

3. Flowers larger than above; keel approximating or shorter than standard.

4. Wings much shorter than standard ($\frac{2}{3}$ — $\frac{3}{4}$ as long), usually considerably narrower than other petals.

5. Flowers 6—8 mm. in length—if slightly less with sharply and closely denticulate leaflets (veinlets slightly exerted).

6. Leaflets inconspicuously or undulate-toothed; flowers usually 7—8 mm. long, the petals about 3 times exceeding the calyx.

M. macrocarpus Coss. and Dur.

6. Leaflets closely denticulate, the veinlets usually slightly exerted; flowers usually (5.5) 6—7 mm. long, the petals approximately twice as long as calyx.

M. infestus Guss.

5. Flowers 3.5—5 mm. in length; leaflets denticulate but veinlets scarcely exerted.

M. segetalis (Brot.) Ser.

4. Wings slightly shorter than standard, not conspicuously narrowed in comparison to other petals.
7. Leaflets obovate-cuneate to oblong-elliptic, closely denticulate, the contiguous veinlets strengthened near margin and sharply exerted; flowers 3—4 mm. long.
M. dentatus (W. K.) Pers.
7. Leaflets cuneate-obovate, frequently nearly as broad as long, inconspicuously or undulate toothed, the veinlets not exerted; flowers 6—8 mm. long.
8. Calyx 3.5—4 mm. long, about half the length of petals; ovary narrowed at base and appearing short stalked; entire plant glaucous.
M. italicus (L.) Lam.
8. Calyx 2.5—3 mm. long, approximately one-third as long as petals; ovary sessile; undersurfaces of leaves slightly glaucous.
M. speciosus Dur.
1. Stipules of middle and upper portions of stem entire or obscurely denticulate at base; lowermost stipules sometimes toothed.
9. Ovary and young fruits hirsute.
10. Stipules lanceolate; plants annual, usually not over 0.5 m. high.
11. Ovary when enlarging from calyx with distinct longitudinal ridges; wings much shorter than standard; leaflets distinctly toothed.
M. bicolor Boiss. and Bal.
11. Ovary not possessing longitudinal ridges; wings subequal to standard; leaflets often obscurely toothed.
M. neapolitanus Ten.
10. Stipules linear to filiform; plants biennial, often up to 1 m.
12. Ovary stipitate; leaflets thick, strongly veined, broadly obovate-cuneate; toothed primarily at apex.
M. tauricus (M. B.) Ser.
12. Ovary narrowed at base but not distinctly stipitate; leaflets various, usually obovate-elliptic to oblong, often narrowly so, frequently toothed about entire margin.
13. Leaflets obovate-elliptic; calyx teeth slender, approximating or exceeding tube; ovary closely appressed-pilose; petals persistent about young fruits.
M. hirsutus Lipsky.
13. Leaflets elliptic-oblong, often sharply toothed; calyx teeth lanceolate, usually shorter than tube; ovary appressed-hirsute; petals quickly deciduous.
M. altissimus Thuill.
9. Ovary glabrous.
14. Pedicels slender, 3—6 mm. long, usually longer than flowers.
15. Racemes few (5—10) flowered.
M. polonicus (L.) Desr.
15. Racemes many (20—50) flowered.
M. wolgicus Poir.

14. Pedicels 1—2.5 mm. long, shorter than flowers.
16. Flowers small, 2—2.5 (3) mm. long; stipules lanceolate, slightly toothed at base; calyx lobes deltoid, the margins slightly convex.
M. indicus (L.) All.
16. Flowers larger, 3—8 mm. long; stipules usually linear-lanceolate, entire; calyx lobes deltoid or lanceolate, the margins straight.
17. Stipules lanceolate; leaflets obovate-cuneate, denticulate primarily at apex; plants annual, often small, only 2—4 dm. high.
M. elegans Salzm.
17. Stipules narrowly lanceolate to linear; leaflets obovate to elliptic, often narrowly so, usually denticulate around most of margin; plants biennial, often exceeding 1 m.
18. Flowers 5—7 mm. long, wings tending to exceed keel; ovary strongly stalked.
M. officinalis (L.) Desr.
18. Flowers 3—5 (5.5) mm. long; wings and keel subequal, ovary narrowed at base but scarcely stalked.
19. Flowers 3—4 mm. long; pedicels mostly somewhat less than 2 mm. in length; calyx teeth usually subequal to tube; leaflets usually sharply toothed.
M. suaveolens Ledeb.
19. Flowers 4—5 (5.5) mm. long; pedicels approximately 2 mm. in length; calyx teeth often considerably shorter than tube; leaflets various, sometimes obscurely toothed.
M. albus Desr.

Literature Cited

- Clapham, A. R., T. G. Tutin, and E. F. Warburg. 1952. *Melilotus*, in: Flora of the British Isles. 421-422.
- Coste, H. 1901. *Melilotus*, in: Flore de la France. 1:331-334.
- Fryer, J. R. 1930. Cytological studies in *Medicago*, *Melilotus* and *Trigonella*. Canad. Jour. Res. 3:3-50.
- Gams, H. 1923-24. *Melilotus*, in: Hegi, G. Illustrierte Flora. Mitteleuropa. IV, 3:1236-1248.
- Hayek, A. 1927. *Melilotus*, in: Prodrum florae penninsulae Balcanicae. Report Spec. Nov. Beih. 30 (1): 843-846.
- Isely, D. 1951. *Melilotus*, in: The Leguminosae of the north central United States. I. Loteae and Trifolieae. Iowa State College Jour. Sci. 25:459-461.
- Kuznetsov, V. A. 1927. Sweet clovers (*Melilotus* Adans.). Ann. Inst. Expt. Agron. Petrog. 5: 178-186.
- Martin, R. F. 1940. Preliminary report on systematic studies of *Melilotus*. U. S. Dept. Agric. Unpublished report.
- Post, G. E. 1932. *Melilotus*, in: Flora of Syria, Palestine and Sinai 2nd ed. rev. by J. E. Dinsmore. 1:329-331.
- Schulz, O. E. 1901. Monographie der Gattung *Melilotus*. Bot. Jahrb. 29:660-735.
- Senn, H. A. 1938. Chromosome number relationships in the Leguminosae. Bibliogr. Gen. 12: 175-336.

DEPARTMENT OF BOTANY
IOWA STATE COLLEGE
AMES, IOWA