

## NUMERICAL TAXONOMIC STUDY ON TURKISH *LATHYRUS* (LEGUMINOSEAE)

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This study examines whether a satisfactory classification of Turkish *Lathyrus* species can be obtained from phenetic clustering based on external vegetative and floral morphological characters of herbarium specimens. Forty morphological characters for each species of the genus *Lathyrus* L. were scored and the data subjected to numerical taxonomic analyses. The results of this study suggest that there are basically nine sections (*Orobus*, *Lathyrostylis*, *Aphaca*, *Nissolia*, *Orobon*, *Gorgonia*, *Clymenum*, *Cicerula* and *Lathyrus*) which can be grouped under two subgenera, namely subgenus *Lathyrus* and subgenus *Orobus*, as far as the material belonging to 54 of the 58 species cited in *Flora of Turkey* allows. Sect. *Gorgonia* Dogan is described.

### INTRODUCTION

The genus *Lathyrus* L. contains about one hundred species which spread through all the north temperate zone (Baker, 1876). The genus is of considerable economic importance (Ali, 1965). Chittenden (1951) lists about 33 species which are grown for ornamental purposes. *Lathyrus hirsutus* L. is used in the southern United States for pasture, hay winter cover and soil improvement. *Lathyrus ochrus* L. is cultivated for similar purposes in the Mediterranean area and *Lathyrus cicera* L., a drought resistant herb, is often grown in southern Europe for fodder or as a green manure plant. In some parts of Asia, Europe and Africa, *Lathyrus sativus* L. is cultivated as an annual cold season crop. *Lathyrus sylvestris* L. has been recommended for erosion control on cut-over or burned-over areas in the United States (Whyte *et al.*, 1953)

The genus *Lathyrus* was first recognized, in the strict sense, by Linnaeus (1753) in his *Species Plantarum* along with *Orobus* L. which covered some of the presently known *Lathyrus* species. Godron (1848) united the two Linnean genera, *Lathyrus* s. str and *Orobus* in *Lathyrus* s. lat. and stated that this genus was characterized by a dorsally compressed style pubescent on the adaxial face. Godron (1848) recognized six sections within *Lathyrus* namely *Eulathyrus*, *Cicerula*, *Clymenum*, *Nissolia*, *Aphaca* and *Orobus*.

Boissier (1872) was the first person to study various Turkish species of *Lathyrus* along with many others from the area covered by *Flora Orientalis*. He accepted the two Linnean genera, *Orobus* and *Lathyrus* s. str. as independent genera. In the genus *Lathyrus* he recognized six sections, namely *Orobastrum*, *Eulathyrus*, *Cicerula*, *Aphaca*, *Nissolia* and *Clymenum*.

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Bässler (1966) revised the members of *Lathyrus* subgenus *Orobus* and recognized six sections within the subgenus, namely *Orobus*, *Platystylis*, *Pratensis*, *Eurytrichon*, *Neurolobus* and *Orobon*. Later, Bässler (1973, 1981) revised sections *Orobus* and *Lathyrostylis*.

Davis (1970) in his *Flora of Turkey*, placed 58 Turkish species under ten sections, namely *Orobus*, *Platystylis*, *Pratensis*, *Orobastrum*, *Orobon*, *Lathyrus*, *Cicerula*, *Aphaca*, *Nissolia* and *Clymenum*. The treatment of Davis (1970) is given in Table 2.

Czefranova (1971) studied the Asiatic and European members of *Lathyrus* s. lat. and grouped them under six subgenera, namely *Orobus*, *Lathyrus*, *Cicerula*, *Aphaca*, *Nissolia* and *Clymenum*. In subgenus *Orobus*, Czefranova (1971) recognized five sections, namely *Lathyrobus*, *Orobus*, *Pratensis*, *Eurytrichon* and *Neurolobus*. Three more sections were also recognized in subgenus *Lathyrus*, namely *Orobon*, *Orobastrum* and *Lathyrus*.

Fairly good accounts on the floral and vegetative morphologies of the genus *Lathyrus* were given by Simola (1968) and Kupicha (1983). Kupicha recognized 13 sections on the basis of the Old World members of the genus, namely *Orobus*, *Lathyrostylis*, *Pratensis*, *Neurolobus*, *Orobon*, *Orobastrum*, *Viciopsis*, *Linearicarpus*, *Lathyrus*, *Aphaca*, *Nissolia*, *Clymenum* and *Notolathyrus*.

Besides these works cited above there have been revisional studies on the genus *Lathyrus* by Burkart (1935, 1942) and Hitchcock (1952).

The main objective of this study is to classify Turkish *Lathyrus* species by means of numerical taxonomic methods and compare the results with the conventional classification of Davis (1970) and the sectional classification of Kupicha (1983).

## MATERIAL AND METHODS

Specimens from 54 species of *Lathyrus*, housed at the Royal Botanic Garden Edinburgh (E), were examined and scored for 40 different characters (Table 1). All the specimens have been collected from the *Flora of Turkey* area and cited in the *Flora* by Davis (1970).

The NTSYS program package written for IBM PC by Rohlf (1986) for clustering and ordination analysis was used, and the product moment correlation coefficients and average taxonomic distances between pairs of OTUs to measure taxonomic resemblance using the standardized scores was computed. When more than one specimen was measured, arithmetical averages were used.

UPGMA clustering of similarity matrices based on product moment correlation coefficient and average taxonomic distance yielded cophenetic correlations (Sneath & Sokal, 1973) of 0.81290 and 0.80508 respectively. Therefore, the results based on the product moment correlation coefficient, are presented in this paper.

## RESULTS

The phenogram resulting from UPGMA clustering of similarity matrix is presented in Figure 1. A line across the phenogram at -0.20 similarity level results in two subgroups or phenons corresponding to the two subgenera of *Lathyrus*, *Orobus* and *Lathyrus* described earlier by Bässler (1966)

TABLE 1. List of characters scored.

- |  |   |
|--|---|
| 1) Annual or biennial (0)<br>Perennial (1)   | 18) Stipule shape: ovate (0), lanceolate (1),<br>orbicular (2), linear (3), subulate (4)  |
| 2) Stem winged (0)<br>Stem not winged (1)  | 19) Stipule margin: entire (0), toothed (1)   |
| 3) Stem angled at middle (0)<br>Stem not angled  | 20) Stipule length (cm)   |
| 4) Leaves tendrilous (0)<br>Leaves not tendrilous (1)  | 21) Stipule base: semihastate (0), sagittate (1),<br>semisagittate (2)  |
| 5) Median leaves pinnate (0)<br>Leaves subdigitate (1)   | 22) Lowest peduncle's length (cm)   |
| 6) Leaves aristate (0)<br>Leaves not aristate (1)  | 23) Number of flowers in a peduncle   |
| 7) Leaves length (cm)  | 24) Flowers axillary raceme (0)<br>Flowers solitary (1)   |
| 8) Petiole length (cm)   | 25) Calyx: hairy (0) glabrous (1)   |
| 9) Leaflet number  | 26) Calyx teeth length equal (0), unequal (1)   |
| 10) Leaflet ovate (0)<br>Leaflet elliptic (1)<br>Leaflet linear (2)<br>Leaflet lanceolate (3)                            | 27) Calyx teeth length (mm)   |
| 11) Leaflet apex acute (0)<br>Leaflet apex acuminate (1)<br>Leaflet apex rounded-obtuse (2)<br>Leaflet apex aristate (3) | 28) Calyx length (mm)   |
| 12) Leaflet green (0)<br>Leaflet glaucous (1)<br>Leaflet dark (2)  | 29) Calyx teeth: acuminate (0), aristate (1),<br>acute (2)  |
| 13) Leaflet margin smooth (0)<br>Leaflet margin undulate (1)   | 30) Flower length (mm)  |
| 14) Leaflet length (mm)  | 31) Standard colour: white (0), cream (1), purple<br>(2), violet-lilac (3), blue (4), yellow (5),<br>gingery orange (6), lavender (7) |
| 15) Leaflet width (mm)   | 32) Style length (mm)   |
| 16) Leaflet hairy (0)<br>Leaflet glabrous (1)  | 33) Style linear (0), spatulate (1)   |
| 17) Leaflet venation pinnate (0)<br>Leaflet venation parallel (1)<br>Leaflet venation reticulate (2)                     | 34) Style twisted (0)<br>Style not twisted (1)  |
|  | 35) Legume length (mm)  |
|  | 36) Legume width (mm)   |
|  | 37) Legume linear (0)<br>Legume oblong (1)  |
|  | 38) Legume hairy (0)<br>Legume glabrous (1)   |
|  | 39) Upper suture 3-keeled (0)<br>Upper suture 2-keeled (1)<br>Upper suture 1-keeled (2)<br>Upper suture not keeled (3)                |
|  | 40) Number of seeds in each legume  |

The phenon line at 0.25 similarity level creates two sections in subgenus *Orobus*, namely sect. *Orobus* and sect. *Lathyrostylis* which were also described earlier by Bässler (1966). The 0.25 phenon line results in seven phenons or sections in subgenus *Lathyrus*. However, there is not any clear correspondence between the phenons and the earlier sectional delimitations (Davis, 1970; Kupicha, 1983)

The results of the principle component analyses on the matrix of correlations are given in Figure 2. It is possible to distinguish the two subgenera, *Orobus* and *Lathyrus* as two distinct clusters when plotted on the first two eigenvectors which explain 37.1% of the total variation. While the two sections within subgenus *Orobus* can be delimited quite easily, the sections in subgenus *Lathyrus* overlap considerably.

Subgenus *Orobus* seems far less problematical than subgenus *Lathyrus*. In the works of Davis (1970) and Kupicha (1983) two sections, *Orobus* and *Lathyrostylis*, were recognized. They both placed seven species under sect. *Orobus* and fourteen species

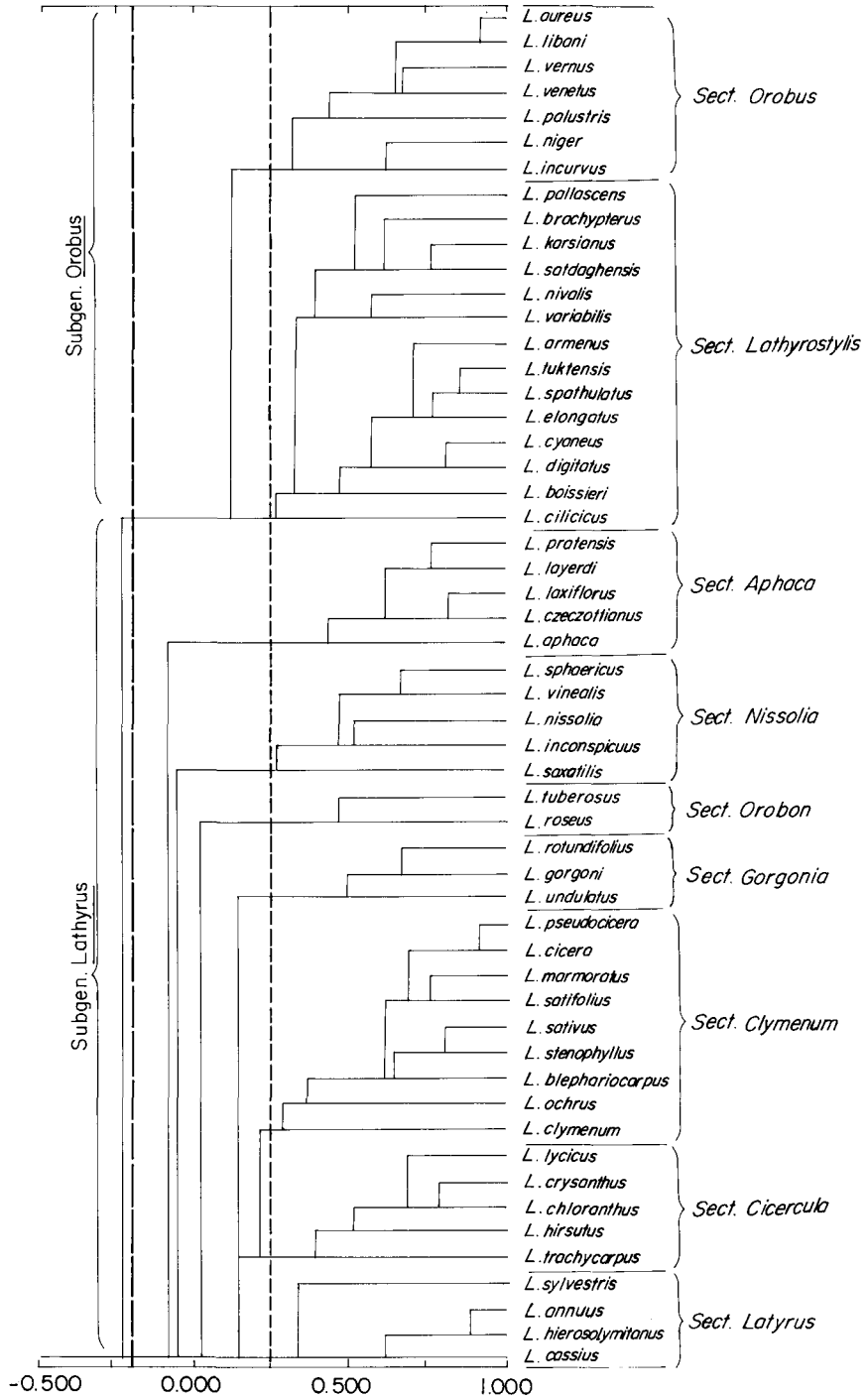


Fig. 1. UPGMA phenogram of Turkish *Lathyrus* species.

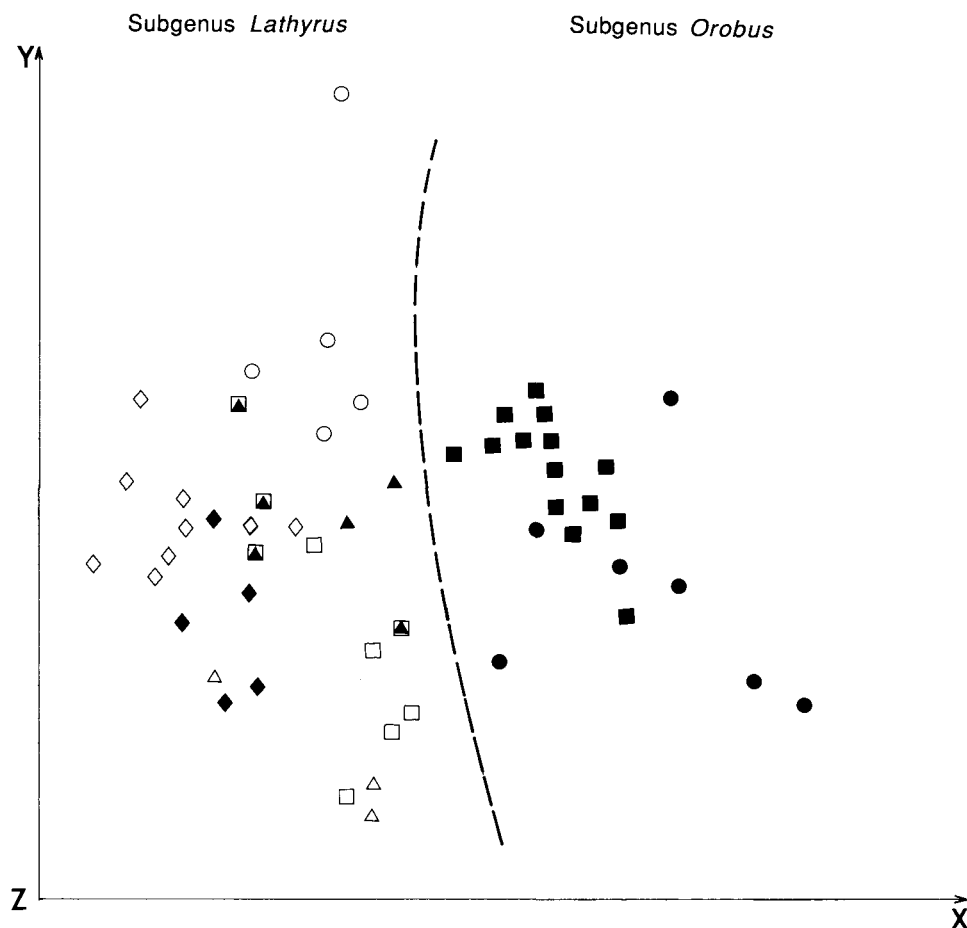


FIG. 2. Two dimensional plot of 54 OTUs.

under sect. *Lathyrostylis*. The results of the present study support the findings of Davis (1970) and Kupicha (1983) in these two sections (Table 2).

In subgenus *Lathyrus* seven sections, namely *Aphaca*, *Orobon*, *Gorgonia*, *Lathyrus*, *Nissolia*, *Clymenum* and *Cicerula*, are recognized. Infrageneric delimitations given by Davis (1970) and Kupicha (1983) seem very much artificial in this second group. Section *Aphaca* covers *L. pratensis*, *L. layerdi*, *L. laxiflorus*, *L. czechottianus* and *L. aphaca*. Davis (1970) and Kupicha (1983) both placed the first four species under sect. *Pratensis* and put *L. aphaca* and *L. stenobolus* together under sect. *Aphaca*.

Section *Nissolia* covers five species namely *L. sphaericus*, *L. vinealis*, *L. nissolia*, *L. inconspicuus* and *L. saxatilis*. Davis (1970) put them together with three more species namely *L. tauricola*, *L. woronowi* and *L. setifolius* under sect. *Orobastrum*, but he treated *L. nissolia* separately under sect. *Nissolia*. This artificial grouping was realized by Kupicha (1985) who placed *L. saxatilis* under sect. *Viciopsis* and named the section *Linearicarpus*. The results suggest that *L. setifolius*, the only Turkish species kept under sect. *Orobastrum* by Kupicha (1983), is actually a member of sect. *Cicerula*. It also

TABLE 2. Infrageneric delimitation of the genus *Lathyrus*

Species	Davis, 1970	Present study	Kupicha, 1983
<i>L. aureus</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. libani</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. vernus</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. venetus</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. niger</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. incurvus</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. palustris</i>	Sect. Orobus	Sect. Orobus	Sect. Orobus
<i>L. pallascens</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. brachypterus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. karsianus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. saïdaghensis</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. nivalis</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. armenus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. cyaneus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. digitatus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. tukhtensis</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. variabilis</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. spatulatus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. elongatus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. cilicicus</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. boissieri</i>	Sect. Platystylis	Sect. Lathrostylis	Sect. Lathrostylis
<i>L. pratensis</i>	Sect. Pratensis	Sect. Aphaca	Sect. Pratensis
<i>L. layerdi</i>	Sect. Pratensis	Sect. Aphaca	Sect. Pratensis
<i>L. laxiflorus</i>	Sect. Pratensis	Sect. Aphaca	Sect. Pratensis
<i>L. czechotianus</i>	Sect. Pratensis	Sect. Aphaca	Sect. Pratensis
<i>L. roseus</i>	Sect. Orobos	Sect. Orobos	Sect. Orobos
<i>L. tuberosus</i>	Sect. Lathyrus	Sect. Orobos	Sect. Lathyrus
<i>L. rotundifolius</i>	Sect. Lathyrus	Sect. Gorgonia	Sect. Lathyrus
<i>L. undulatus</i>	Sect. Lathyrus	Sect. Gorgonia	Sect. Lathyrus
<i>L. sylvestris</i>	Sect. Lathyrus	Sect. Lathyrus	Sect. Lathyrus
<i>L. saxatilis</i>	Sect. Orobastrum	Sect. Nissolia	Sect. Viciopsis
<i>L. vinealis</i>	Sect. Orobastrum	Sect. Nissolia	Sect. Linearicarpus
<i>L. sphaericus</i>	Sect. Orobastrum	Sect. Nissolia	Sect. Linearicarpus
<i>L. inconspicuus</i>	Sect. Orobastrum	Sect. Nissolia	Sect. Linearicarpus
<i>L. tauricola</i>	Sect. Orobastrum	Not examined	Sect. Linearicarpus
<i>L. woronowii</i>	Sect. Orobastrum	Not examined	Sect. Linearicarpus
<i>L. setifolius</i>	Sect. Orobastrum	Sect. Clymenum	Sect. Orobastrum
<i>L. annuus</i>	Sect. Cicercula	Sect. Lathyrus	Sect. Lathyrus
<i>L. hierosolymitanus</i>	Sect. Cicercula	Sect. Lathyrus	Sect. Lathyrus
<i>L. cassius</i>	Sect. Cicercula	Sect. Lathyrus	Sect. Lathyrus
<i>L. gorgoni</i>	Sect. Cicercula	Sect. Gorgonia	Sect. Lathyrus
<i>L. pseudocicera</i>	Sect. Cicercula	Sect. Clymenum	Sect. Lathyrus
<i>L. cicera</i>	Sect. Cicercula	Sect. Clymenum	Sect. Lathyrus
<i>L. sativus</i>	Sect. Cicercula	Sect. Clymenum	Sect. Lathyrus
<i>L. blepharicarpus</i>	Sect. Cicercula	Sect. Clymenum	Sect. Lathyrus
<i>L. marmoratus</i>	Sect. Cicercula	Sect. Clymenum	Sect. Lathyrus
<i>L. stenophyllus</i>	Sect. Cicercula	Sect. Clymenum	Sect. Lathyrus
<i>L. lycius</i>	Sect. Cicercula	Sect. Cicercula	Sect. Lathyrus
<i>L. phaselitanus</i>	Sect. Cicercula	Not examined	Sect. Lathyrus
<i>L. hirsutus</i>	Sect. Cicercula	Sect. Cicercula	Sect. Lathyrus

TABLE 2 contd.

<i>L. chrysanthus</i>	Sect. <i>Cicerula</i>	Sect. <i>Cicerula</i>	Sect. <i>Lathyrus</i>
<i>L. chloranthus</i>	Sect. <i>Cicerula</i>	Sect. <i>Cicerula</i>	Sect. <i>Lathyrus</i>
<i>L. trachycarpus</i>	Sect. <i>Cicerula</i>	Sect. <i>Cicerula</i>	Sect. <i>Lathyrus</i>
<i>L. clymenum</i>	Sect. <i>Clymenum</i>	Sect. <i>Clymenum</i>	Sect. <i>Clymenum</i>
<i>L. ochrus</i>	Sect. <i>Clymenum</i>	Sect. <i>Clymenum</i>	Sect. <i>Clymenum</i>
<i>L. nissolia</i>	Sect. <i>Nissolia</i>	Sect. <i>Nissolia</i>	Sect. <i>Nissolia</i>
<i>L. aphaca</i>	Sect. <i>Aphaca</i>	Sect. <i>Aphaca</i>	Sect. <i>Aphaca</i>
<i>L. stenolobus</i>	Sect. <i>Aphaca</i>	Not examined	Sect. <i>Aphaca</i>

seems unnecessary to recognize sect. *Viciopsis* as an individual section on the basis of *L. saxatilis*.

In sect. *Orobon*, there are two species, *L. roseus* and *L. tuberosus*. Davis (1970) and Kupicha (1983) both placed *L. roseus* in sect. *Orobon* and *L. tuberosus* in sect. *Lathyrus*. In reality these two species are close to each other and should be in the same section (Table 2).

*L. rotundifolius*, *L. undulatus* and *L. gorgoni* seem closer to each other than any other Turkish species. This is why they are grouped under a new sectional name, *Gorgonia*. Davis (1970) placed the first two species in sect. *Lathyrus* but he put *L. gorgoni* under sect. *Cicerula*

This new section is formally described.

#### Section *Gorgonia* Dogan, sect nov.

Plantae perennes (species *L. gorgoni* Parl. annua excepta). Caulis alatia. Folia stomatibus adaxialibus, unijuga, foliola elliptica vel lanceolati, parallelinervia; stipule ovate-lanceolati vel lanceolati, semisagittatae. Inflorescentia uniflora pauciflora. Flores pedunculati. Fructus linearis vel oblonga linearis.

Type: *L. gorgoni* Parl. in Giorn. Sci. Sicilia 62:3 (1838).

In sect. *Clymenum* there are nine species namely *L. pseudocicera*, *L. cicera*, *L. marmoratus*, *L. setifolius*, *L. sativus*, *L. stenophyllus*, *L. blepharicarpus*, *L. ochrus* and *L. clymenum*. Davis (1970) placed most of them under sect. *Cicerula* and Kupicha (1983) put the same species under sect. *Lathyrus*. Beside these they put *L. clymenum* and *L. ochrus* under sect. *Clymenum*. The results of this study indicate neither of the previous groupings seems to be satisfactory. Therefore, *Clymenum* is accepted here as the sectional name.

Section *Cicerula* includes *L. lycicus*, *L. chrysanthus*, *L. chloranthus*, *L. hirsutus* and *L. trachycarpus*. Davis (1970) and Kupicha (1983) also used this sectional name to cover 16 species in their studies, but the present findings suggest that these species should be placed under four different sections, namely *Cicerula*, *Clymenum*, *Gorgonia* and *Lathyrus* (Table 2). The remaining four species namely *L. sylvestris*, *L. annuus*, *L. hierosolymitanus* and *L. cassius* are grouped under sect. *Lathyrus*

Nevertheless, the classification obtained by numerical taxonomic methods appears to give more information than those of conventional methods on the relationship between

OTUs used in this study. Therefore, the classification obtained in this study would be expected to approximate natural groupings better than the previous studies.

The present study is somewhat limited because it is based on only the Turkish species. A comprehensive study covering all of the *Lathyrus* species seems to be necessary to construct a satisfactory infrageneric classification.

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