MORPHOLOGY, ANATOMY AND SYSTEMATICS OF THE GENUS *LATHYRUS* L. (LEGUMINOSAE) IN CENTRAL ANATOLIA, TURKEY

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MORPHOLOGY, ANATOMY AND SYSTEMATICS OF THE GENUS LATHYRUS L.(LEGUMINOSAE) IN CENTRAL ANATOLIA, TURKEY

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ABSRACT

MORPHOLOGY, ANATOMY AND SYSTEMATICS OF THE GENUS *LATHYRUS* L.(LEGUMINOSAE) IN CENTRAL ANATOLIA, TURKEY

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Ph.D., Department of Biology

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In this study, morphology, anatomy and systematics of the Genus *Lathyrus* L. (Leguminosae) in Central Anatolia is presented. Comparative morphological characters and their variation in the *Genus*; Calyx, leaf, corolla and pollen grains micro-morphology of the species; Anatomy of the species; Ecology, endemism, phytogeography and IUCN threat categories of the species; Numerical analysis and Revision of the genus in Central Anatolia were conducted.

For the first time the calyx, corolla and leaf micromorphology, and the anatomical characteristics of *Lathyrus* were examined. Infrageneric delimitation of the species is performed by using multivariate analysis. As a result of morphological and anatomical data, it is suggested that *L. haussknechtii* should be classified as different species not variety of *L. brachypterus*.

The collected specimens was crosschecked with neighboring floras and the existing type specimens known from Turkey ANK, GAZİ, HUB, KNYA, CUFH, Erciyes, and Royal Botanic Garden Edinburgh **(**RBGE**)** herbaria.

Morphological and micromorphological characters of pollen grains were revealed. It was determined that the pollen grains size and sculpturing were important diagnostic characters for the species. The statistical analysis was applied to compare P/E ratios of the pollen grains of studied taxa. According to this analysis, the P/E ratio is important diagnostic feature for most of the sections and the species.

Sectional key and species key were prepared and updated. Expanded descriptions, GPS data, some photographs and some notes on the taxonomy of the species were given.

Key words: Leguminosae, *Lathyrus* L., anatomy, morphology, systematics, Central Anatolia geographic region, Turkey.

ÖZ

İÇ ANADOLU BÖLGESİ'NDEKİ *LATHYRUS* L. (LEGUMINOSAE) CİNSİNİN MORFOLOJİSİ, ANATOMİSİ VE SİSTEMATİĞİ

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Bu çalışmada, İç Anadolu bölgesinde yayılış gösteren *Lathyrus* L. (Leguminosae) cinsinin morfolojisi, anatomisi ve sistematiği sunulmaktadır. Karşılaştırmalı morfolojik karakterler ve bu karakterlerin cins içi varyasyonları belirlenmiş; türlerin kaliks, yaprak, korolla ve pollen mikromorfolojileri ile kök, gövde ve yaprak anatomisi özellikleri incelenmiş ; türlerin ekoloji, endemism, fitocoğrafya ve IUCN tehlike kategorileri belirlenmiş; cinsin numeric analizi ve revizyonu yapılmıştır.

Bu çalışma ile Türkiye'de ilk kez *Lathyrus* cinsini oluşturan tülerin kaliks, korolla ve yaprak mikromorfolojisi ile anatomik özellikleri incelenmiştir. Türlerin Infrageneric sınırlandırılması çoklu varyasyon (multivariety) analiziyle yapılmıştır. Morfolojik ve anatomik veriler sonucunda *L. brachypterus* türünün bir varyetesi olarak sınıflandırılan *L. haussknechtii*' nin ayrı bir tür olarak sınıflandırılması gerektiği önerilmiştir.

Araziden toplanan örneklerin teşhisinde Türkiye Florası ve komşu ülkelerin floraları kullanılmıştır. Bunun yanı sıra toplanan örneklerin çapraz kontrolleri Ankara Üniversitesi herbaryumu, Gazi Üniversitesi herbaryumu, Hacettepe Üniversietsi herbaryumu, Selçuk Üniversitesi herbaryumu, Cumhuriyet üniversitesi herbaryumu, Erciyes Üniversitesi herbaryumu ve Kraliyet Botanik Bahçesi Edinburg (RBGE) herbaryumundaki mevcut örneklerle yapılmıştır.

Polenlerin morfolojik ve mikromorfolojik karakterleri belirlenmesi ile polen boyutu ve yüzey yapılarının türlerin teşhisinde önemli olduğu saptanmıştır. Taksonların polenlerinin P/E oranlarında anlamlı bir farlılık olup olmadığını araştırmak için istatiksel analiz yapılmıştır. Analiz sonucunda P/E oranının türlerin teşhisinde önemli olduğu sonucuna varılmıştır.

Seksiyon ve tür anahtarları hazrılanmış ve güncellenmiştir. Seksiyon ve türlerin genişletilmiş açıklamaları, GPS verileri, bazı fotoğraflar ve türlerin taksonomisi üzeirne bazı notlar verilmiştir.

Anahtar kelimeler: Leguminosae, *Lathyrus* L., anatomi, morfoloji, sistematik, İç Anadolu Bölgesi, Türkiye.

To my family, my wife and son.

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ABBREVIATIONS

ANK	: Ankara Üniversitesi Fen Fakültesi Herbaryumu
ANOVA	: Analysis of variance
c.	: Approximately
Da.	: Dağı-mountain
CUFH	: Cumhuriyet Üniversitesi Herbaryumu
EN	: Endangered
Fig.	: Figure
GPS	: Global Positioning System
GAZİ	: Gazi Üniversitesi Fen fakültesi Herbayumu
Holo.	: Holotype
HUB	: Hacettepe Üiversitesi Fen Fakültesi Herbaryumu
IUCN	: International Union for Conservation of Nature
KNYA	: Selçuk Üniversitesi Fen Fakültesi Herbaryumu
LC	: Least concern
LM	: Light microscopy
m	: Meter
NT	: Near threatened
RBGE	: Royal Botanic Garden Edinburgh
Subps.	: Subspecies
Syn.	: Synonym
UPGMA	: Un-Weihted Pair Group Method with Arithmetic mean
Var.	: Variety
VU	: Vulnerable
Unk. Or Multi.	Unknown or Multiregional
µm	: Micrometer

CHAPTER 1

INTRODUCTION

1.1 Historical Background of the Family Leguminosae

The origin of the name of "legume" (from French *légume,* from Latin *legūmen*) is unknown. But it is suggested that legume name is derived from Latin word *legere*, means "to gather" (APA, 2011; CMS, 2011; MLA, 2011)

Linnaean (1753) legume account is based on his sexual system. He classifed most of the genera in the Diadelphia Decandria, the precursor of the *Papilionoideae*; the single genus *Mimosa* in the Polyandria Monogynia, the precursor of the *Mimosoideae*; and others in the Decandria Monogynia, the precursor of the *Caesalpinioideae*.

Persoon (1805, 1807) updated Linnaeus' inventory. He included the Diadelphia Decandria and the Monadelphia Polyandria, into a single leguminous genus, *Mimosa.* According to the Persoon, the largest leguminous genus *Astragalus* (169), is now appreciably bigger than *Hedysarum* (129) and *Mimosa* which includes *Acacia* (129). The next genera in size are *Trifolium* (72), *Cassia* (70) and *Aspalathus* (69).

Bentham (1865a,b) transfered the *Adenanthera* from the Caesalpinoid genera of the Decandria Monogynia to the Mimoseae (i.e. Mimosoideae) and *Sophora* and *Anagyris* (also of the Decandria Monogynia) to the Papilionaceae (i.e.

Papilionoideae). *Astragalus* is still the largest genus with 1500 species. *Cassia* (200) and *Bauhinia* (130) are the largest genera in the Caesalpinioideae; *Acacia* (420) and *Mimosa* (230) are in the Mimosoideae.

Astragalus is followed by *Acacia* (900), *Indigofera* (800), *Mimosa* (600), *Cassia* (600) and *Bauhinia* (570) (Hutchinson, 1964).

Traditionally, Leguminosae is divided into three subfamilies namely Papilionoideae, Mimosoideae and Caesalpinieae (Table 1). The Papilionoideae is most widely distributed and largest of the three, traditionally accepted as subfamily of Leguminosae. This subfamily having nearly estimated 483 genera and 12000 species, is readily distinguished from the other subfamilies by its fruit, vegetative and floral characters (Polhill, 1981; Cronk, 1990; Chappill, 1995; Wojciechowski, 2003) including floral development (Tucker, 2002).

Table 1. Leguminosae subfamilies and their number of genera and species

Subfamily	Mimosoideae	Caesalpinioideae	Papilionoideae
Number of Genera	80	170	483
Number of Species	3,200	2000	12000

Recent studies have been suggested that legumes evolved in arid and/or semi-arid regions along the Tethys seaway during the early Tertiary (Schrire *et al.* 2005a,b).

The leguminosae is a family in the Fabales order, which is one of the order of dicotyledonous flowering plants in the Rosid I group among the core eudicots (Watson & Dallwitz, 1992; Wojciechowski, 2003; APG III 2009).

Leguminosae was found to have a sister group relationship to Poligalaceae and Surianaceae according to molecular phylogenies derived from DNA sequences of the chloroplast regions *matK*, *rbcL*, *trnL* and multi gene analysis (Bowe et al., 2000; Nickren et al., 2000; Chaw et al., 2000; Soltis et al., 1995)

Leguminosae is the third largest family of flowering plants, after Asteraceae (sunflower family) and Orchidaceae (orchid family) (Mabberley, 1997). It contains approximately 720 genera and more than 18000 species worldwide (Levis et al., 2005). It is the second only perhaps to Poaceae, in its agricultural and economic importance, and includes species used for soil enrichment, food, oils, fibre, fuel, timber, medicinals, numerous chemicals, and horticulture. Ecologically, especially the subfamily Papilionoideae is present and often dominant, from tropical rainforests to deserts and alpine tundra (Wojciechowski, 2003) members of the family play a vital role in global nitrogen cycle; nearly all species having root-nodulate formed by symbiotic bacteria so as to fix atmospheric nitrogen (Sprent & McKey, 1994; Sprent, 2001)

Table 2. Characteristics of Leguminosae

Life form	Trees, shrubs, woody vines, and annual or perennial herbs.
Leaves	Usually alternate and compound-bipinnate, simply pinnate or palmate rarely simple.
Inflorescence	Variously racemose, in simple racemes, panicles, spikes or heads.
Flower structure	Varies to the extent that 3 subfamilies are recognized; corolla typically 5 parted; stamens 3-many, mostly 10, free or united by their filaments in various ways
Pistil	Single, simple free
Fruit	Characteristically a pod, dehiscent or indehiscent.

There are four global legume biomes, which are succulent (dry tropical forest, succulent-rich and grass poor a fire intolerant, thicket and bushland biome) , grassland (a fire tolerant, seasonally dry tropical forest succulent poor and grass-rich, woodland and savanna biome) , rainforest (a tropical wet forest biome Rain forest) and temperate (a temperate biome including both the Northern and Southern Hemispheres) (Schrire et al. 2005a, b) (Figure 1).

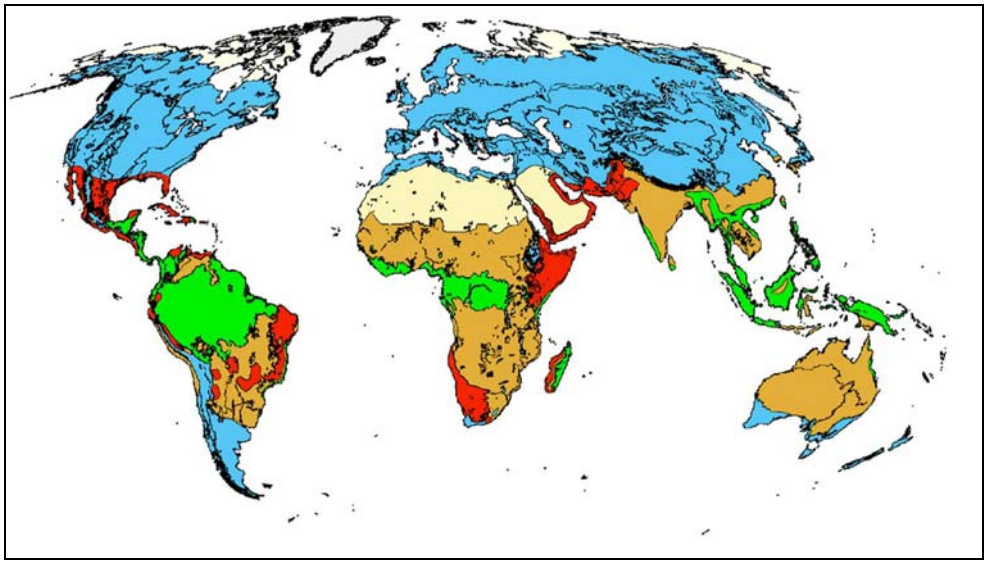


Figure 1. Generalised Legume distribution patterns at the biome level in the world. Red: succulent biome, Brown: grass biome, Green: rainforest biome, Blue: temperate biome (Kew, 2011)

All legumes are recognized as single family, Leguminosae or Fabaceae, the alternative name, is ambiguous because it is used for either the whole family, or only the papilionoid part of it. (Elwis & Schrire, 2003).

In Turkey, the family is represented by 71 genera and 1013 species and 400 of the species are endemic. Rate of endemism is 39% (Erik S. & Tarıkahya B., 2004)

The genus *Lathyrus* L is classified in the tribe Fabeae (syn. vicieae), of the subfamily Papilionoideae (or Faboideae), Leguminosae. The modern composition of the tribe Fabeae includes five genera; *Lathyrus, Lens, Pisum, Vavilovia,* and *Vicia,* (Kupicha,1974). *Lathyrus* is the largest genus in the tribe (Kenicer, 2008) (Table 3).

Reichenbach estabiiehed the tribe Fabeae in 1832, based on the earlier study of Adanson and Bronn. The characters, which define the tribe, are leaves with terminal tendrils, unusual stem vasculature supplying the stipules, adaxially pubescent styles, and several floral characters (Kupicha, 1974, 1977, 1981; Lavin & Delgado, 1990;

Lock & Maxted, 2005). It is evolved in Miocene and monophyletic group occupying a highly derived position in the legumes (Wojciechowski et al., 2000; Steele &Wojciechowski, 2003; Lock & Maxted, 2005; Lavin et al., 2005).

Table 3. Number of Species and Genera included in the tribe Fabea and their common usage

	Genera				
	Lathyrus	***Lens***	***Pisum***	***Vavilovia***	***Vicia***
Number of species	c. 160	5 – 6	3 (2-5)	1	c. 150
Distribution	Eurasia, Temperate Americas	East Mediterranean	East Mediterranean, Caucasus	Caucasus endemic	Eurasia, Temperate Americas
Uses	- Ornamentals - Food – seeds - Fodder - Rotation crops	- Food – seeds - Rotation crops	- Food – seeds, fruits and whole plants - Fodder - Rotation crops	- No uses	- Fodder - Rotation crops

1.2 The Genus *Lathyrus* L. in the World

The genus is belonging to the tribe *Fabeae* (syn. *Vicieae*; leguminosae). Tribe Fabeae is placed in the "temperate herbaceous" Papilionoid group of Leguminosae (Gunn, 1969; Polhill, 1981; Wojciechowski et al., 2000).

The genus *Lathyrus* L. (Leguminosae; Papilionoideae; the sweet peas) was first recognized, by Linnaeus in his "Species Plantarum" (Linnaeus, 1753) along with *Orobus* L. which covered some of the presently known *Lathyrus* species (Dogan et al., 1992).

The name of *Lathyrus* is derived from λα−τουρισ (la-thyris) of Theophrastus, Greek philospher. The "thyris" is usually interpreted as 'powerful' or 'vigorous'. The 'la' prefix state a diminutive form (Kenicer, 2008).

The genus *Lathyrus* is the largest genus in the economically important tribe Fabeae (Adans.) DC. (Ali, 1965; Kenicer et al., 2005). Members of *Lathyrus* are used as food and fodder crop, and ornamentals, Chittenden (1951) listed about 33 species grown as ornamentals, soil nitrifiers, dune stabilizers, important agricultural weeds, and model genetic organisms and ecological reasons (Kenicer et al., 2005).

L. odoratus, L: latifolius, L. grandiflorus, L. rotundifolius, L. undulatus, L. aureus, L. vernus are commercially significant ornomentals. *L. ochrus, L. tingitanus, and L sativus* are used as a food and fooder (Fedchenko, 1948; van der Maesen & Somaatmadja, 1989; Mathur et al., 1999). Seeds of *L. japonicus* were eaten, in Suffolk, England during a famine period in 1555 (Miller, 1768). *L. tuberosus* is cultivated for its edible tubers throughout northern Europe (Lawson, 1852; Johnson & Sowerby, 1862; Norton, 1996). *L. sativus* can store large amounts of lead in its tissue and it could be used for the development of new rhizofiltration system (Brunet et al., 2008)

L. sativus, L. odorus, L. niger, L. japonicus, L. sylvestris L., L. latifolius, and *L. pannonicus* are used as a model organism (Lambein et al., 1999; Bell et al., 1978; Rees & Narayan, 1989; Ehrlen & Eriksson, 1995).

L. hirsutus L., is used in the southern United States for pasture, hay winter cover and soil improvement. *L. ochrus* L., is cultivated for similar purposes in the Mediterranean area. *L. cicera* L., *L. aphaca* and *L. ochrus* are draught resistant herb, are often grown in southern Europe, for fodder or as a green manure plant (Holm et al., 1979). In some parts of Asia, Europe and Africa *L. sylvestris* L. has been recommended for erosion control on cutover or burned-over areas in the United States (Whyte et al., 1953).

The main distribution of *Lathyrus* is exhibiting predominantly extra tropical pattern in both the northern and southern hemisphere (Humphries & Parenti, 1999). The

primary center of diversity of the Genus is in the seasonally dry Mediterranean basin and neighboring western Irano-Turanian region.

Secondary center of diversity of the genus is in North America and temperate areas of South America. A few species reach tropical and the highlands of East Africa (Senn, 1938, Davis, 1970; Kenicer et al., 2005).

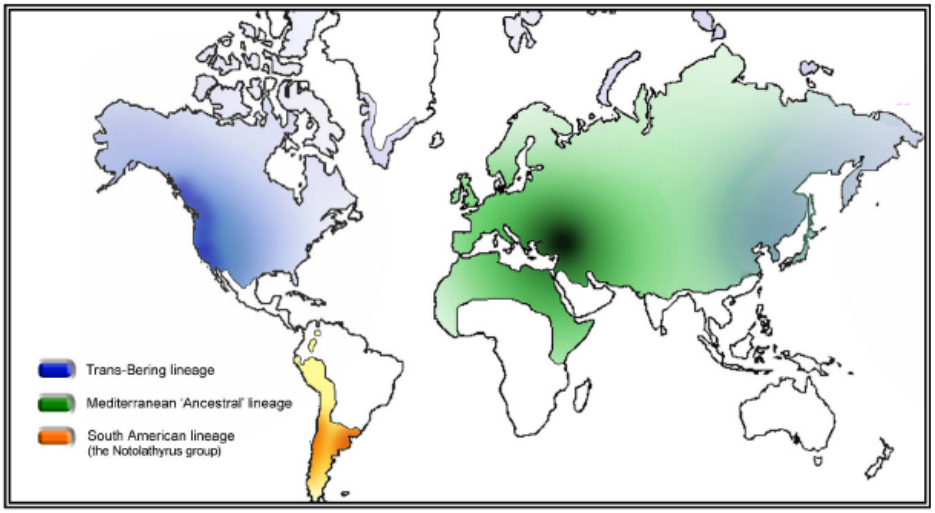


Figure 2. Generalised genus *Lathyrus* distribution patterns in the World. The diversity of species in each area is idicated by the color density. The main center of diversity in the genus is the Eastern Mediterranean and Pontic region.The North West of Argentina, Uruguay and Southeastern Brazil have greatest species diversity within South America (Kenicer, 2005).

The genus *Lathyrus* L. comprises about 160 species in the world and approximately 140 of them are found throughout the temperate northern hemisphere (Kupicha, 1983; Tsui, 1984; Asmussen & Liston, 1998). Most researchers divide *Lathyrus* into 12 or 13 sections (Czefranova, 1971; Kupicha, 1983; Asmussen & Liston, 1998; International Legume Data Base and Information Service, 2002; Leht, 2009) (Figure 2)

Botanists had accepted the two Linnean genera, *Lathyrus* and *Orobus,* until the classification of Godron (1848) who divided the genus into six sections; *Orobus*,

Aphaca, Eulathyrus, *Cicercula*, *Clymenum*, and *Nissolia*. In order to include those members of sect. *Orobus* which lacked tendril, Boissier (1872) restore *Orobus* as a distinct genus. The remaining species which have tendrils were placed *Lathyrus* sect. *Orobastrum*.

Bässler (1966) proposed *Lathyrus* subgen. *Orobus*, a unit containing all the perennial members of sect. *Orobus sensu* Godron. Bässler proposed the following sections within subgen. *Orobus*: *Orobus, Lathyrostylis (as platystylis), Orobon, Pratensis, Eurytrichon and Neurolobus*. The annual species excluded from subgen. *Orobus* formed the small and well-defined sect. *Orobastrum*.

Davis (1970), divided the genus into eleven section. They are sect. *Orobus*, sect. *Lathyrostylis* as plathystylis, sect. *Pratensis*, sect. *Neurolobus*, sect. *Orobon*, sect. *Orobastrum*, sect. *Lathyrus*, sect. *Cicercula*, sect. *Aphaca*, sect. *Nissolia*, sect. *clymenum*.

Czefranova (1971), divided Eurasian species of the genus *Lathyrus* into six subgenera: *Orobus*, *Lathyrus*, *Clymenum*, *Nissolia*, *Cicercula* and *Aphaca*. Subgen. *Orobus* contained five sections: sect. *Orobus*, sect. *Lathyrobus*, sect. Orobus, sect. Pratensis, sect. Eurytrichon and sect. Neurolobus. Subgen *Lathyrus* contained sect. Orobon, sect. *Orobastrum*, sect. *Lathyrus*

Kupicha (1983), divided genus *Lathyrus* into 13 sections: sect. *Orobus,* sect. *Lathyrosytlis*, sect. *Pratensis,* sect. *Neurolobus*, sect. *Orobon*, sect. *Orobastrum*, sect. *Viciopsis*, sect. *Linearicarpus*, sect. *Lathyrus*, sect. *Aphaca*, sect. *Nissolia*, sect.*Clymenum*, and sect. *Notolathyrus*.

The most modern phylogenetic analysis of DNA (Asmussen & Liston, 1998; Kenicer *et al.*, 2005; Kenicer, 2007) supports the majority of Kupicha's taxonomic decisions on tribal delimitation (Table 4).

Table 4. Comparison of the most recent three sectional classifications of *Lathyrus.* (* *Clymenum* may be a sister species to a clade containing all the *Lathyrus* and *Pisum*)

Kupicha (1983)	Asmussen & Liston (1998) {based on RFLP data}	Kenicer *et al.* (2005); Kenicer (2007) {based on DNA sequence from ITS (nuclear) & *trn*L-F & *trn*S-G & *mat K* (chloroplast)}
Aphaca	Aphaca	Aphaca
Clymenum	Clymenum	* Clymenum
Neurolobus	Neurolobus	Neurolobus
Nissolia	Nissolia	Nissolia
Lathyrus	Lathyrus Orobon Orobastrum	Lathyrus
Lathyrostylis	Lathyrostylis	Lathyrostylis
Linearicarpus	Linearicarpus	Linearicarpus
Notolathyrus	Notolathyrus	Notolathyrus
Orobastrum	*sunk into Lathyrus*	Orobastrum
Orobon	*sunk into Lathyrus*	Orobon
Orobus	Orobus	Orobus
Pratensis	Pratensis	Pratensis
Viciopsis	Viciopsis	Viciopsis

1.3 The Genus *Lathyrus* L. in Turkey

Boissier (1872) was the first person to study various Turkish species of *Lathyrus* along with many others known 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*.

Davis (1970), in his *Flora of Turkey,* placed 58 Turkish species under ten sections, namely *Orobus, Platystylis, Orobastrum, Pratensis, Orobon, Lathyrus, Cicercula, Aphaca*, *Nissolia*, and *Clymenum*.

Doğan et al. (1992) conducted a "Numerical Taxonomic Study on Turkish *Lathyrus* (Leguminosae) and recognized basically nine sections (*Orobus, Lathyrostylis, Aphaca, Nissolia, Orobon, Gorgonia, Clymenum, Cicercula* and *Lathyrus*) based on a phenetic analysis of vegetative and floral characters. These sections were 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. He described Sect. *Gorgonia*.

Today, the genus is represented by 62 species (78 taxa formed by the species, subspecies and varieties) belonging to 10 sections and 22 of them are endemic in Turkey (Davis, 1970; Davis et al., 1988; Güneş & Özhatay, 2000; Genç & Şahin, 2008; Genç, 2009).

According to Davis (1970, 1988) the study area, Central Anatolia contains 25 *Lathyrus* taxa and six of them are endemic to Turkey.

Members of genus *Lathyrus* in Central Anatolia (Table 1.4) are belonging to the sect. *Orobus,* sect. *Lathyrostylis*, sect. *Pratensis,* sect. *Orobon*, sect. *Viciopsis*, sect. *Linearicarpus*, sect. *Lathyrus*, sect. *Aphaca*, and sect. *Nissolia*.

Table 5. The studied taxa found in Central Anatolia, Turkey (* the endemic taxa)

Sections	Taxa
Orobus	*L. aureus* (Stev.) Brandza *L. incurvus* (Roth) Willd.
Lathyrostylis	* *L. brachypterus* Čelak. * *L. haussknechtii* (Davis) Sirj. * *L. armenus* (Boiss & Huet) Čelak. *L. digitatus* (M. Bieb.) Fiori * *L. tukhtensis* Czecz. *L. spathulatus* Čelak. * *L. cilicicus* Hayek & Siehe
Pratensis	*L. pratensis* Linnaeus *L. laxiflorus* (Desf.) O. Kuntze subsp *laxiflorus* (Desf.) O. Kuntze * *L. czeczottianus* Bässler
Orobon	*L. roseus* Stev. subsp. *roseus* Stev
Lathyrus	*L. tuberosus* Linnaeus *L. cassius* Boiss. *L. hirsutus* Linnaeus *L. chloranthus* Boiss. *L. sativus* Linnaeus *L. cicera* Linnaeus
Viciopsis	*L. saxatilis* (Ventenat) Visiani
Linearicarpus	*L. inconspicuus* L. var. *inconspicuus* Linnaeus *L. sphaericus* Retz.
Nissolia	*L. nissolia* Linnaeus
Aphaca	*L. aphaca* Linnaeus var. *biflorus* Post *L. aphaca* Linnaeus var. affinis Guss.

Species counts for unequivocal natives from some standard neighboring "Floras" are "Flora of Europaea (Tutin & Heywood, 1981): 54", "Flora of Cyprus (Meikle, 1977): 11", "Flora of Syria, Palestine and Sinai (Post, 1932): 24", "Flora of Iranica (Rechinger, 1979): 25", "Flora of Iraq (Townsend & Guest, 1977): 18" and "Flora of USSR ((Fedchenko, 1954): 50"

1.4 General Description of the Study Area

1.4.1 Location of the Study Area

Turkey is divided into three phytogeographic regions namely Euro-Siberian, Mediterranean, and Irano-Turanian. The study area, Central Anatolia, confined to the

west part of the Irano-Turanian phytogeographic region is the most isolated part of Turkey.

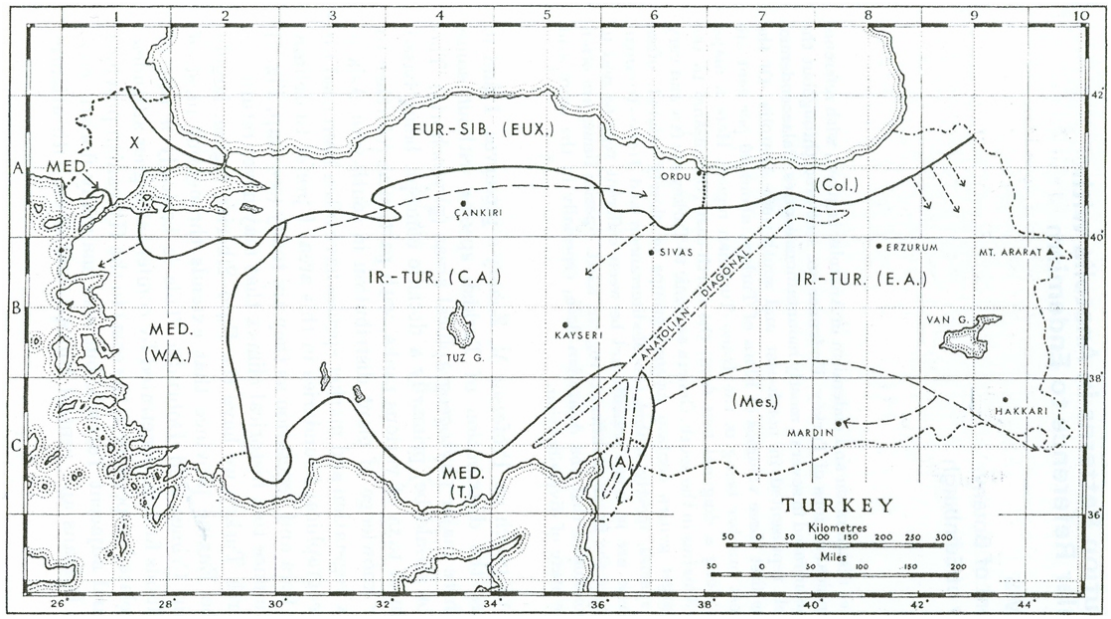


Figure 3. Phytogeographical Regions of Turkey (Davis, 1970). Eur.Sib. (Eux): Euro Siberian, Ir. – Tur.: Irano – Turanian, Med: Mediterranean Phytogeographical Regions. A.: Amanos Mountains, C.A.: Central Anatolia, E.A.: East Anatolia, T.: Taurus Mountains, Mes.: Mesopotamia.

Central Anatolian basin consists of salt steppe, saline lakes, and halophytic vegetation as well as marshes, rivers and freshwater bodies. This area represents one of the centers of endemism. Twelve of the taxa are endemic to this area.

This region is composed of three seperate areas of steppe vegetation. The Salt Lake is covering the majority of the first area. It lies in the center of the Anatolian basin. The northern and eastern edges of this area are surounded by the Kızılırmak River, the longest river in Anatolia. The Kızılırmak River starts from the Çankırı environs to the north of Tuz Lake and reaches to the Nevşehir environs in the east. The second area of this region is divided from the central area by the Obruk Plateau and lies in the Karapınar Plain to the south of Tuz Lake. The third area is composed of Porsuk

and Sakarya River basins and is seperated from by the Haymana and Cihanbeyli Plateaus. These three areas are enclosed within an area where deciduous forests represent the primary vegetation type. The absence of any woody formations is the principal feature that distinguishes this steppe region from the surrounding deciduous forests. (Birand, 1960; Davis, 1965; Boulos et al., 1994; Vural et al., 1999; Eken & Magnin, 1999)

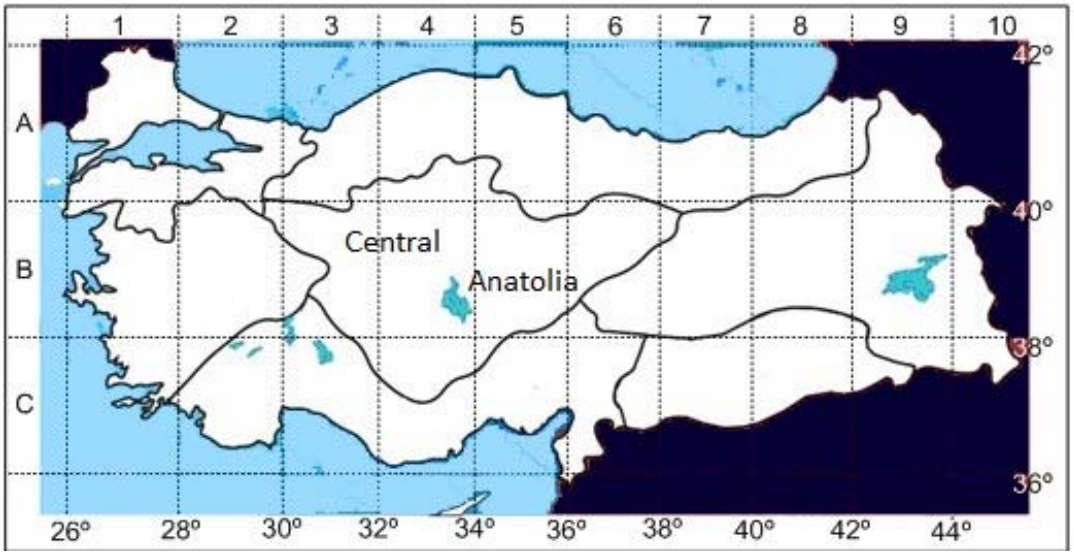


Figure 4. Location of the study area

1.4.2 Climate of the Study Area

One of the most important factors determining the distribution of plants in the world is climate. The climate of study area, Central Anatolia, resembles that of the Mediterranean climate, of West and South Anatolia. Local climatic characteristics can also be seen in the study area. In most areas of Central Anatolia, precipitation is less and much of it falls as snow (Davis, 1965). An average rainfall is 40 cm per year. The semiarid center of the plateau, which is the driest part of the region, receives average precipitaiton 30 cm per year in the area. Towards the East Anatolia winter, temperatures are very much lower. There is a huge temperature difference between day and night. Rainfall is low. January is the coldest mount and average

temperature is -0.7 ^{0}C. July is the hottest mount and average temperature is 22 ^{o}C. Average annual temperature is 10.8 ^{0}C. In general, Central Anatolia experiences high temperatures in summer and cold weather with heavy snow in winter. (Sensoy et al., 2010)

1.4.3. Topography and Vegetation of the Study Area

Anatolia consists of a plateau, rising steadily towards the east and bounded on the north and south by steep mountain ranges. In the center of Central Anatolia, the plateau falls gradually to the treeless depression containing the large Salt Lake (Tuz Gölü). Most of this central plateau is covered by very soft rocks – chalk, clay and marl, in the vicinity of the Çankırı and Sivas. Several extinct volcanoes rise from the plateau of Central Anatolia; some of the more prominent in this area are Karadağ (2771 m) near Karaman, Hasan Dağı (3268 m) and Melendiz Dağları near Niğde, and Erciyes Dağı (3,917 m) near Kayseri. Most of them have been formed in Quaternary times. A large area of volcanic tuff occurs near Nevşehir. The plateau-like, semiarid highlands of Anatolia varies in elevation from 600–1,200 m from west to east

The main geological formation of Central Anatolia is young alluvial deposits. These young aluvial deposits are Oligocene formations of saline and gypsum. Because the principal formation in this region is salt steppes and lakes, woody plants do not occur here and halophytic plants are favored. (Birand, 1960; Davis ,1965; Boulos et al., 1994; Akman et al., 1994; Aydoğdu et al., 1994; Vural et.al., 1999; Eken & Magnin, 1999)

Central Anatolian territory is covered by the steppe vegetation, extending from Taurus Mountains at south to Ilgaz Mountains at north and from Anatolian Diagonal at east to Afyonkarahisar at west. All of the steppe communities of Central Anatolia belong to the *Astragalo-Brometea* class, the onobrychido Armenae-Thymetalia leucostomi order, and its two suborders. Steppe vegetation of Central Anatolia also

shows attitudinal variation. The “plain steppe” vegetation covers between 800 – 1200 m and the “montane steppe” vegetation covers above 1200 m. (AkmanY. & Ketenoğlu O. 1976; Akman Y. & Ketenoğlu O. 1979;; Çetik, 1985; Akman Y. & Ketenoğlu O. 1986; Aydoğdu M. & Ketenoğlu O. 1993; Akman et al., 1996; Ketenoğlu et al., 1996; Ketenoğlu et al., 1999; Kurt, 2000; Kurt, 2002; Kurt et al., 2006)

1.5. Objectives and Scope of the study

The objectives of this study were as follows;

- To collect all of the *Lathyrus* taxa growing in Central Anatolia so as to study the morphology, anatomy and systematics of them.
- To classify *Lathyrus* species by means of using numeric taxonomic methods.
- To understand macro and micro morphological, palynological, phytogeographical and anatomical diagnostic characteristics of the taxa.
- To construct an identification key for the species found in the study area.
- To make a more accurate revision of the genus in Central Anatolia
- To determine the threat categories of the Genus
- To identify habitat preferences of the Genus

CHAPTER 2

MATERIAL AND METHODS

2.1 Collection of the Plant Materials

According to the standard techniques (Woodland, 1997) large number of specimens were collected from all parts of Central Anatolia, between 2008 and 2010. All collected specimens were dried first using standard techniques given by Davis & Heywood (1973) and preserved in Plant Systematics Laboratory, Department of Biological Sciences, Middle East Technical University (METU), Ankara. During the study period, many herbarium specimens from ANK, GAZİ, HUB, KNYA, CUFH, Erciyes, and Royal Botanic Garden Edinburgh **(**RBGE**)** herbaria.

During the field studies, when the specimens was detected, their geographic locations (including GPS and Latitude record), habitat, phenological data, and relevant field observations were recorded. The collected specimens' vulnerability on the bases of the current version of the conservation status was checked (IUCN, 2001). The distribution maps of the *Lathyrus* species are prepared.

The specimens were cross checked with the *Layhyrus* accounts given in various relevant floras such as *Flora Orientalis* (Boissier, 1879), *Flora of the USSR* (Fedchenko, 1954), *Flora of Syria, Palestina and, Sinai* (Post 1933), *Flora of Iranica* (Rechinger, 1979) and *Flora of Europaea* (Ball, 1968; Tutin & Heywood, 1981) and

Flora of Iraq (Townsend & Guest, 1977) All the plant names are given according to Brummit & Powell (1992).

2.2 Morphological Studies of Vegetative and Reproductive Structures

In order to perform morphological studies, live and herbarium materials were examined. Using a Leica S8AP0 stereomicroscope, the leaf, stem, inflorescence, calyx, and corolla characters of each taxon were studied and measured to determine their morphological characteristics.

2.3. Anatomical Method

In this study, for practical reason, the method described by Metcalfe, was slightly altered and used. The specimens kept in 70 % alcohol were used in anatomical studies. In order to take the cross sections of the leaves, stems, and roots the paraffin method was used. The specimens were embedded in paraffin first and then sectioned at 10 µm thickness with a Leica RM2125RT rotary microtome. All sections were stained with safranin-fast green respectively and then mounted with Entellan. Photo and measurements were taken using a Leica DM100 binocular light microscope with a DFC280 camera (Johansen, 1944; Metcalfe & Chalk 1950, Doğan, 1986)

For the preparation of SEM slides, corolla (standart), calyx and leaf samples for each taxon were mounted on double – sided carbon tape affixed to aluminum stubs, covered with gold Hummle VII sputter coater and photographed at scanning electron microscope to determine the micromorphology of the corolla (standart), calyx and leaves (Johansen, 1944; Metcalfe & Chalk 1950; Doğan, 1986)

2.4 Micromorphological and Statistical Method

The pollen grains were obtained from collected specimens for palynological investigations. The pollen grains were dissected from collected samples and placed

on clean microscope slides. Then they were treated with 70% alcohol to remove oily substances. Glycerin and basic fuchsine were added on the pollen grains and then they were mixed with a clean pin to be scattered according to the method giveb by Wodehouse (1935). The Leiaca DM1000 binocular light microscope with the Leiaca DFC280 camera was used to make measurements and observations. Polar diameter (P), Equatorial diameter (E), pollen grains shape (P/E), exine thickenes (Ex), colpus lenght (clg), porus length regarding the poles, and porus width regarding the equatorial diameter (plt) for 25 pollen grains were measured by light microscope (x1000). P/E ratios, minimum, maximum and mean±standard deviation for each variable were calculated (Table 7).

For the preparation of SEM slides, unacetolyzed pollen grains were mounted on double – sided carbon tape affixed to aluminum stubs, covered with gold Hummle VII sputter coater and photographed with a 25 taxa at scanning electron microscope to determine the micromorphology of the pollen grains. The Faegri and Iverson (1989) Henderson et al. (1968), and Punt et al. (2007) pollen grains terminology were used in palynological investigations.

For the preparation of SEM slides, unacetolyzed calyx, corolla and leaf sections were mounted on double – sided carbon tape affixed to aluminum stubs, covered with gold Hummle VII sputter coater and photographed with a 25 taxa at scanning electron microscope to determine the micromorphology of the calyx, corolla and leaf (Figure 10 to Figure 23).

For statistical analysis, SPSS 13.0 for Windows package programe was used. Anova and Post hoc statistical analysis were applied to compare the value of P/E to find any significant diffence at sectional and at species level for grouping the taxa. In this statistical analysis, the LSD test was applied because it is used to explore all possible pair-wise comparisons of means comprising a factor using the equivalent of multiple t-tests.

2.5. Multivariety Analysis

By measuring the 39 vegetative and reproductive characters to investigate their taxonomic delimitations, the morphometric analysis was carried out on the stemming from my own collections (Table 46). The characters were selected according to two criteria; (i) variability among the different taxa and (ii) their common usage of taxonomic identification. The selected but overlapping characters were omitted. Some morphological characters, such as length of the corolla and calyx, and color of corolla, were difficult to measure from dried specimens. For this reason, these morphological characters were measured and noted in the field.

For multivariety analysis, all specimens were termed as OTU's (operational taxonomic unit) in numerical phenetics, and characters were scored for multivariate analysis according to Sneath & Socal (1973). The similarity matrix was created first using Gower's (1971), and general coefficient similarity (Sneath and Sokal, 1973), which can be used directly with a mixture of character types (qualitative characters, quantitative characters, semi-quantitative characters, binary and alternative) as well as taking into account missing values (St-Laurent *et al.,* 2000). Then, this similarity matrix was clustered by using UPGMA (the unweighted pair-group method using arithmetic averages) and the results are shown in the phenogram. The MVSP (a multivariate statistics package for IBM PC and compatibles) program package for clustering analysis was applied for this analysis (Kovach, 1999).

2.6 Assesment of Geographical Distribution, Endemism, Phytogeography and IUCN Threat Categories of the Species

Distributions of the taxa were given on the maps according to Davis' grid square system (Figure 88 to Figure 99). In order to asses, the species distribution in the study area, our own collected samples, herbarium specimens, and Floristic studies had carefully investgated.

According to IUCN Red List Catagories 3.1 (2001) and the Application of IUCN Red List Criteria at regional Levels (Gardenfors et al., 2001), the threat categories are proposed for all the studied taxa. Details of the threats are determined for each collected species and comments are made according to Broughton & McAdam (2002).

The threat categories were proposed for all the collected taxa according to IUCN Red List Categories Version 3.1 (2001). When the species was detected at their natural habitat, their actual or potential levels of exploitation (in criteria A), the area of occupancy (in criteria B), and distribution (GPS locations), population and their size (in criteria C) and the number of mature individuals (in criteria D) were observed. Current conservation status of the taxa was re-evaluated according to the results (Table 44, Table 45, Figure 85, Figure 86).

The following categories used in this study were established and defined by IUCN (2001).

- Endangered (EN): a taxon faces a very high risk of extinction in the near future in the wild.
- Vulnarable (VU): a taxon faces a high risk of extinction in the medium-term future
- Near threatened (NT): a taxon may be considered threatened in the near future.
- Least concern (LC): there is no immediate threat to the survival of the taxon.

Findings about the IUCN threath categories in this thesis were compared with the Turkish Red Data Book (Ekim et al., 2000).

CHAPTER 3

RESULTS

3.1 Vegetative and Reproductive Morphological Characters and Their Variation

Both reproductive and vegetative structures were observed in the field. By using x10 to x80 dissecting binocular microscope, reproductive and vegetative structures were studied. To make further investigations, if necessary, the reproductive and vegetative structures were put into hot water to restore as possible as to get their shape. Then, they were placed on a smooth tile and dissected under light microscope, by using two fine needles.

3.1.1. Habit

All the members of *Lathyrus* living in Central Anatolia is herbaceous. *L. aureus* and *L. incurvus* (sect. *Orobus*); *L. brachypterus, L. haussknechtii, L. armenus, L. digitatus, L. spathulatus*, *L. tukhtensis*, and *L. cilicicus* (sect. *Lathyrostylis*), *L. czeczottianus, L. laxiflorus* subsp *laxiflorus ,* and *L. pratensis* (sect. Pratensis); *L roseus* (sect. *Orobon*) are perennial (Figure 7). *L. saxatilis*(sect. Viciopsis); *L. inconspicuus* and *L. sphaericus* (sect. *Linearicarpus*); *L. nissolia* (sect. *Nissolia*); *L. aphaca* (sect. *Aphaca*) are annual. Most of annual *Lathyrus* species are relatively delicate.

Except for the *L. tuberosus*, all the members of sect. *Lathyrus* (*L. cassius, L. hirsutus, L. chloranthus, L. sativus* and *L. cicera*) are annual.

Perennial species of *Lathyrus* have creeping, or thickened rhizomes or tubers and may form extensive clumps or patches when the above-ground stems themselves are relatively short.

Genus *Lathyrus* is mainly restricted to cool temperate and mediteranean climate. For this reason, above –ground stem die back duruing the non-growing season.

L. incurvus belong to a sect. *Orobus* is clamber with the aid of tendril. Members of sect. *Pratensis*; *L. pratensis* and *L. laxiflorus* subsp. *laxiflorus* (only upper leaves) have simple-slender tendril. 3 sect tendril is feature of sect. *Lathyrus* (*L. tuberosus, L. cassius, L. hirsutus, L. chloranthus, L. sativus,*and *L. cicera*). Only upper leaves are bearing simple tendril in *L. inconspicuus* L. var. *inconspicuus* and *L. sphaericus* members of sect. *Linearicarpus*. The leaves of sect. *Aphaca* have been reduced to a pair of large, sagittate stipules and a simple tendril. The species having a tendril is climbing to surrounding vegetation for their support. For this reason these tedrillous species perefer lower vegetation areas such as roadsides and meadows.

All the members of sect. *Lathyrostylis* (*L. brachypterus, L. haussknechtii, L. armenus, L. digitatus, L. tukhtensis, L. spathulatus* and *L. cilicicus*), *L. roseus* subsp. *roseus* belong to a sect. *Orobon* and *L. aureus* belong to a sect. *Orobus* have no tendril and have free standing. Therefore, they live in more open habitat and forest understoris.

L. nissolia belong to a sect. *Nissolia* have no tendril and plant of meadows and pastures. *L. saxatilis* belong to a sect. *Viciopsis* have no tendril and slender. This species is common in areas of roadsides and rocky slopes.

3.1.2 Stem Morphology

Stems of *Lathyrus* are herbaceous. Nevertheless, in the oldest stem bases of *L. roseus* subsp. *roseus* contain slightly woody tissue.

Members of genus *Lathyrus* have procumbent, climbing or erect stem. Stems can be angeled, winged, terete, striate or quadrate.

The stem wings increase the photosynthetic area available to the plant (Kenicer, 2007). *L. incurvus* belong to a sect. *Orobus* has winged stem. Except for the *L. tuberosus* all the members of sect. *Lathyrus* have winged stem. The wings of *L. sativus* is as broad as stem but the wings of *L. cicera* is somewhat narrower than the stem. These two species are look like very closely to each other. Thus the wing size can be an important character to differenciate these two species.

All the members of sect. *Lathyrostylis*, sect. *Pratensis*, sect. *Viciopsis* and sect. *Linearicarpus* have angled or slightly angled stem. *L. roseus* subsp. *roseus* belong to a sect. *Orobon* has terete and striate stem. *L. nissolia* and *L. aphaca* have slightly terete stem.

The stem of *L. armenus, L. spathulatus, L. cilicicus, L. roseus* subsp. *roseus, L. saxatilis, L. sphaericus* and *L. aphaca* are glabrous. The stem of rest of the studied taxa is more or less pubescent.

3.1.3. Leaf Morphology

All species of genus *Lathyrus* have herbaceous leaves. Leaf characters have been given strong weighting in classifications. Leaves in *Lathyrus* are paripinnate and subdigitate, ending in mucro, arista or tendril. The main distinction between *L. brachypterus* and *L. haussknechtii* is the leaf character. *L. brachypterus* has pinnate leaf and *L. haussknechtii* has subdigitate leaf. Leaf of *L. incurvus* belong to a sect.

Orobus, members of sect. *Pratensis,* sect. *Lathyrus*, sect. *Linearicarpus* ending with tendril.

L. saxatilis has multijugate and non-phyllodic leaves. All leaves have mucronate rachis; with reticulate veins. Leaflets of lower leaves are 1-3-paired and narrowly cuneateoblong, 3-toothed above; leaflets of upper leaves are 2-3-paired, narrowly linear.

In *L. nissolia*, the leaves are simplified to phyllodes, lanceolate-linear and stipules are reduced to spurs.

In *L. aphaca*, the leaflets are completely absent and the leaves are reduced to a simple tendril with shortly hastate stipules (Figure 5).

Leaflets are 3- 5 paired in the members of sect. *Orobus*. In sect. *Lathyrostylis* 2 paired leaflets are common. *L. brachypterus* and *L. haussknechtii* have 2-3 paired leaflets. L. digitatus has 1-2 paired leaflets. The members of sect. *Pratensis*, sect. *Orobon*, and sect. *Lathyrus* 1 paired leaflets.

The members of sect. *Lathyrostylis*, sect. *Pratensis*, sect. *Linearicarpus*, sect. *Nissolia* and sect. *Lathyrus* have parallel veins in the leaflets. *L. roseus* subsp. *roseus* belong to sect. *Orobon* have reticulate veins in the leaflets.

Figure 5. General Appearences of *L. aphaca*

In *L. Nissolia* stipules are reduced to spurs and in *L. aphaca* and in *L. saxatilis* stipules are shortly hastate (Figure 6). Rest of the studied taxa has semisagittate stipules.

The distribution of stomata on upper and lower surface of leaf and the shape of the epidermal cells are vary and taxonomically significant characters. Stomata are found both upper and lower surface of epidermis. Members of sect *Orobus* (mesophytic) have more even distributions of stomata. Members sect *Lathyrostylis* (xerophytic) have more stomata on the undersides of leaves.

3.1.4 Inflorescence Morphology

The inflorescences are solitary *L. nissolia*, *L. sphaericus, L. cicera, L. sativus, L. saxatilis,* and *L. inconspicuus; L. hirsutus, L. chloranthus, and L. aphaca* have 1-2 flowers. The inflorescences are in racemes of up to 25 flowers rest of the species studied. Dense raceme caharaceter is associated with a bushy habitat, etendrillous leaves and broad leaflets. In *Lathyrus*, the evolution of annual groups has been accompanied by a decrease in flower number (Kupicha, 1983).

Peduncle length is the minor variable character. Some members of *Lathyrus* such as *L. sphaericus* and *L. inconspicuus* are unusual in having sessile flowers (Figure 6). Flowers are always pedicellate with or without a floral bract at the base and the pedicel are articulated smoothly with the peduncle.

Figure 6. General Appearences of *L. nissolia*

Figure 7. General Appearences of *L. czeczottianus*

3.1.5 Flowers

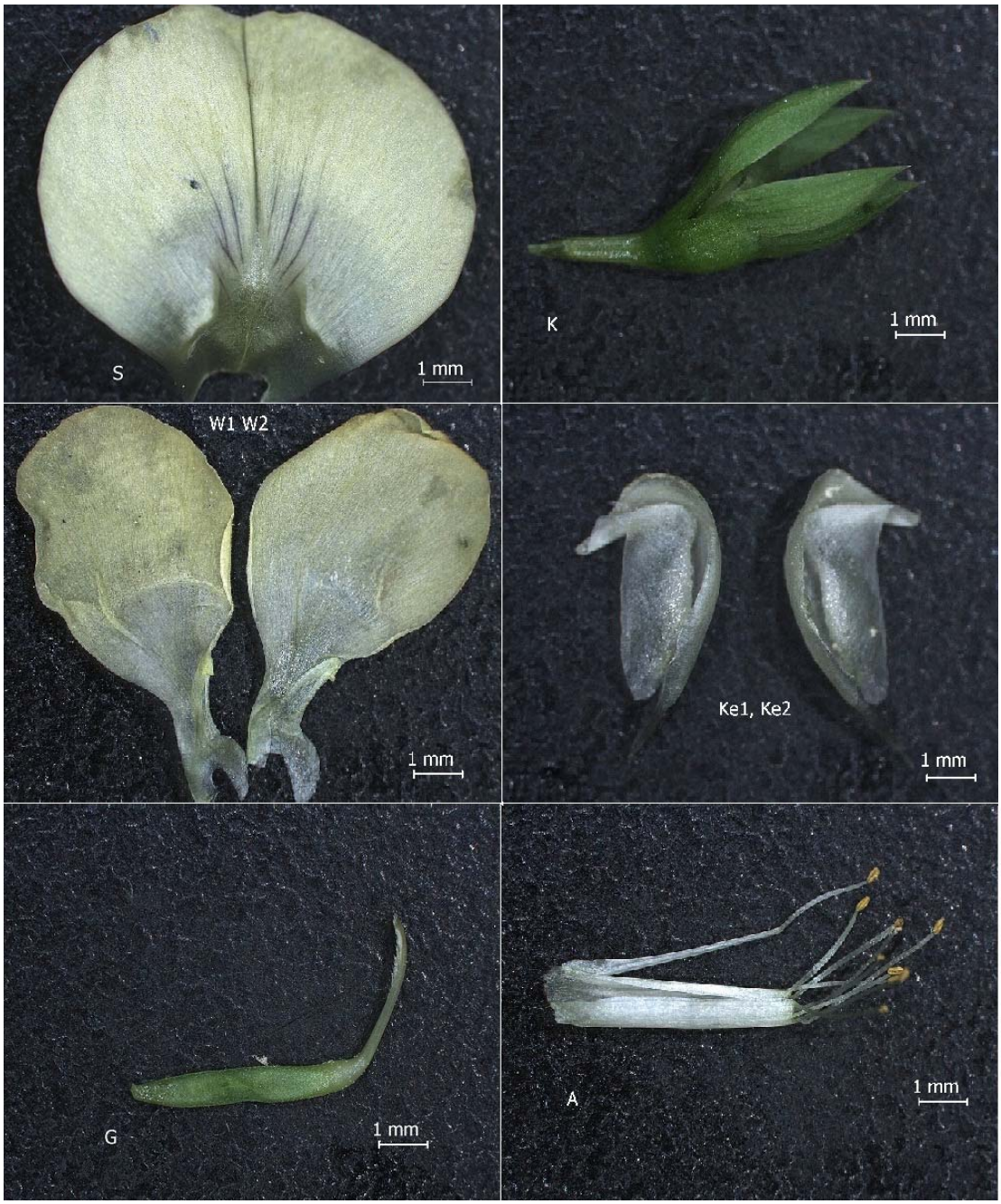


Figure 8. Flower parts of *L. aphaca* var. *biflorus*. S = standard petal, K = Calyx, W1 & W2 = Wing petals, Ke1 & Ke2 = Keel petals, G = Gynoecium, A = Androecium

Lathyrus have typical papilionoid legume flowers and have three kinds of petals; a dorsal petal, called a "standard" (Figure 8. S), the two lateral petals called a "wing" (Figure 8. W1, W2), and two ventral petals forming the "keel" (Figure 8. Ke1, Ke2).

The flower is somewhat protandrous; pollen grains go out from the bursting anther into the pouched apex of the carina, and collects in a mass round the stigma. The hairs on the adaxial side of the style also help to move the pollen grains into this position, where it is ready to be transferred to an insect visiting the flower for nectar.

3.1.5.1. Calyx

Calyces may be regular or irregular. Regular calyces have equal calyx teeth and irregular calyces have longer lower calyx teeth (Figure 8 K). The members of sect. *Orobus* have unequal calyx teeth. *L. aureus* has slightly pubescent calyx but *L. incurvus* has glabrous calyx; the members of sect. *Lathyrostylis* have unequal or subequal calyx teeth. *L. brachypterus, L. haussknechtii, L. armenus,* and *L. digitatus* have unequal calyx teeth. *L. tukhtensis, L. spathulatus,* and *L. cilicicus* have subequal calyx teeth; the members of sect. *Pratensis* have subequal calyx teeth; *L. roseus* subsp. *roseus* belong to sect. *Orobon* has unequal calyx teeth; all the members of sect. *Lathyrus*, sect. *Viciopsis*, sect. *Nissolia* and sect. *Aphaca* have subequal calyx teeth; *L. inconspicuus* belong to sect. *Linearicarpus* has equal cayx teeth, but L. sphaericus has subequal calyx teeth.

3.1.5.2. Corolla

Corolla color is variable across the genus, within the larger sections and even within species and changes, usually deepening as the individual flowers age. Purple and blue colors are predominate, but pinks, reds, including brick red, yellows and white are also found. The corolla color is important in distinguishing between related species such as *L. sativus* and *L. cicera.*

L. aureus (sect. *Orobus*) have almost linear standard. However, the standard is stenonychioid, with a relatively wide banner and narrow claw in most members of *Lathyrus*. The stenonychioid standard is characteristic of species with few-flowered racemes. Except for the *L. tuberosus* , *L. cassius*, *L. hirsutus*, *L. chloranthus*, *L. sativus*, *L. cicera* (sect. *Lathyrus*) and *L. roseus* (sect. *Orobon*) in all groups of genus *Lathyrus* the standard has two more or less prominent pouches or bosses at the fold which carries banner away from the wings (Figure 9). These processes are help to support the standard and rest against the wings. *L. tuberosus* (sect. *Lathyrus*) and *L. roseus* subsp. *roseus* (sect. *Orobon*) have flowers in which the tube is relatively short and standard wide.

Figure 9. General Appearences of *L.roseus* subsp. *roseus*

The wings of most species of *Lathyrus* have a lower and upper process but no pleat in the upper edge of the wing. The wings are simpler construction, only the lower process is present in sects *Orobon* and sect. *Lathyrus.* Members of sects. *Aphaca* and *Pratensis* have wings with a waist between the limb and the middle area that is united with the keel. Keel petals are always strongly fused along the basal margin.

3.1.5.3 Androecium

In genus *Lathyrus,* the androecium is diadelphous, with the single near-free stamen at the adaxial part (Figure 8. A). The nine remaining stamens form a tube with a truncate apex in most of the species. In the research area, all the collected species have truncate apices except for the *L pratensis,* which is intermediate.

3.1.5.4 Gynoecium

The style of all the members of *Lathyrus* has a dorsally compressed. It is pubescent on the adaxial side and generally linear. But some members of *Lathyrus* e.g. *L. tukhtensis, L. spathulatus* and *L. cilicicus* (style obovate to spathulate) belong to sect. *Lathyrostylis* have spathulate style. Many intermediate species are found throughout the genus. The style ends in a mucro of non-stigmatic tissue that divides the stigma into two (Figure 8. G).

All the collected species have an adaxial pollen grains brush. This is formed from stylar trichomes (Gunn & Kluve, 1976; Lavin and Delgado 1990). It has been suggested that stiff hairs play a role in holding the pollen grains in place to present it to pollinators; although it is thought that they have role in breaking, the anthers open (Gunn & Kluve 1976).

L. hirsutus and *L. chloranthus* have a twisted style. This is a good character for diagnosing the members of sect. *Lathyrus*.

3.1.6. Fruit

Fruits can have between two to fifteen seeds. The members of sect. *Orobus,* sect. *Lahyrostylis*, and sect. *Nissolia, L. inconspicuus* and *L. laxiflorus* subsp. *laxiflorus* have linear legume. The members of sect. *Aphaca,* sect. *Viciopsis, L. chloranthus*, *L. hirsutus*, *L. tuberosus,* and *L. pratensis* have linear oblong legume. *L. incurvus* has linear-incurved legume. *L. roseus* subsp. *roseus* has linear oblanceolate legume. *L.*

sativus and *L. cicera* have oblong legume. *L. sphaericus* has linear- ensiform legume. Especially among annual groups, Fruit characters have some taxonomic value within genus *Lathyrus*.

3.2 Calyx, Leaf, Corolla and Pollen grains Micromorphology

3.2.1 Calyx, Leaf and Corolla Micromorphology

There is little varation in the epidermal cell structure in calices of the genus. Epidermal cells of the calices are generally irregular in shape and covered with thin or thick cuticle. Cuticles are either smooth or granulate with or without wax secretion. The stomata are very sparsely distributed. *L. aureus, L. chloranthus, L. czeczottianus, L. hirsitus, L. inconspicuus* and *L. nissolia* have trichomes on their calyx (Figure 10, Figure 18, Figure 20, Figure 21, Figure 25).

Non-glandular trichomes are present in some of the studied taxa. The trichomes are situated both on the calyx and on leaf. The nonglandular trichomes are either short (Figure 25), long (Figure 18), 1 celled and thin or thick.

The shape of the epidermal cells and the distribution of stomata are taxonomically significant (Kupicha, 1983). Four different epidermal cell types are specified in the *Lathyrus*, characterized as follows;

1. Epidermal cells are isodiametric with strongly wavy walls in *L. roseus* subsp. *roseus, L. laxiflorus* subsp. *laxiflorus* (Figure 17 and Figure 19).

2. Epidermal cells isodiametric or slightly elongated with wavy or straight walls *L. armenus, L. aureus, L. cassius, L. cilicicus, L. czeczottianus, L. pratensis, L. sativus, L. saxatilis, L. tuberosus*.

3. Epidermal cells elongated slightly wavy walled. *L. chloranthus, L. digitatus, L. haussknectii, L. hirsutus, L. inconspicuus* var. *inconspicuus, L. incurvus, L. nissolia* (Figure 13, Figure 20, Figure 21, Figure 23, Figure 25)

4. Epidermal cells elongated with strongly wavy walled *L. brachypterus, L. cicera, L. spathulatus, L. sphaericus, L. tukhtensis* (Figure 12, Figure 15, Figure 24)

The stomata are level with the epidermis in *L. armenus, L. aureus, L. cassius, L. chloranthus, L. cicera, L. cilicicus, L. pratensis, L. spathulatus, L. sphaericus, L. tuberosus, L. incurvus, L. laxiflorus* subsp. *laxiflorus, L. roseus* subs. *roseus*, *L. sativus*. The stomata are sunken somewhat into the epidermis in *L. brachypterus, L. digitatus, L. haussknechtii, L. hirsutus, L. inconspicuus* var. *inconspicuus, L. nissolia, L. saxatilis and L. tukhtensis* (Figure 10 to Figure 27)

The corolla epidermal surface is important in pollination by influencing the pollinators. The corolla epidermal type and its surface ornamentation affect color depth, iridescence, scent production, temperature, and provide tactile cues. (Kay et al., 1981; Kay, 1988; Gorton and Vogelmann, 1996; Dyer et al., 2007; Whitney et al., 2009; Kolossova et al., 2001; Comba et al., 2000; Dyer et al., 2006; Stirton, 1981; Kevan and Lane, 1985; Comba et al., 2000; Whitney et al., 2009).

According to a major epidermal cell in their corolla, studied taxa can be divided into three group (Table 6).

Type I; Papillose conicals cells with striations. This type is unique to sect. Aphaca.
Type II; Papillose knobby cells with a rugose sculpture. Surface ornamntation of standard of *L. choloranthus* is different from the rest of the taxa. It is suggested that, this species should be grouped as tabular knobby cells with a rugose sculpture as a new ornamentation type for the genus *Lathyrus*.

Type III; Tabular rugose cells with longitudinal striations. This type is common in the genus.

In contrast to the Isidro et al., (2009) the tabular rugose cells are mainly found on "standard" petal.

Table 6. Classification of the petal epidermal types observed in *Lathyrus*.

Major type group	Major epidermal cell	Taxa
Papillose	Papillose conicals cells with striations	*L. aphaca* var.*biflorus* *L. aphaca* var.*afinis*
	Papillose knobby cells with a rugose sculpture	*L. chloranthus*[2] *L. czeczottianus*
Tabular	Tabular rugose cells with longitudinal striations	*L. armenus* *L. aureus*[1] *L. brachypterus* *L. haussknectii* *L. cassius* *L. cicera* *L.cilicicus*[3] *L. digitatus*[4] *L. hirsitus* *L. inconspicuus* var. *inconspicuus* *L. incurvus*[5] *L. laxiflorus* subsp. *laxiflorus* *L. nissolia* *L. pratensis* *L. roseus* subsp. *roseus* *L. sativus* *L. saxatilis* *L. spathulatus* *L. sphaericus* *L. tuberosus* *L. tukhtensis*[4,5]

(1. cells elongated with dense striation; 2. most distinc type; 3. cells isodiametric or elongated cells with less-dense striations; 4. cells more or less isodiametric with dense striation; 5. cell borders distinct)

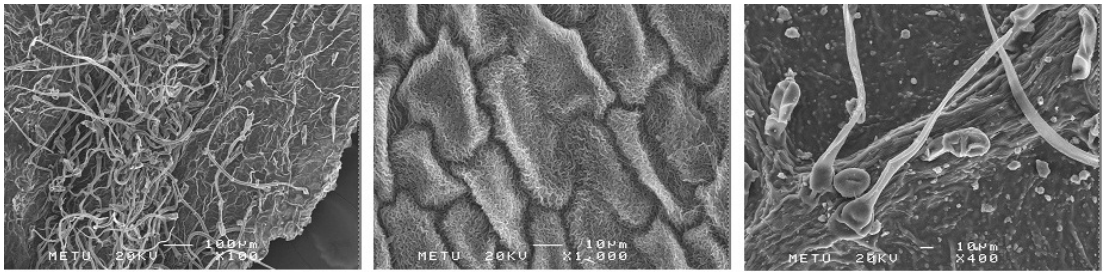


Figure 10. Calyx, Corolla and Leaf Micromorphology of *L. aureus*

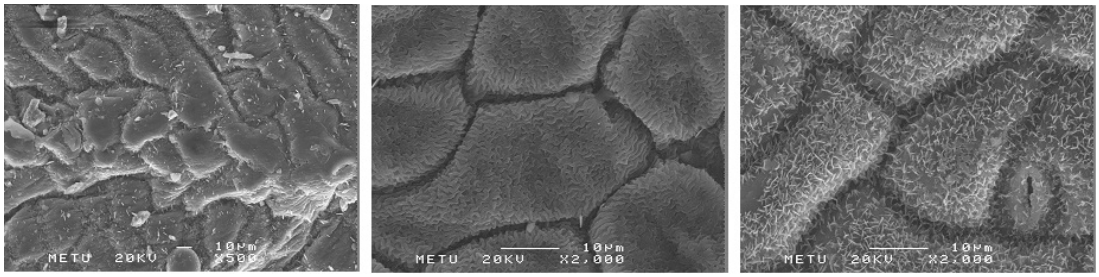


Figure 11. Calyx, Corolla and Leaf Micromorphology of *L. incurvus*

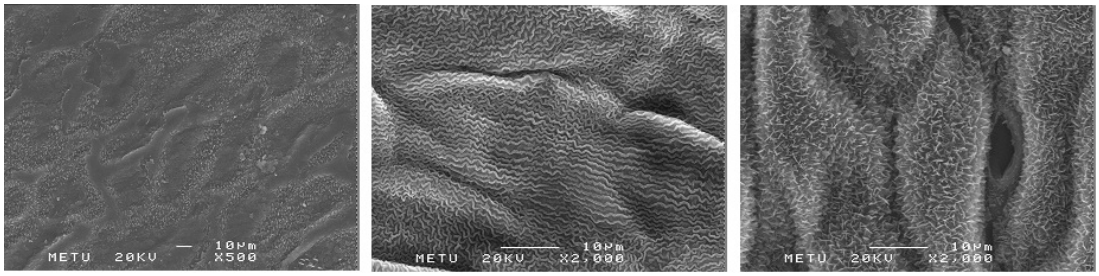


Figure 12. Calyx, Corolla and Leaf Micromorphology of *L. brachypterus*

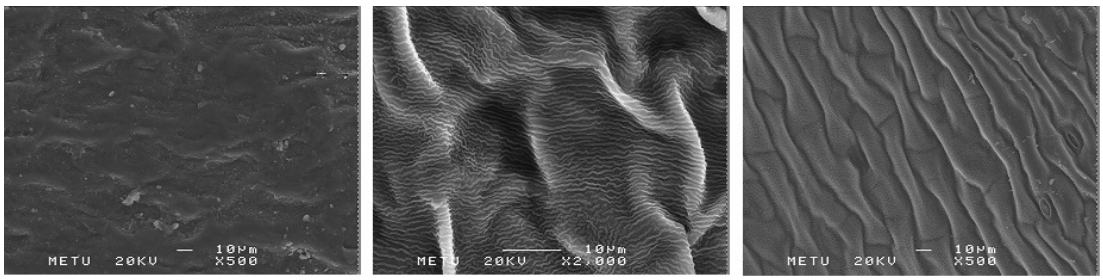


Figure 13. Calyx, Corolla and Leaf Micromorphology of *L. haussknechtii*

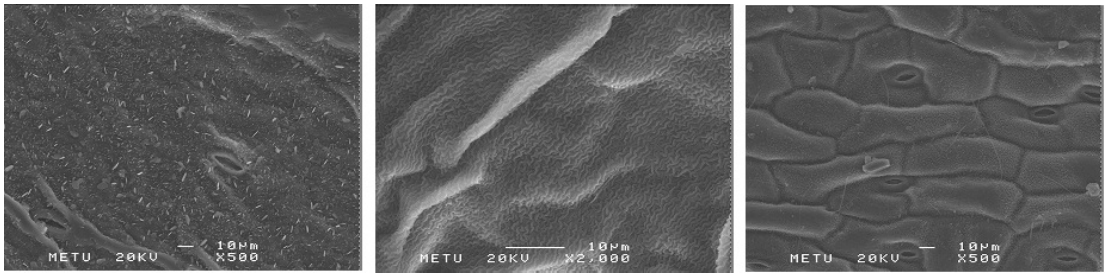


Figure 14. Calyx, Corolla and Leaf Micromorphology of *L. armenus*

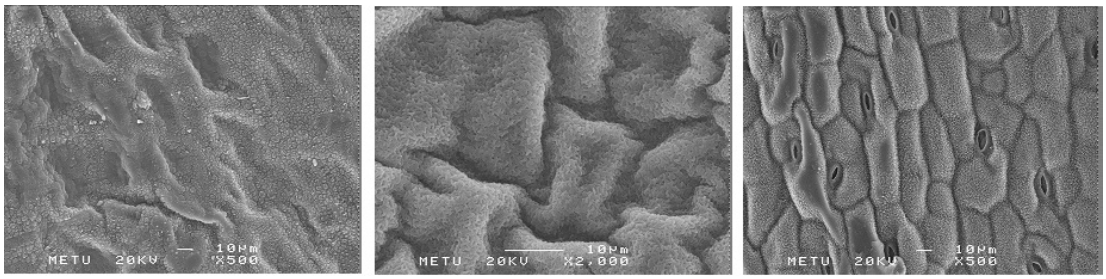


Figure 15. Calyx, Corolla and Leaf Micromorphology of *L. tukhtensis*

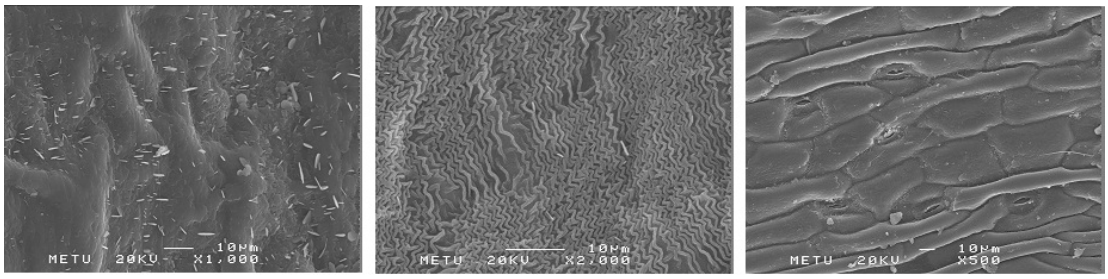


Figure 16. Calyx, Corolla and Leaf Micromorphology of *L. cilicicus*

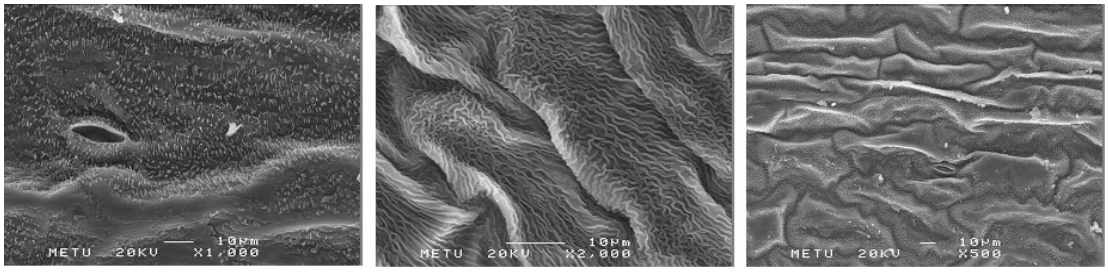


Figure 17. Calyx, Corolla and Leaf Micromorphology of *L. laxiflorus* subsp. *laxiflorus*

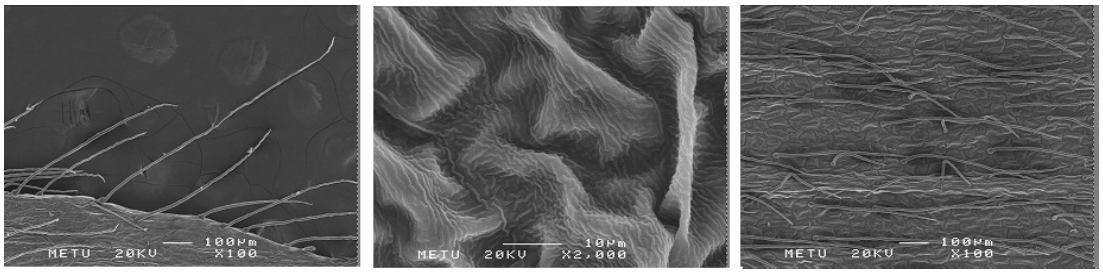


Figure 18. Calyx, Corolla and Leaf Micromorphology of *L. czeczottianus*

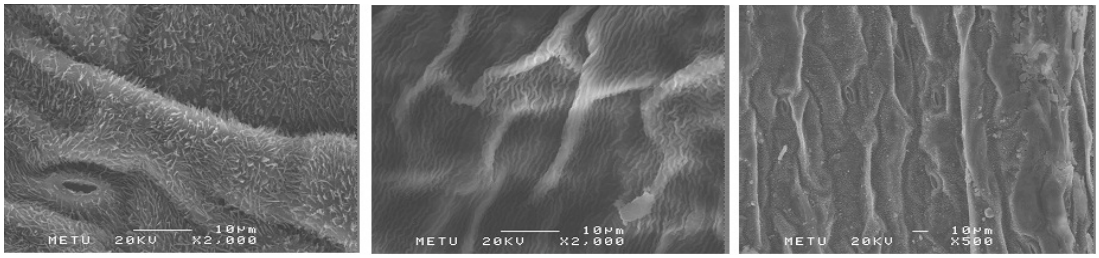


Figure 19. Calyx, Corolla and Leaf Micromorphology of *L. roseus* subs. *roseus*

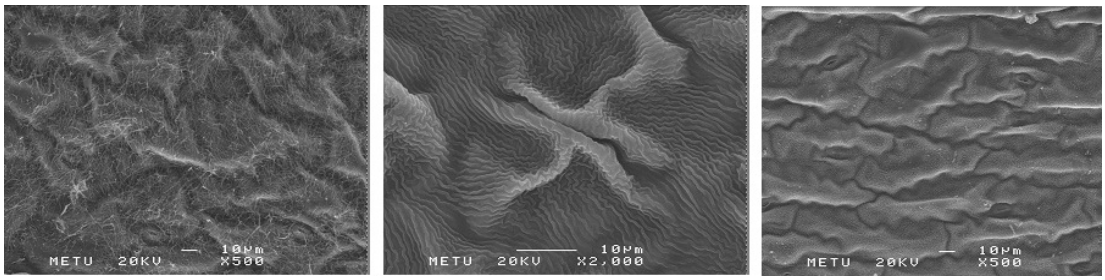


Figure 20. Calyx, Corolla and Leaf Micromorphology of *L. hirsutus*

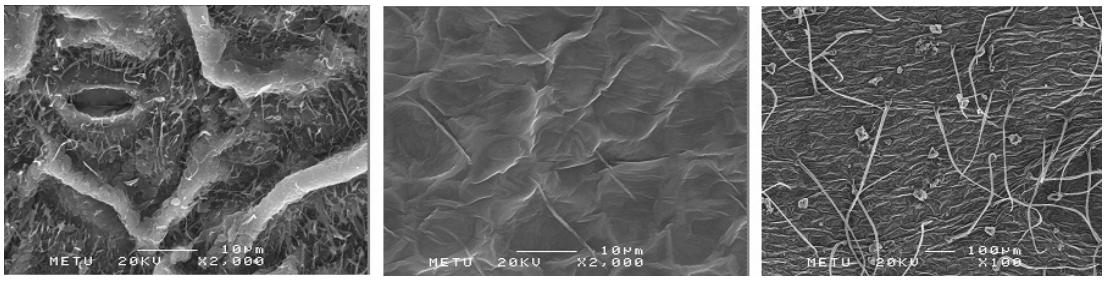


Figure 21. Calyx, Corolla and Leaf Micromorphology of *L. chloranthus*

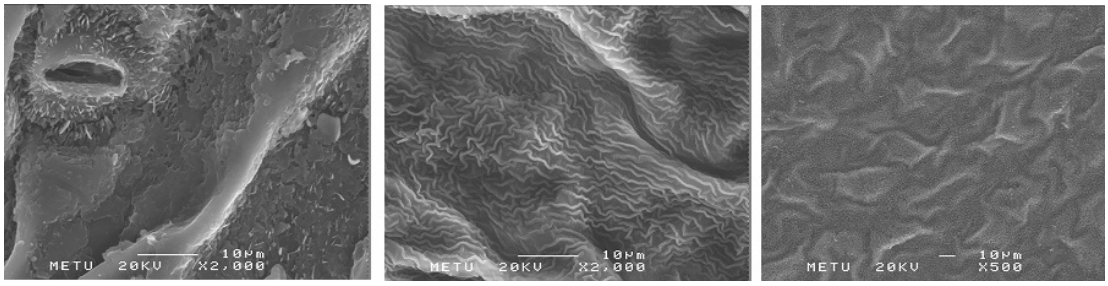


Figure 22. Calyx, Corolla and Leaf Micromorphology of *L. sativus*

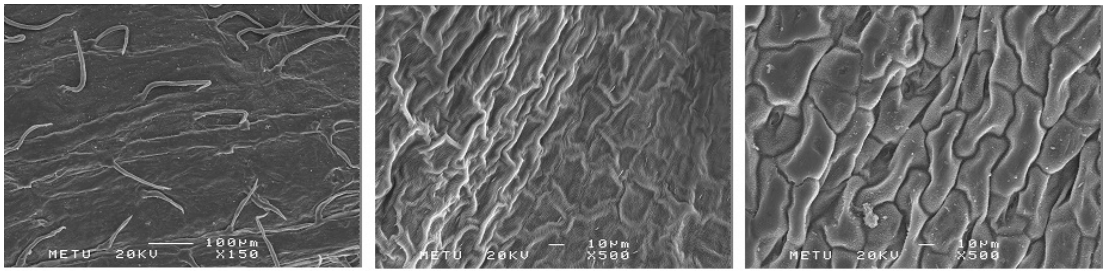


Figure 23. Calyx, Corolla and Leaf Micromorphology of *L. inconspicuus* var. i*nconspicuus*

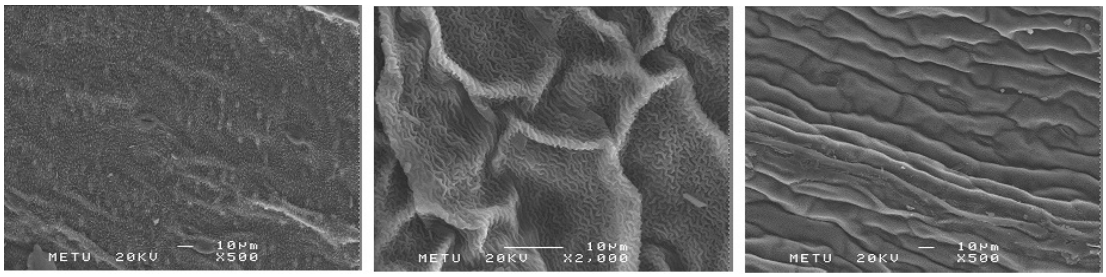


Figure 24. Calyx, Corolla and Leaf Micromorphology of *L. sphaericus*

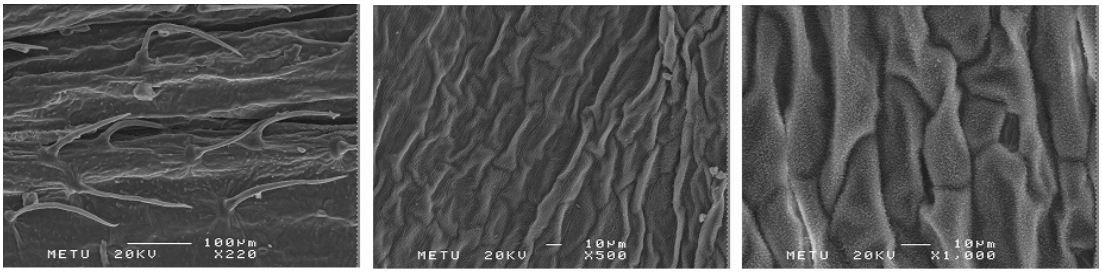


Figure 25. Calyx, Corolla and Leaf Micromorphology of *L. nissolia*

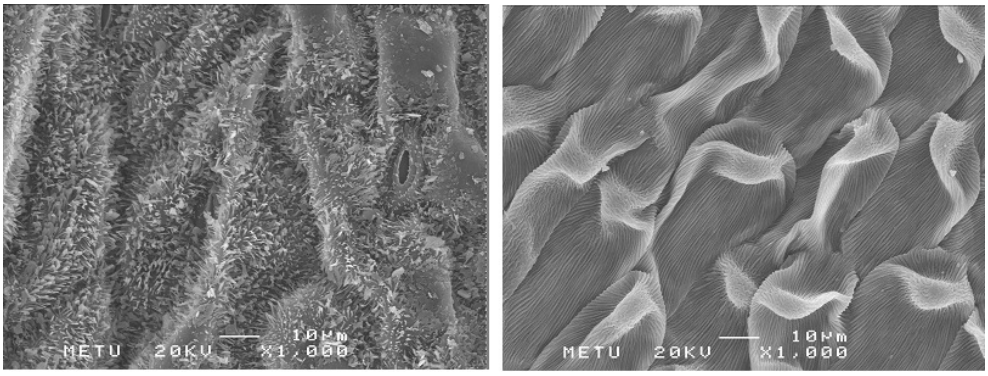


Figure 26. Calyx & Corolla Micromorphology of *L. aphaca* var. *affinis*

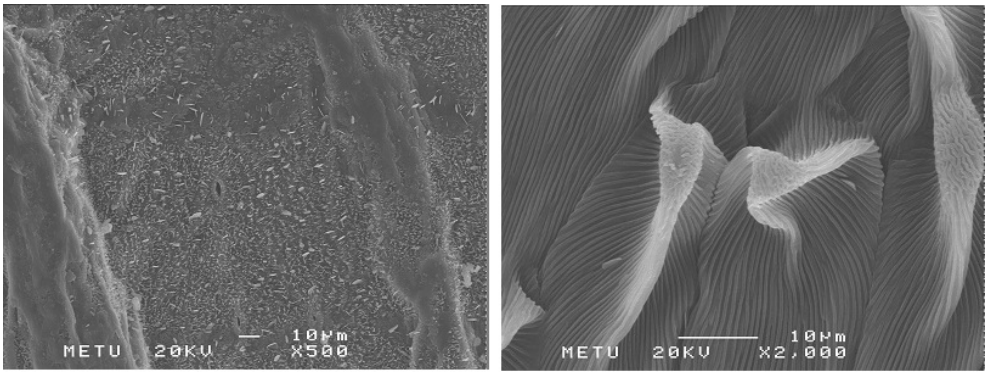


Figure 27. Calyx & Corolla Micromorphology of *L. aphaca* var. *biflorus*

3.2.1 Pollen grains Micromorphology

Pollen grains micromorphological studies of taxa belong to the *Lathyrus* species have been carried out in Turkey and worldwide by many researchers

The micromorphology of the pollen grains of *L. digitatus* (Aytug et al., 1971); *L. undulatus*, *L. sylvestris* and *L. ochrus* (Gunes & Cirpici,1998); *L. pratensis*, *L. layardii*, *L. laxiflorus* subsp. *laxiflorus*, *L. laxiflorus* subsp. *angustifolius* and *L. czeczottianus* (Gunes & Aytug, 2010); *L. annuus*, *L. cicera*, *L. gorgoni* var. *pilosus* and *L. hirsutus* (Gunes & Cirpici, 2010); *L. niger* (L.) Bernh. subsp. *niger, L. palustris* L. subsp. *palustris*, *L. tuberosus* L., *L. sphaericus* Retz., *L. setifolius* L., *L. clymenum* L., *L. nissolia* L., *L. aphaca* L. var. *aphaca*, *L. aphaca* var. *affinis* (Guss.)

Arc, *L. aphaca* var. *Bifilorus* (Gunes, 2011a); and the the Platystylis section (Gunes, 2011b) have been studied in Turkey.

The micromorphology of the pollen grains of *L. niger* (Gapotchka & Chamara, 1972; Gapotchka, 1974), *L. palustris* (Faegri & Iversen, 1989), *L. latifolius* and *L. tuberosus* (Halbritter, 2000) in Russia; *L. sylvestris*, *L. pratensis*, *L. maritimus*, *L. nissolia* and *L. montanus* (Moore *et al.*, 1991) in France; *L. emodii*, *L. cicera*, *L. humulis* and *L. pratensis* (Perveen & Qaiser, 1998) in Pakistan; *L. grandiflorus*, *L. latifolius*, *L. sylvestris*, *L. tuberosus* (Tosheva *et al.*, 2004), *L. alpestris*, *L. aureus*, *L. linifolius*, *L. niger*, *L. palustris*, *L. transsilvanicus*, *L. venetus* and *L. vernus* (Tosheva & Tonkov, 2005), *L. digitatus*, *L. filiformis*, *L. pallescens*, *L. pancicii* and *L. pannonicus* (Tosheva & Tonkov, 2007) in Bulgaria, have been studied in the worldwide.

Main pollen grains characteristics for the taxa studied are given in Tables 7 and SEM micrographs of pollen grains are illustrated in Figures 28 to Figure 40.

Table 7. Pollen grains characteristics in the taxa studied of *Lathyrus* based on LM. All sizes are in µm. Numbers refer to (minimum-maximum)(mean±standard deviation). Polar diameter (P), Equatorial diameter (E), pollen grains shape (P/E), exine thickenes (Ex), colpus lenght (clg), porus length regarding the poles, porus width regarding the equatorial diameter (plt). Marks are in micrometer (µm) * indicates endemic species to Turkey.

Sections	Taxa	P	E	P/E & Shape	Ex	clg	plg	plt
Orobus	*L. aureus*	(47,28 – 41,23) (44,77±2,29)	(40,48 – 36,20) (37,78±1,41)	1,15 – 1,26 subprolate	(1,09 – 0,82) (0,92±0,17)	(32,89 – 28,43) (30,69±1,33)	(8,33 – 5,21) (7,72±0,63)	(7,89 – 6,08) (6,96±0,98)
	L. incurvus	(40,33 – 30,55) (35,12,16±1,16)	(34,26 – 29,91) (31,90±1,13)	0.99 – 1.13 Oblate-spheroidal, to prolate-spheroidal	(1,35 – 0,89) (1,12±0,23)	(31,02 – 26,80) (29,48±2,02)	(9,92 – 7,12) (8,65±0,9)	(9,11 – 6,14) (8,38±1,02)
Lathyrostylis	*L. brachypterus*	(48,05 – 40,29) (43,63±2,23)	(38,66 – 32,70) (36,97±2,61)	1,13 – 1,19 Prolate-spheroida to Subprolate	(1,25 – 0,98) (1,05±0,16)	(42,15 – 38,16) (40,24±1,46)	(13,18 – 8,77) (12,76±2,01)	(18,12 –13,78) (16,88±1,21)
	L. haussknechtii	(47,03 – 41,23) (42,98±2,56)	(38,23 – 32,65) (35,05±2,15)	1,15 – 1,22 Subprolate	(1,06 – 0,87) (0,96±0,15)	(36,23 – 33,78) (35,31±2,45)	(12,87 – 7,15) (10,96±2,64)	(16,21 – 9,97) (13,65±1,24)
	L. armenus	(39,42 – 34,54) (36,76±2,05)	(36,31 – 31,17) (33,17±2,24)	1,03 – 1. 13 Prolate-spheroidal	(1,29 – 0,86) (0,98±0,13)	(29,78 – 24,45) (27,65±2,33)	(13,80 – 9,19) (10,05±1,23)	(16,23 – 12,56) (14,57±1,26)
	L. digitatus	(45,56 – 40,45) (42,54±1,13)	(33,45 – 26,89) (31,78±1,43)	1,17 – 1,34 Subprolate to Prolate	(1,03 – 0,87) (0,93±0,14)	(30,67 – 25,35) (27,24±2,63)	(9,28 – 5,67) (7,89±1,76)	(12,65 – 8,78) (10,09±1,31)
	L. tukhtensis	(54,32 – 46,15) (48,08±1,81)	(52,58 – 44,12) (46,44±1.89)	1,03 – 1,06 Prolate-spheroidal	(1,43 – 0,85) (1,01±0,14)	(34,65 – 28,48) (31,19±2,25)	(14,32 – 10,43) (12,45±2,16)	(18,01 – 13,99) (16,71±1,45)
	L. spathulatus	(45,32 – 40,54) (42,96±2,45)	(42,54 – 37,13) (40,54±2,70)	1,03 – 1,08 Prolate-spheroidal	(0,89 – 1,03) (0,98±0,23)	(36,12 – 30,49) (33,72±2,01)	(16,98 – 13,97) (15,28±1,67)	(18,19 – 14,33) (17,21±1,1)
	L. cilicicus	(44,89 – 40,67) (42,19±1,69)	(45 - 98 – 39,67) (41,89±1,46)	0,96 – 1,01 Oblate-spheroidal – Prolate-spheroidal	(1,78 – 1,02) (1,12±0,16)	(41,67 – 39,98) (40,19±1,35)	(19,67 – 15,45) (17,47±1,81)	(18,98 – 14,16) (16,33±1,31)
Pratensis	*L. pratensis*	(40,67 – 34,56) (37,13±2,19)	(32,67 – 26,45) (30,28±1,66)	1,19 – 1,24 Subprolate	(1,34 – 0,78) (1,01±0,18)	(30,65 – 24,56) (27,29±2,79)	(9,74 – 6,06) (8,91±0,64)	(12,34 – 8,89) (9,01±0,99)
	L. laxiflorus subsp. *laxiflorus*	(42,89 – 36,24) (38,25±1,78)	(33,76 – 27,34) (30,58±2,13)	1,21 – 1,26 Subprolate	(1,46 – 0,78) (0,94±0,14)	(27,72 – 22,87) (23,14±2,34)	(10,34 – 7,89) (8,34±1,12)	(12,43 – 8,02) (9,21±0,89)
	L. czeczottianus	(45,67 – 38,98) (42,79±1,87)	(34,27 – 29,54) (32,46±2,09)	1,32 – 1,35 Subprolate to Prolate.	(1,05 – 0,78) (0,89±0,15)	(30,67 – 25,88) (27,23±2,13)	(11,68 – 7,89) (9,04±1,65)	(12,19 – 7,03) (8,58±0,92)

Table 7. (Continued)

Sections	Taxa	P	E	P/E	Ex	Clg	plg	plt
Oroban	*L. roseus* subsp. *roseus*	(46,76 – 41,90) (43,67±2,14)	(35,16 – 31,25) (33,64±1,73)	1,29 – 1,34 Subprolate to Prolate.	(1,46 – 0,98) (1,05±0,17)	(37,41 – 33,24) (35,55±1,18)	(13,68 – 9,87) (10,08±1,32)	(12,14 – 8,41) (9,61±1,21)
Lathyrus	*L. tuberosus*	(48,86 – 40,15) (42,08±2,49)	(37,95 – 30,21) (36,89±1,80)	1,08 – 1,19 Prolate-spheroidal to Subprolate	(1,04 – 0,87) (0,98±0,2)	(35,65 – 30,46) (33,16±2,78)	(8,67 – 4,56) (6,78±1,08)	(9,74 – 5,67) (7,06±1,08)
	L. cassius	(50,15 – 40,51) (46,93±2,45)	(36,79 – 24,99) (34,05±1,11)	1,34 – 1,39 Prolate	(1.03 – 0,89) (0,96±0,1)	(30,66 – 37,78) (35,78±2,43)	(13,98 – 7,74) (9,12±2,54)	(13,39 – 9,92) (10,21±1,19)
	L. hirsutus	(45,36 – 38,35) (40,87±2,56)	(30,52 – 23,09) (29,34±2,19)	1,36 – 1,4 Prolate	(1,32 – 0,79) (0,95±0,2	(40,12 – 36,52) (38,28±2,87)	(9,49 – 4,02) (7,45±1,43)	(10,09 – 6,21) (7,96±1,21)
	L. chloranthus	(50,12 – 44,21) (46,82±1,96)	(41,90 – 36,01) (37,16±2,41)	1,19 – 1,27 Subprolate	(1,11 – 0,79) (0,94±0,15)	(37,48 – 32,82) (34,76±1,98)	(11,04 – 7,87) (9,81±1,46)	(12,29 – 9,21) (10,86±0,99)
	L. sativus	(49,77 – 38,80) (45,60±2,25)	(38,71 – 22,91) (33,52±3,19)	1,34 – 1,39 Prolate	(1,23 – 0,89) (1,02±0,27)	(34,05 – 29,72) (31,67±2,12)	(9,98 – 4,93) (6,87±1,97)	(10,31 – 6,09) (7,69±1,17)
	L. cicera	(48,75 – 46,20) (47,32±1,19)	(36,92 – 25,91) (34,36±2,03)	1,32 – 1,36 Subprolate to Prolate	(1,81 – 0,98) (1,21±0,15)	(40,55 – 34,11) (37,91±3,27)	(11,95 – 9,61) (10,86±1,24)	(11,73 – 8,54) (9,19±1,31)
Viciopsis	*L. saxatilis*	(40,67 – 37,21) (38,89±1,57)	(33,01 – 25,45) (31,50±1,42)	1,23 – 1,28 Subprolate	(1,15 – 0,98) (1,02±0,3)	(36,34 – 29,45) (34,61±2,12)	(9,98 – 4,56) (6,45±1,76)	(10,86 – 8,35) (7,76±1,05)
Linearicarpus	*L. sphaericus*	(47,77 – 43,27) (44,78±2,07)	(42,32 – 35,07) (38,12±2,47)	1,15 – 1,21 Subprolate	(0,98 – 0,67) (0,91±0,1)	(35,78 – 29,32) (33,21±2,32)	(10,23 – 6,12) (8,32±2,65)	(13,02 – 8,31) (10,11±1,45)
	L. inconspicuus var. inconspicuus	(34,28 – 28,67) (33,57±2,02)	(35,79 – 30,78) (33,48±1,93)	0,98 – 1,03 Oblate-spheroidal to Prolate-spheroidal	(1,34 – 0,93) (1,07±0,14)	(28,54 – 26,58) (27,78±0,96)	(9,27 – 7,23) (8,25±0,76)	(11,84 – 8,09) (9,02±1,18)
Nissolia	*L. nissolia*	(36,81 – 3032) (32,98±2,15)	(21,14 – 28,97) (24,18±2,02)	1,32 – 1,36 Subprolate to Prolate	(1,11 – 0,78) (0,96±0,2)	(31,67 – 25,87) (27,89±2,42)	(11,32 - 5,34) (8,91±1,14)	(13,07 – 8,26) (10,18±1,63)
Aphaca	*L. aphaca var. biflorus*	(54,06 – 44,42) (46,44±3,67)	(33,05 – 20,17) (29,54±3,12)	1,54 – 1,58 Prolate	(1,01 – 0,78) (0,92±0,19)	(37,86 – 34,15) (35,78±1,93)	(9,67 – 4,89) (6,05±1,54)	(10,31 – 7,67) (9,56±1,35)
	L. aphaca var. affinis	(53,15 – 45,32) (46,64±3,89)	(34,15 – 28,67) (30,81±3,08)	1,49 – 1,53 Prolate	(1,02 – 0,82) (0,95±0,21)	(35,98 – 30,31) (32,37±2,01)	(8,92±5,43) (6,16±1,31)	(11,73 – 8,89) (9,98±1,42)

3.2.1.1 Pollen grains Size and Shape

The morphological characteristics of pollen grains of the studied taxa showed heterogenic structure. All the pollen grains type was found to be 3-zonocolporate and medium sized. The P/E ratio of the pollen grains is in between 0.96 and 1.58. The smallest P/E ratio of pollen grains on average, was observed in *L. cilicicus* and the largest was observed *L. aphaca* (Table 7)

Generally, pollen grains shapes are variable among the taxa and slightly different within the same taxa. The shape of the pollen grains in equatorial view ranges from oblate to prolate (Table 7, Table 8, and Figures 28 to Figure 40). All the taxa have plt clt value.

In terms of the equatorial view, the pollen grainss of the studied taxa can be clasifed in three main groups, which are elliptical, elliptical to rectangular - obtuse convex and rectangular – obtuse – emarginate. *L. chloranthus, L. aphaca* var. *affinis, L. czeczottianus,* and *L. incurvus* have elliptical pollen grains. *L. Brachypterus, L. haussknechtii, L. armeus, L. sphaericus, L. nissolia, L. pratensis, L. aphaca* var *biflorus, L. cassius, L. cicera, L. hirsutus, L. tuberosus, L. laxiflorus* subsp. *laxiflorus L. aureus, L. digitatus, L. roseus* subsp. *roseus, L. sativus,* and *L. saxatilis* pollen grains shape ranges from elliptical to rectangular-obtuse-convex. Rectangular – obtuse – emarginate pollen grains shape is found in *L. tukhtensis, L. spathulatus, L. cilicicus,* and *L. inconspicuus* var. *inconspicuus*. In terms of the equatorial view – pollen grains shape, there is no consistency within the species of the same Sections, even variety of same species. For example, *L. aphaca* var. *affinis* has elliptical pollen grains and *L. aphaca* var. *biflorus* has elliptical to rectangular – obtuse – convex pollen grains. In some extent, equatorial view characters can be used to differentiate the genus at species level but it is not useful at sectional level, because there is no consistency of the taxa belongs to the same section. (Table 8)

Table 8. Classification of pollen grainss in terms of their equatorial view

Elliptical	Elliptical to rectangular – obtuse – convex	Rectangular – obtuse - emarginate
L. chloranthus *L. aphaca var affinis* *L. czeczottianus* *L. incurvus*	*L. brachypterus* *L. haussknechtii* *L. armeus* *L. sphaericus* *L. nissolia* *L. pratensis* *L. aphaca* var *biflorus* *L. cassius* *L. cicera* *L. hirsutus* *L: tuberosus* *L. laxiflorus* subsp. *laxiflorus* *L. aureus* *L. digitatus* *L. roseus* subsp. *roseus* *L. sativus* *L. saxatilis*	*L. tukhtensis* *L. spathulatus* *L. cilicicus* *L. inconspicuus* var. *inconspicuus*

Polar view of the pollen grainss ranges from circular-obtuse-convex to rectangular-convex (Figures 28 to Figure 40). The polar view of *L. brachypterus, L. haussknechtii*, *L. tukhtensis*is, *L. armeus, L. aureus, L. roseus* subsp. *roseus, L. inconspicuus* var. *inconspicuus*, *L. saxatilis* and *L. hirsutus* is circular to triangular-obtuse convex. The polar view of *L. spathulatus* and *L. cilicicus* is circular to quinquangular obtuse convex. The polar view of *L. cicera, L. sativus, L. sphaericus, L. nissolia, L. aphaca* var. *biflorus and L. aphaca* var. *affinis, L. laxiflorus* subsp. *laxiflorus, L. cassius, L. incurvus* and *L. tuberosus* is circular. The polar view of *L. chloranthus, L. pratensis, L. czeczottianus,* and *L. digitatus* is triangular to slightly triangular obtuse convex. Again this character is useful to differentiate some species but it is not useful at sectional level classification because there is no consistency of the taxa belong to the same section.

In terms of the value of P/E, there is no significant difference between the literature studies (Gunes, 2011a; Gunes, 2011b; Gunes & Aytug, 2010; Gunes & Cirpici, 2010 Tosheva & Tonkov, 2007; Tosheva & Tonkov, 2005; Tosheva *et al.*, 2004; Perveen

& Qaiser, 1998; Moore *et al.*, 1991) and this study. For this reason, the value of P/E is used for the statistical analysis.

According to ANOVA result, there is a significant diference determined between P/E ratios of the Sections (Table 9, Table 10). In order to specify which sections P/E ratio is different from the others (Table 11, Table 12, and Table 13), Post hoc test, multiple comparisons was applied. According to this test;

- There is no significant difference between section *Orobus* and section *Lathyrostylis*. However, other section's P/E values are different from the section *Orobus*. Thus, the P/E value can be used to differentiate the section *Orobus* from the other sections except for the section *Lathyrostylis.*
- There is no significant difference between section *Lathyrostylis*, section *Orobus* and section *Linearicarpus*. Nevertheless, other section's P/E ratios are different from the section *Latyrostylis*. Thus the P/E value can be used to differentiate the section *Latyrostylis* from the other sections except for the section *Orobus* and section *Linearicarpus*.
- There is no significant difference between section *Pratensis* and section *Viciopsis*. However, other section's P/E ratios are different from the section *Pratensis*. Thus the P/E value can be used to differentiate the section *Pratensis* from the other sections except for the section *Viciopsis*.
- There is no significant difference between section *Orobon* and section *Lathyrus* and section *Nissolia*. However, other section's P/E ratios are different from the section *Orobon.* Thus the P/E value can be used to differentiate the section *Orobon* from the other sections except for section *Lathyrus* and section *Nissolia*.
- There is no significant difference between section *Lathyrus* and section *Orobon* and section *Nissolia*. However, other section's P/E ratios are different from the section *Latyhrus.* Thus the P/E value can be used to

differentiate the section *Lathyrus* from the other sections except for section *Orobon* and section *Nissolia*.

- There is no significant difference between section *Viciopsis* and section *Pratensis*. Nevertheless, other section's P/E ratios are different from the section *Viciopsis*. Thus the P/E value can be used to differentiate the section *Viciopsis* from the other sections except for section *Pratensis.*
- There is no significant difference between section *Linearicarpus* and section *Lathyrostylis*. Nevertheless, other section's P/E ratios are different from the section *Linearicarpus*. Thus the P/E value can be used to differentiate the section *Linearicarpus* from the other sections except for section *Lathyrostylis.*
- There is a significant difference between the P/E ratio of section *Aphaca* and the other sections. As a result this value can be used to differentiate section *Aphaca* form the other sections.

Table 9. Descriptives for the Sections.

Sections	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orobus	60	1.1340	.10470	.01656	1.1005	1.1675	.81	1.27
Lathyrostylis	210	1.1099	.09943	.00840	1.0933	1.1265	.95	1.54
Pratensis	90	1.2613	.05824	.00752	1.2463	1.2764	1.18	1.37
Orobon	30	1.3190	.02900	.00648	1.3054	1.3326	1.27	1.36
Lathyrus	180	1.3012	.09367	.00855	1.2842	1.3181	1.08	1.41
Viciopsis	30	1.2550	.02259	.00505	1.2444	1.2656	1.21	1.28
Linearicarpus	60	1.0965	.09198	.01454	1.0671	1.1259	.97	1.22
Nissolia	30	1.3405	.02038	.00456	1.3310	1.3500	1.31	1.37
Aphaca	60	1.5565	.01703	.00269	1.5511	1.5619	1.53	1.59
Total	750	1.2340	.15416	.00689	1.2204	1.2475	.81	1.59

Table 10. Anova results for the Sections

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.438	8	1.055	151.395	.000
Within Groups	3.421	491	.007		
Total	11.858	749			

Table 11. Post hoc test, multiple comparisons of the Sections

I taxa	j taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
Orobus	Lathyrostylis	.02407	.01496	.108	-.0053	.0535
	Pratensis	-.12733(*)	.01704	.000	-.1608	-.0939
	Orobon	-.18500(*)	.02286	.000	-.2299	-.1401
	Lathyrus	-.16717(*)	.01524	.000	-.1971	-.1372
	Viciopsis	-.12100(*)	.02286	.000	-.1659	-.0761
	Linearicarpus	.03748(*)	.01866	.045	.0008	.0741
	Nissolia	-.20650(*)	.02286	.000	-.2514	-.1616
	Aphaca	-.42250(*)	.01866	.000	-.4592	-.3858
Lathyrostylis	Orobus	-.02407	.01496	.108	-.0535	.0053
	Pratensis	-.15140(*)	.01288	.000	-.1767	-.1261
	Orobon	-.20907(*)	.01995	.000	-.2483	-.1699
	Lathyrus	-.19124(*)	.01038	.000	-.2116	-.1708
	Viciopsis	-.14507(*)	.01995	.000	-.1843	-.1059
	Linearicarpus	.01340	.01496	.371	-.0160	.0428
	Nissolia	-.23057(*)	.01995	.000	-.2698	-.1914
	Aphaca	-.44657(*)	.01496	.000	-.4760	-.4172
Pratensis	Orobus	.12733(*)	.01704	.000	.0939	.1608
	Lathyrostylis	.15140(*)	.01288	.000	.1261	.1767
	Orobon	-.05767(*)	.02155	.008	-.1000	-.0153
	Lathyrus	-.03983(*)	.01320	.003	-.0658	-.0139
	Viciopsis	.00633	.02155	.769	-.0360	.0487
	Linearicarpus	.16481(*)	.01704	.000	.1313	.1983
	Nissolia	-.07917(*)	.02155	.000	-.1215	-.0368
	Aphaca	-.29517(*)	.01704	.000	-.3286	-.2617

* The mean difference is significant at the .05 level.

Table 12. Post hoc test, multiple comparisons of the Sections

I taxa	j taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
Orobon	Orobus	.18500(*)	.02286	.000	.1401	.2299
	Lathyrostylis	.20907(*)	.01995	.000	.1699	.2483
	Pratensis	.05767(*)	.02155	.008	.0153	.1000
	Lathyrus	.01783	.02016	.377	-.0218	.0574
	Viciopsis	.06400(*)	.02639	.016	.0121	.1159
	Linearicarpus	.22248(*)	.02286	.000	.1776	.2674
	Nissolia	-.02150	.02639	.416	-.0734	.0304
	Aphaca	-.23750(*)	.02286	.000	-.2824	-.1926
Lathyrus	Orobus	.16717(*)	.01524	.000	.1372	.1971
	Lathyrostylis	.19124(*)	.01038	.000	.1708	.2116
	Pratensis	.03983(*)	.01320	.003	.0139	.0658
	Orobon	-.01783	.02016	.377	-.0574	.0218
	Viciopsis	.04617(*)	.02016	.022	.0066	.0858
	Linearicarpus	.20464(*)	.01524	.000	.1747	.2346
	Nissolia	-.03933	.02016	.052	-.0789	.0003
	Aphaca	-.25533(*)	.01524	.000	-.2853	-.2254
Viciopsis	Orobus	.12100(*)	.02286	.000	.0761	.1659
	Lathyrostylis	.14507(*)	.01995	.000	.1059	.1843
	Pratensis	-.00633	.02155	.769	-.0487	.0360
	Orobon	-.06400(*)	.02639	.016	-.1159	-.0121
	Lathyrus	-.04617(*)	.02016	.022	-.0858	-.0066
	Linearicarpus	.15848(*)	.02286	.000	.1136	.2034
	Nissolia	-.08550(*)	.02639	.001	-.1374	-.0336
	Aphaca	-.30150(*)	.02286	.000	-.3464	-.2566

* The mean difference is significant at the .05 level.

Table 13. Post hoc test, multiple comparisons of the Sections

I taxa	j taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
Linearicarpus	Orobus	-.03748(*)	.01866	.045	-.0741	-.0008
	Lathyrostylis	-.01340	.01496	.371	-.0428	.0160
	Pratensis	-.16481(*)	.01704	.000	-.1983	-.1313
	Orobon	-.22248(*)	.02286	.000	-.2674	-.1776
	Lathyrus	-.20464(*)	.01524	.000	-.2346	-.1747
	Viciopsis	-.15848(*)	.02286	.000	-.2034	-.1136
	Nissolia	-.24398(*)	.02286	.000	-.2889	-.1991
	Aphaca	-.45998(*)	.01866	.000	-.4966	-.4233
Nissolia	Orobus	.20650(*)	.02286	.000	.1616	.2514
	Lathyrostylis	.23057(*)	.01995	.000	.1914	.2698
	Pratensis	.07917(*)	.02155	.000	.0368	.1215
	Orobon	.02150	.02639	.416	-.0304	.0734
	Lathyrus	.03933	.02016	.052	-.0003	.0789
	Viciopsis	.08550(*)	.02639	.001	.0336	.1374
	Linearicarpus	.24398(*)	.02286	.000	.1991	.2889
	Aphaca	-.21600(*)	.02286	.000	-.2609	-.1711
Aphaca	Orobus	.42250(*)	.01866	.000	.3858	.4592
	Lathyrostylis	.44657(*)	.01496	.000	.4172	.4760
	Pratensis	.29517(*)	.01704	.000	.2617	.3286
	Orobon	.23750(*)	.02286	.000	.1926	.2824
	Lathyrus	.25533(*)	.01524	.000	.2254	.2853
	Viciopsis	.30150(*)	.02286	.000	.2566	.3464
	Linearicarpus	.45998(*)	.01866	.000	.4233	.4966
	Nissolia	.21600(*)	.02286	.000	.1711	.2609

* The mean difference is significant at the .05 level.

According to ANOVA result, there is a significant diference determined between P/E ratios of the taxa (Table 14, Table 15). In order to specify which taxa's P/E ratio is different from the others, "Post hoc" test, multiple comparisons was applied (Table 16 to Table 40).

According to this test, there is no significant difference between

* *L. aureus* - *L. haussknechtii, L. pratensis,* and *L. inconspicuus* var *inconspicuus*;
* *L. incurvus – L. tukhtensis, L. armenus,* and *L. spathulatus*;
* *L. brachypterus* - *L. haussknechtii,* and *L. inconspicuus* var *inconspicuus*;
* *L. armenus – L. incurvus*;
* *L. digitatus* - *L. laxiflorus* subsp. *laxiflorus* and *L. saxatilis;*

* *L. tukhtensis* - *L. incurvus* and *L. spathulatus;*

* *L. spathulatus* - *L. tukhtensis* and *L. incurvus*;

* *L. cilicicus – L. sphaericus*;

* *L. pratensis – L. aureus, L. laxiflorus* subsp. *laxiflorus* and *L. chloranthus*;

* *L. laxiflorus* subsp. *laxiflorus* - *L. digitatus, L. pratensis, L. chloranthus,* and *L. saxatilis*;

* *L. czeczottianus* - *L. roseus* subsp. *roseus, L. nissolia,* and *L. cicera*;

* *L. roseus* subsp. *roseus* - *L. czeczottianus* and *L. nissolia*;

* *L. cassius* - *L. hirsutus, L. cicera* and *L. sativus*;

* *L. hirsutus* - *L. cassius, L. cicera* and *L. sativus*;

* *L. chloranthus* - *L. pratensis, L. laxiflorus* subsp. *laxiflorus,* and *L. saxatilis*;

* *L. sativus* - *L. cassius, L. hirsutus, L. cicera,* and *L. nissolia*;

* *L. cicera* - *L. czeczottianus, L. cassius, L. hirsutus, L. sativus,* and *L. nissolia*;

* *L. saxatilis* - *L. digitatus, L. laxiflorus* subsp. *laxiflorus,* and *L. chloranthus*;

* *L. inconspicuus var inconspicuus* - *L. aureus, L. haussknechtii* and *L. brachypterus*;

* *L. sphaericus* - *L. cilicicus*

* *L. nissolia* - *L. czeczottianus, L. roseus* subsp. *roseus, L. sativus* and *L. cicera*

* *L. aphaca var. biflorus* - *L. aphaca var affinis*

In general, except for the list given above, the P/E value is sinificantly different among the taxa and can be used to differentiate the taxa by usuing other variables. The *L. tuberosus* has unique P/E value and can be differentiated from the other taxa. The P/E value of *L. inconspicuus* var. *inconspicuus* and *L. haussknechtii* are same and cant be used to differentiate these two taxa. The P/E value of the varietes of section *Aphaca* are same and it can be concluded that this value is not differentiable character for the varieties of section *Aphaca*.

Table 14. Descriptives of the Species

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
L. aureus	30	1.2065	.04902	.01096	1.1836	1.2294	1.11	1.27
L. incurvus	30	1.0615	.09505	.02125	1.0170	1.1060	.81	1.16
L. brachypterus	30	1.1615	.02661	.00595	1.1490	1.1740	1.11	1.20
L. haussknechtii	30	1.1840	.03872	.00866	1.1659	1.2021	1.14	1.25
L. armenus	30	1.0780	.05258	.01176	1.0534	1.1026	1.01	1.16
L. digitatus	30	1.2570	.09625	.02152	1.2120	1.3020	1.14	1.54
L. tukhtensis	30	1.0485	.02815	.00629	1.0353	1.0617	1.00	1.10
L. spathulatus	30	1.0515	.03514	.00786	1.0351	1.0679	1.00	1.10
L. cilicicus	30	.9890	.02614	.00584	.9768	1.0012	.95	1.03
L. pratensis	30	1.2120	.02238	.00501	1.2015	1.2225	1.18	1.25
L. laxiflorus subsp laxiflorus	30	1.2360	.02062	.00461	1.2263	1.2457	1.20	1.26
L. czeczottianus	30	1.3360	.02234	.00499	1.3255	1.3465	1.30	1.37
L. roseus	30	1.3190	.02900	.00648	1.3054	1.3326	1.27	1.36
L. tuberosus	30	1.1330	.04067	.00909	1.1140	1.1520	1.08	1.19
L. cassius	30	1.3660	.02501	.00559	1.3543	1.3777	1.33	1.40
L. hirsutus	30	1.3670	.02319	.00519	1.3561	1.3779	1.34	1.41
L. chloranthus	30	1.2315	.03660	.00818	1.2144	1.2486	1.18	1.28
L. sativus	30	1.3645	.01849	.00413	1.3558	1.3732	1.34	1.39
L. cicera	30	1.3450	.01850	.00414	1.3363	1.3537	1.31	1.37
L. saxatilis	30	1.2550	.02259	.00505	1.2444	1.2656	1.21	1.28
L. inconspicuus var inconspicuus	30	1.1840	.02780	.00622	1.1710	1.1970	1.14	1.22
L. sphaericus	30	1.0091	.02198	.00492	.9988	1.0193	.97	1.04
L. nissolia	30	1.3405	.02038	.00456	1.3310	1.3500	1.31	1.37
L. aphaca var. biflorus	30	1.5600	.01892	.00423	1.5511	1.5689	1.53	1.59
L. aphaca var. affisnis	30	1.5530	.01455	.00325	1.5462	1.5598	1.53	1.58
Total	750	1.2340	.15416	.00689	1.2204	1.2475	.81	1.59

Table 15. Anova for the Species.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.132	24	.464	303.221	.000
Within Groups	.727	475	.002		
Total	11.858	749			

Table 16. Multiple comparisons for *L. aureus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. aureus	L. incurvus	.14500(*)	.01237	.000	.1207	.1693
	L. brachypterus	.04500(*)	.01237	.000	.0207	.0693
	L. haussknechtii	.02250	.01237	.070	-.0018	.0468
	L. armenus	.12850(*)	.01237	.000	.1042	.1528
	L. digitatus	-.05050(*)	.01237	.000	-.0748	-.0262
	L. tukhtensis	.15800(*)	.01237	.000	.1337	.1823
	L. spathulatus	.15500(*)	.01237	.000	.1307	.1793
	L. cilicicus	.21750(*)	.01237	.000	.1932	.2418
	L. pratensis	-.00550	.01237	.657	-.0298	.0188
	L. laxiflorus subsp laxiflorus	-.02950(*)	.01237	.017	-.0538	-.0052
	L. czeczottianus	-.12950(*)	.01237	.000	-.1538	-.1052
	L. roseus	-.11250(*)	.01237	.000	-.1368	-.0882
	L. tuberosus	.07350(*)	.01237	.000	.0492	.0978
	L. cassius	-.15950(*)	.01237	.000	-.1838	-.1352
	L. hirsutus	-.16050(*)	.01237	.000	-.1848	-.1362
	L. chloranthus	-.02500(*)	.01237	.044	-.0493	-.0007
	L. sativus	-.15800(*)	.01237	.000	-.1823	-.1337
	L. cicera	-.13850(*)	.01237	.000	-.1628	-.1142
	L. saxatilis	-.04850(*)	.01237	.000	-.0728	-.0242
	L. inconspicuus var inconspicuus	.02250	.01237	.070	-.0018	.0468
	L. sphaericus	.19745(*)	.01237	.000	.1731	.2218
	L. nissolia	-.13400(*)	.01237	.000	-.1583	-.1097
	L. aphaca var. biflorus	-.35350(*)	.01237	.000	-.3778	-.3292
	L. aphaca var affinis	-.34650(*)	.01237	.000	-.3708	-.3222

* The mean difference is significant at the .05 level.

Table 17. Multiple comparisons for *L. incurvus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. incurvus	L. aureus	-.14500(*)	.01237	.000	-.1693	-.1207
	L. brachypterus	-.10000(*)	.01237	.000	-.1243	-.0757
	L. haussknechtii	-.12250(*)	.01237	.000	-.1468	-.0982
	L. armenus	-.01650	.01237	.183	-.0408	.0078
	L. digitatus	-.19550(*)	.01237	.000	-.2198	-.1712
	L. tukhtensis	.01300	.01237	.294	-.0113	.0373
	L. spathulatus	.01000	.01237	.419	-.0143	.0343
	L. cilicicus	.07250(*)	.01237	.000	.0482	.0968
	L. pratensis	-.15050(*)	.01237	.000	-.1748	-.1262
	L. laxiflorus subsp laxiflorus	-.17450(*)	.01237	.000	-.1988	-.1502
	L. czeczottianus	-.27450(*)	.01237	.000	-.2988	-.2502
	L. roseus	-.25750(*)	.01237	.000	-.2818	-.2332
	L. tuberosus	-.07150(*)	.01237	.000	-.0958	-.0472
	L. cassius	-.30450(*)	.01237	.000	-.3288	-.2802
	L. hirsutus	-.30550(*)	.01237	.000	-.3298	-.2812
	L. chloranthus	-.17000(*)	.01237	.000	-.1943	-.1457
	L. sativus	-.30300(*)	.01237	.000	-.3273	-.2787
	L. cicera	-.28350(*)	.01237	.000	-.3078	-.2592
	L. saxatilis	-.19350(*)	.01237	.000	-.2178	-.1692
	L. inconspicuus var inconspicuus	-.12250(*)	.01237	.000	-.1468	-.0982
	L. sphaericus	.05245(*)	.01237	.000	.0281	.0768
	L. nissolia	-.27900(*)	.01237	.000	-.3033	-.2547
	L. aphaca var. biflorus	-.49850(*)	.01237	.000	-.5228	-.4742
	L. aphaca var affinis	-.49150(*)	.01237	.000	-.5158	-.4672

* The mean difference is significant at the .05 level.

Table 18. Multiple comparisons for *L. brachypterus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. brachypterus	L. aureus	-.04500(*)	.01237	.000	-.0693	-.0207
	L. incurvus	.10000(*)	.01237	.000	.0757	.1243
	L. haussnecktii	-.02250	.01237	.070	-.0468	.0018
	L. armenus	.08350(*)	.01237	.000	.0592	.1078
	L. digitatus	-.09550(*)	.01237	.000	-.1198	-.0712
	L. tukhtensis	.11300(*)	.01237	.000	.0887	.1373
	L. spathulatus	.11000(*)	.01237	.000	.0857	.1343
	L. cilicicus	.17250(*)	.01237	.000	.1482	.1968
	L. pratensis	-.05050(*)	.01237	.000	-.0748	-.0262
	L. laxiflorus subsp laxiflorus	-.07450(*)	.01237	.000	-.0988	-.0502
	L. czeczottianus	-.17450(*)	.01237	.000	-.1988	-.1502
	L. roseus	-.15750(*)	.01237	.000	-.1818	-.1332
	L. tuberosus	.02850(*)	.01237	.022	.0042	.0528
	L. cassius	-.20450(*)	.01237	.000	-.2288	-.1802
	L. hirsutus	-.20550(*)	.01237	.000	-.2298	-.1812
	L. chloranthus	-.07000(*)	.01237	.000	-.0943	-.0457
	L. sativus	-.20300(*)	.01237	.000	-.2273	-.1787
	L. cicera	-.18350(*)	.01237	.000	-.2078	-.1592
	L. saxatilis	-.09350(*)	.01237	.000	-.1178	-.0692
	L. inconspicuus var inconspicuus	-.02250	.01237	.070	-.0468	.0018
	L. sphaericus	.15245(*)	.01237	.000	.1281	.1768
	L. nissolia	-.17900(*)	.01237	.000	-.2033	-.1547
	L. aphaca var. biflorus	-.39850(*)	.01237	.000	-.4228	-.3742
	L. aphaca var affinis	-.39150(*)	.01237	.000	-.4158	-.3672

* The mean difference is significant at the .05 level.

Table 19. Multiple comparisons for *L. haussknechtii*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. haussknechtii	L. aureus	-.02250	.01237	.070	-.0468	.0018
	L. incurvus	.12250(*)	.01237	.000	.0982	.1468
	L. brachypterus	.02250	.01237	.070	-.0018	.0468
	L. armenus	.10600(*)	.01237	.000	.0817	.1303
	L. digitatus	-.07300(*)	.01237	.000	-.0973	-.0487
	L. tukhtensis	.13550(*)	.01237	.000	.1112	.1598
	L. spathulatus	.13250(*)	.01237	.000	.1082	.1568
	L. cilicicus	.19500(*)	.01237	.000	.1707	.2193
	L. pratensis	-.02800(*)	.01237	.024	-.0523	-.0037
	L. laxiflorus subsp laxiflorus	-.05200(*)	.01237	.000	-.0763	-.0277
	L. czeczottianus	-.15200(*)	.01237	.000	-.1763	-.1277
	L. roseus	-.13500(*)	.01237	.000	-.1593	-.1107
	L. tuberosus	.05100(*)	.01237	.000	.0267	.0753
	L. cassius	-.18200(*)	.01237	.000	-.2063	-.1577
	L. hirsutus	-.18300(*)	.01237	.000	-.2073	-.1587
	L. chloranthus	-.04750(*)	.01237	.000	-.0718	-.0232
	L. sativus	-.18050(*)	.01237	.000	-.2048	-.1562
	L. cicera	-.16100(*)	.01237	.000	-.1853	-.1367
	L. saxatilis	-.07100(*)	.01237	.000	-.0953	-.0467
	L. inconspicuus var inconspicuus	.00000	.01237	1.000	-.0243	.0243
	L. sphaericus	.17495(*)	.01237	.000	.1506	.1993
	L. nissolia	-.15650(*)	.01237	.000	-.1808	-.1322
	L. aphaca var. biflorus	-.37600(*)	.01237	.000	-.4003	-.3517
	L. aphaca var affinis	-.36900(*)	.01237	.000	-.3933	-.3447

* The mean difference is significant at the .05 level.

Table 20. Multiple comparisons for *L. armenus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. armenus	L. aureus	-.12850(*)	.01237	.000	-.1528	-.1042
	L. incurvus	.01650	.01237	.183	-.0078	.0408
	L. brachypterus	-.08350(*)	.01237	.000	-.1078	-.0592
	L. haussknechtii	-.10600(*)	.01237	.000	-.1303	-.0817
	L. digitatus	-.17900(*)	.01237	.000	-.2033	-.1547
	L. tukhtensis	.02950(*)	.01237	.017	.0052	.0538
	L. spathulatus	.02650(*)	.01237	.033	.0022	.0508
	L. cilicicus	.08900(*)	.01237	.000	.0647	.1133
	L. pratensis	-.13400(*)	.01237	.000	-.1583	-.1097
	L. laxiflorus subsp laxiflorus	-.15800(*)	.01237	.000	-.1823	-.1337
	L. czeczottianus	-.25800(*)	.01237	.000	-.2823	-.2337
	L. roseus	-.24100(*)	.01237	.000	-.2653	-.2167
	L. tuberosus	-.05500(*)	.01237	.000	-.0793	-.0307
	L. cassius	-.28800(*)	.01237	.000	-.3123	-.2637
	L. hirsutus	-.28900(*)	.01237	.000	-.3133	-.2647
	L. chloranthus	-.15350(*)	.01237	.000	-.1778	-.1292
	L. sativus	-.28650(*)	.01237	.000	-.3108	-.2622
	L. cicera	-.26700(*)	.01237	.000	-.2913	-.2427
	L. saxatilis	-.17700(*)	.01237	.000	-.2013	-.1527
	L. inconspicuus var inconspicuus	-.10600(*)	.01237	.000	-.1303	-.0817
	L. sphaericus	.06895(*)	.01237	.000	.0446	.0933
	L. nissolia	-.26250(*)	.01237	.000	-.2868	-.2382
	L. aphaca var. biflorus	-.48200(*)	.01237	.000	-.5063	-.4577
	L. aphaca var affinis	-.47500(*)	.01237	.000	-.4993	-.4507

* The mean difference is significant at the .05 level.

Table 21. Multiple comparisons for *L. armenus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. digitatus	L. aureus	.05050(*)	.01237	.000	.0262	.0748
	L. incurvus	.19550(*)	.01237	.000	.1712	.2198
	L. brachypterus	.09550(*)	.01237	.000	.0712	.1198
	L. haussknechtii	.07300(*)	.01237	.000	.0487	.0973
	L. armenus	.17900(*)	.01237	.000	.1547	.2033
	L. tukhtensis	.20850(*)	.01237	.000	.1842	.2328
	L. spathulatus	.20550(*)	.01237	.000	.1812	.2298
	L. cilicicus	.26800(*)	.01237	.000	.2437	.2923
	L. pratensis	.04500(*)	.01237	.000	.0207	.0693
	L. laxiflorus subsp laxiflorus	.02100	.01237	.090	-.0033	.0453
	L. czeczottianus	-.07900(*)	.01237	.000	-.1033	-.0547
	L. roseus	-.06200(*)	.01237	.000	-.0863	-.0377
	L. tuberosus	.12400(*)	.01237	.000	.0997	.1483
	L. cassius	-.10900(*)	.01237	.000	-.1333	-.0847
	L. hirsutus	-.11000(*)	.01237	.000	-.1343	-.0857
	L. chloranthus	.02550(*)	.01237	.040	.0012	.0498
	L. sativus	-.10750(*)	.01237	.000	-.1318	-.0832
	L. cicera	-.08800(*)	.01237	.000	-.1123	-.0637
	L. saxatilis	.00200	.01237	.872	-.0223	.0263
	L. inconspicuus var inconspicuus	.07300(*)	.01237	.000	.0487	.0973
	L. sphaericus	.24795(*)	.01237	.000	.2236	.2723
	L. nissolia	-.08350(*)	.01237	.000	-.1078	-.0592
	L. aphaca var. biflorus	-.30300(*)	.01237	.000	-.3273	-.2787
	L. aphaca var. affinis	-.29600(*)	.01237	.000	-.3203	-.2717

* The mean difference is significant at the .05 level.

Table 22. Multiple comparisons for *L. tukhtensis*.

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. tukhtensis	L. aureus	-.15800(*)	.01237	.000	-.1823	-.1337
	L. incurvus	-.01300	.01237	.294	-.0373	.0113
	L. brachypterus	-.11300(*)	.01237	.000	-.1373	-.0887
	L. haussknechtii	-.13550(*)	.01237	.000	-.1598	-.1112
	L. armenus	-.02950(*)	.01237	.017	-.0538	-.0052
	L. digitatus	-.20850(*)	.01237	.000	-.2328	-.1842
	L. spathulatus	-.00300	.01237	.808	-.0273	.0213
	L. cilicicus	.05950(*)	.01237	.000	.0352	.0838
	L. pratensis	-.16350(*)	.01237	.000	-.1878	-.1392
	L. laxiflorus subsp laxiflorus	-.18750(*)	.01237	.000	-.2118	-.1632
	L. czeczottianus	-.28750(*)	.01237	.000	-.3118	-.2632
	L. roseus	-.27050(*)	.01237	.000	-.2948	-.2462
	L. tuberosus	-.08450(*)	.01237	.000	-.1088	-.0602
	L. cassius	-.31750(*)	.01237	.000	-.3418	-.2932
	L. hirsutus	-.31850(*)	.01237	.000	-.3428	-.2942
	L. chloranthus	-.18300(*)	.01237	.000	-.2073	-.1587
	L. sativus	-.31600(*)	.01237	.000	-.3403	-.2917
	L. cicera	-.29650(*)	.01237	.000	-.3208	-.2722
	L. saxatilis	-.20650(*)	.01237	.000	-.2308	-.1822
	L. inconspicuus var inconspicuus	-.13550(*)	.01237	.000	-.1598	-.1112
	L. sphaericus	.03945(*)	.01237	.002	.0151	.0638
	L. nissolia	-.29200(*)	.01237	.000	-.3163	-.2677
	L. aphaca var. biflorus	-.51150(*)	.01237	.000	-.5358	-.4872
	L. aphaca var affinis	-.50450(*)	.01237	.000	-.5288	-.4802

* The mean difference is significant at the .05 level.

Table 23. Multiple comparisons for *L. spathulatus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. spathulatus	L. aureus	-.15500(*)	.01237	.000	-.1793	-.1307
	L. incurvus	-.01000	.01237	.419	-.0343	.0143
	L. brachypterus	-.11000(*)	.01237	.000	-.1343	-.0857
	L. haussknechtii	-.13250(*)	.01237	.000	-.1568	-.1082
	L. armenus	-.02650(*)	.01237	.033	-.0508	-.0022
	L. digitatus	-.20550(*)	.01237	.000	-.2298	-.1812
	L. tukhtensis	.00300	.01237	.808	-.0213	.0273
	L. cilicicus	.06250(*)	.01237	.000	.0382	.0868
	L. pratensis	-.16050(*)	.01237	.000	-.1848	-.1362
	L. laxiflorus subsp laxiflorus	-.18450(*)	.01237	.000	-.2088	-.1602
	L. czeczottianus	-.28450(*)	.01237	.000	-.3088	-.2602
	L. roseus	-.26750(*)	.01237	.000	-.2918	-.2432
	L. tuberosus	-.08150(*)	.01237	.000	-.1058	-.0572
	L. cassius	-.31450(*)	.01237	.000	-.3388	-.2902
	L. hirsutus	-.31550(*)	.01237	.000	-.3398	-.2912
	L. chloranthus	-.18000(*)	.01237	.000	-.2043	-.1557
	L. sativus	-.31300(*)	.01237	.000	-.3373	-.2887
	L. cicera	-.29350(*)	.01237	.000	-.3178	-.2692
	L. saxatilis	-.20350(*)	.01237	.000	-.2278	-.1792
	L. inconspicuus var inconspicuus	-.13250(*)	.01237	.000	-.1568	-.1082
	L. sphaericus	.04245(*)	.01237	.001	.0181	.0668
	L. nissolia	-.28900(*)	.01237	.000	-.3133	-.2647
	L. aphaca var. biflorus	-.50850(*)	.01237	.000	-.5328	-.4842
	L. aphaca var affinis	-.50150(*)	.01237	.000	-.5258	-.4772

* The mean difference is significant at the .05 level.

Table 24. Multiple comparisons for *L.cilicicus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. cilicicus	L. aureus	-.21750(*)	.01237	.000	-.2418	-.1932
	L. incurvus	-.07250(*)	.01237	.000	-.0968	-.0482
	L. brachypterus	-.17250(*)	.01237	.000	-.1968	-.1482
	L. haussknechtii	-.19500(*)	.01237	.000	-.2193	-.1707
	L. armenus	-.08900(*)	.01237	.000	-.1133	-.0647
	L. digitatus	-.26800(*)	.01237	.000	-.2923	-.2437
	L. tukhtensis	-.05950(*)	.01237	.000	-.0838	-.0352
	L. spathulatus	-.06250(*)	.01237	.000	-.0868	-.0382
	L. pratensis	-.22300(*)	.01237	.000	-.2473	-.1987
	L. laxiflorus subsp laxiflorus	-.24700(*)	.01237	.000	-.2713	-.2227
	L. czeczottianus	-.34700(*)	.01237	.000	-.3713	-.3227
	L. roseus	-.33000(*)	.01237	.000	-.3543	-.3057
	L. tuberosus	-.14400(*)	.01237	.000	-.1683	-.1197
	L. cassius	-.37700(*)	.01237	.000	-.4013	-.3527
	L. hirsutus	-.37800(*)	.01237	.000	-.4023	-.3537
	L. chloranthus	-.24250(*)	.01237	.000	-.2668	-.2182
	L. sativus	-.37550(*)	.01237	.000	-.3998	-.3512
	L. cicera	-.35600(*)	.01237	.000	-.3803	-.3317
	L. saxatilis	-.26600(*)	.01237	.000	-.2903	-.2417
	L. inconspicuus var inconspicuus	-.19500(*)	.01237	.000	-.2193	-.1707
	L. sphaericus	-.02005	.01237	.106	-.0444	.0043
	L. nissolia	-.35150(*)	.01237	.000	-.3758	-.3272
	L. aphaca var. biflorus	-.57100(*)	.01237	.000	-.5953	-.5467
	L. aphaca var affinis	-.56400(*)	.01237	.000	-.5883	-.5397

* The mean difference is significant at the .05 level.

Table 25. Multiple comparisons for *L.pratensis*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. pratensis	L. aureus	.00550	.01237	.657	-.0188	.0298
	L. incurvus	.15050(*)	.01237	.000	.1262	.1748
	L. brachypterus	.05050(*)	.01237	.000	.0262	.0748
	L. haussknechtii	.02800(*)	.01237	.024	.0037	.0523
	L. armenus	.13400(*)	.01237	.000	.1097	.1583
	L. digitatus	-.04500(*)	.01237	.000	-.0693	-.0207
	L. tukhtensis	.16350(*)	.01237	.000	.1392	.1878
	L. spathulatus	.16050(*)	.01237	.000	.1362	.1848
	L. cilicicus	.22300(*)	.01237	.000	.1987	.2473
	L. laxiflorus subsp laxiflorus	-.02400	.01237	.053	-.0483	.0003
	L. czeczottianus	-.12400(*)	.01237	.000	-.1483	-.0997
	L. roseus	-.10700(*)	.01237	.000	-.1313	-.0827
	L. tuberosus	.07900(*)	.01237	.000	.0547	.1033
	L. cassius	-.15400(*)	.01237	.000	-.1783	-.1297
	L. hirsutus	-.15500(*)	.01237	.000	-.1793	-.1307
	L. chloranthus	-.01950	.01237	.116	-.0438	.0048
	L. sativus	-.15250(*)	.01237	.000	-.1768	-.1282
	L. cicera	-.13300(*)	.01237	.000	-.1573	-.1087
	L. saxatilis	-.04300(*)	.01237	.001	-.0673	-.0187
	L. inconspicuus var inconspicuus	.02800(*)	.01237	.024	.0037	.0523
	L. sphaericus	.20295(*)	.01237	.000	.1786	.2273
	L. nissolia	-.12850(*)	.01237	.000	-.1528	-.1042
	L. aphaca var. biflorus	-.34800(*)	.01237	.000	-.3723	-.3237
	L. aphaca var affinis	-.34100(*)	.01237	.000	-.3653	-.3167

* The mean difference is significant at the .05 level.

Table 26. Multiple comparisons for *L. laxiflorus* subsp.*laxiflorus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. laxiflorus subsp laxiflorus	L. aureus	.02950(*)	.01237	.017	.0052	.0538
	L. incurvus	.17450(*)	.01237	.000	.1502	.1988
	L. brachypterus	.07450(*)	.01237	.000	.0502	.0988
	L. haussknechtii	.05200(*)	.01237	.000	.0277	.0763
	L. armenus	.15800(*)	.01237	.000	.1337	.1823
	L. digitatus	-.02100	.01237	.090	-.0453	.0033
	L. tukhtensis	.18750(*)	.01237	.000	.1632	.2118
	L. spathulatus	.18450(*)	.01237	.000	.1602	.2088
	L. cilicicus	.24700(*)	.01237	.000	.2227	.2713
	L. pratensis	.02400	.01237	.053	-.0003	.0483
	L. czeczottianus	-.10000(*)	.01237	.000	-.1243	-.0757
	L. roseus	-.08300(*)	.01237	.000	-.1073	-.0587
	L. tuberosus	.10300(*)	.01237	.000	.0787	.1273
	L. cassius	-.13000(*)	.01237	.000	-.1543	-.1057
	L. hirsutus	-.13100(*)	.01237	.000	-.1553	-.1067
	L. chloranthus	.00450	.01237	.716	-.0198	.0288
	L. sativus	-.12850(*)	.01237	.000	-.1528	-.1042
	L. cicera	-.10900(*)	.01237	.000	-.1333	-.0847
	L. saxatilis	-.01900	.01237	.125	-.0433	.0053
	L. inconspicuus var inconspicuus	.05200(*)	.01237	.000	.0277	.0763
	L. sphaericus	.22695(*)	.01237	.000	.2026	.2513
	L. nissolia	-.10450(*)	.01237	.000	-.1288	-.0802
	L. aphaca var. biflorus	-.32400(*)	.01237	.000	-.3483	-.2997
	L. aphaca var affinis	-.31700(*)	.01237	.000	-.3413	-.2927

* The mean difference is significant at the .05 level.

Table 27. Multiple comparisons for *L. czeczottianus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. czeczottianus	L. aureus	.12950(*)	.01237	.000	.1052	.1538
	L. incurvus	.27450(*)	.01237	.000	.2502	.2988
	L. brachypterus	.17450(*)	.01237	.000	.1502	.1988
	L. haussknechtii	.15200(*)	.01237	.000	.1277	.1763
	L. armenus	.25800(*)	.01237	.000	.2337	.2823
	L. digitatus	.07900(*)	.01237	.000	.0547	.1033
	L. tukhtensis	.28750(*)	.01237	.000	.2632	.3118
	L. spathulatus	.28450(*)	.01237	.000	.2602	.3088
	L. cilicicus	.34700(*)	.01237	.000	.3227	.3713
	L. pratensis	.12400(*)	.01237	.000	.0997	.1483
	L. laxiflorus subsp laxiflorus	.10000(*)	.01237	.000	.0757	.1243
	L. roseus	.01700	.01237	.170	-.0073	.0413
	L. tuberosus	.20300(*)	.01237	.000	.1787	.2273
	L. cassius	-.03000(*)	.01237	.016	-.0543	-.0057
	L. hirsutus	-.03100(*)	.01237	.013	-.0553	-.0067
	L. chloranthus	.10450(*)	.01237	.000	.0802	.1288
	L. sativus	-.02850(*)	.01237	.022	-.0528	-.0042
	L. cicera	-.00900	.01237	.467	-.0333	.0153
	L. saxatilis	.08100(*)	.01237	.000	.0567	.1053
	L. inconspicuus var inconspicuus	.15200(*)	.01237	.000	.1277	.1763
	L. sphaericus	.32695(*)	.01237	.000	.3026	.3513
	L. nissolia	-.00450	.01237	.716	-.0288	.0198
	L. aphaca var. biflorus	-.22400(*)	.01237	.000	-.2483	-.1997
	L. aphaca var affinis	-.21700(*)	.01237	.000	-.2413	-.1927

* The mean difference is significant at the .05 level.

Table 28. Multiple comparisons for *L. roseus* subsp. *roseus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. roseus	L. aureus	.11250(*)	.01237	.000	.0882	.1368
	L. incurvus	.25750(*)	.01237	.000	.2332	.2818
	L. brachypterus	.15750(*)	.01237	.000	.1332	.1818
	L. haussknechtii	.13500(*)	.01237	.000	.1107	.1593
	L. armenus	.24100(*)	.01237	.000	.2167	.2653
	L. digitatus	.06200(*)	.01237	.000	.0377	.0863
	L. tukhtensis	.27050(*)	.01237	.000	.2462	.2948
	L. spathulatus	.26750(*)	.01237	.000	.2432	.2918
	L. cilicicus	.33000(*)	.01237	.000	.3057	.3543
	L. pratensis	.10700(*)	.01237	.000	.0827	.1313
	L. laxiflorus subsp laxiflorus	.08300(*)	.01237	.000	.0587	.1073
	L. czeczottianus	-.01700	.01237	.170	-.0413	.0073
	L. tuberosus	.18600(*)	.01237	.000	.1617	.2103
	L. cassius	-.04700(*)	.01237	.000	-.0713	-.0227
	L. hirsutus	-.04800(*)	.01237	.000	-.0723	-.0237
	L. chloranthus	.08750(*)	.01237	.000	.0632	.1118
	L. sativus	-.04550(*)	.01237	.000	-.0698	-.0212
	L. cicera	-.02600(*)	.01237	.036	-.0503	-.0017
	L. saxatilis	.06400(*)	.01237	.000	.0397	.0883
	L. inconspicuus var inconspicuus	.13500(*)	.01237	.000	.1107	.1593
	L. sphaericus	.30995(*)	.01237	.000	.2856	.3343
	L. nissolia	-.02150	.01237	.083	-.0458	.0028
	L. aphaca var. biflorus	-.24100(*)	.01237	.000	-.2653	-.2167
	L. aphaca var. affinis	-.23400(*)	.01237	.000	-.2583	-.2097

* The mean difference is significant at the .05 level.

Table 29. Multiple comparisons for *L. tuberosus.*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. tuberosus	L. aureus	-.07350(*)	.01237	.000	-.0978	-.0492
	L. incurvus	.07150(*)	.01237	.000	.0472	.0958
	L. brachypterus	-.02850(*)	.01237	.022	-.0528	-.0042
	L. haussknechtii	-.05100(*)	.01237	.000	-.0753	-.0267
	L. armenus	.05500(*)	.01237	.000	.0307	.0793
	L. digitatus	-.12400(*)	.01237	.000	-.1483	-.0997
	L. tukhtensis	.08450(*)	.01237	.000	.0602	.1088
	L. spathulatus	.08150(*)	.01237	.000	.0572	.1058
	L. cilicicus	.14400(*)	.01237	.000	.1197	.1683
	L. pratensis	-.07900(*)	.01237	.000	-.1033	-.0547
	L. laxiflorus subsp laxiflorus	-.10300(*)	.01237	.000	-.1273	-.0787
	L. czeczottianus	-.20300(*)	.01237	.000	-.2273	-.1787
	L. roseus	-.18600(*)	.01237	.000	-.2103	-.1617
	L. cassius	-.23300(*)	.01237	.000	-.2573	-.2087
	L. hirsutus	-.23400(*)	.01237	.000	-.2583	-.2097
	L. chloranthus	-.09850(*)	.01237	.000	-.1228	-.0742
	L. sativus	-.23150(*)	.01237	.000	-.2558	-.2072
	L. cicera	-.21200(*)	.01237	.000	-.2363	-.1877
	L. saxatilis	-.12200(*)	.01237	.000	-.1463	-.0977
	L. inconspicuus var inconspicuus	-.05100(*)	.01237	.000	-.0753	-.0267
	L. sphaericus	.12395(*)	.01237	.000	.0996	.1483
	L. nissolia	-.20750(*)	.01237	.000	-.2318	-.1832
	L. aphaca var. biflorus	-.42700(*)	.01237	.000	-.4513	-.4027
	L. aphaca var. affinis	-.42000(*)	.01237	.000	-.4443	-.3957

* The mean difference is significant at the .05 level.

Table 30. Multiple comparisons for *L.cassius*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. cassius	L. aureus	.15950(*)	.01237	.000	.1352	.1838
	L. incurvus	.30450(*)	.01237	.000	.2802	.3288
	L. brachypterus	.20450(*)	.01237	.000	.1802	.2288
	L. haussknechtii	.18200(*)	.01237	.000	.1577	.2063
	L. armenus	.28800(*)	.01237	.000	.2637	.3123
	L. digitatus	.10900(*)	.01237	.000	.0847	.1333
	L. tukhtensis	.31750(*)	.01237	.000	.2932	.3418
	L. spathulatus	.31450(*)	.01237	.000	.2902	.3388
	L. cilicicus	.37700(*)	.01237	.000	.3527	.4013
	L. pratensis	.15400(*)	.01237	.000	.1297	.1783
	L. laxiflorus subsp laxiflorus	.13000(*)	.01237	.000	.1057	.1543
	L. czeczottianus	.03000(*)	.01237	.016	.0057	.0543
	L. roseus	.04700(*)	.01237	.000	.0227	.0713
	L. tuberosus	.23300(*)	.01237	.000	.2087	.2573
	L. hirsutus	-.00100	.01237	.936	-.0253	.0233
	L. chloranthus	.13450(*)	.01237	.000	.1102	.1588
	L. sativus	.00150	.01237	.904	-.0228	.0258
	L. cicera	.02100	.01237	.090	-.0033	.0453
	L. saxatilis	.11100(*)	.01237	.000	.0867	.1353
	L. inconspicuus var inconspicuus	.18200(*)	.01237	.000	.1577	.2063
	L. sphaericus	.35695(*)	.01237	.000	.3326	.3813
	L. nissolia	.02550(*)	.01237	.040	.0012	.0498
	L. aphaca var. biflorus	-.19400(*)	.01237	.000	-.2183	-.1697
	L. aphaca var affinis	-.18700(*)	.01237	.000	-.2113	-.1627

* The mean difference is significant at the .05 level.

Table 31. Multiple comparisons for *L.hirsutus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. hirsutus	L. aureus	.16050(*)	.01237	.000	.1362	.1848
	L. incurvus	.30550(*)	.01237	.000	.2812	.3298
	L. brachypterus	.20550(*)	.01237	.000	.1812	.2298
	L. haussknechtii	.18300(*)	.01237	.000	.1587	.2073
	L. armenus	.28900(*)	.01237	.000	.2647	.3133
	L. digitatus	.11000(*)	.01237	.000	.0857	.1343
	L. tukhtensis	.31850(*)	.01237	.000	.2942	.3428
	L. spathulatus	.31550(*)	.01237	.000	.2912	.3398
	L. cilicicus	.37800(*)	.01237	.000	.3537	.4023
	L. pratensis	.15500(*)	.01237	.000	.1307	.1793
	L. laxiflorus subsp laxiflorus	.13100(*)	.01237	.000	.1067	.1553
	L. czeczottianus	.03100(*)	.01237	.013	.0067	.0553
	L. roseus	.04800(*)	.01237	.000	.0237	.0723
	L. tuberosus	.23400(*)	.01237	.000	.2097	.2583
	L. cassius	.00100	.01237	.936	-.0233	.0253
	L. chloranthus	.13550(*)	.01237	.000	.1112	.1598
	L. sativus	.00250	.01237	.840	-.0218	.0268
	L. cicera	.02200	.01237	.076	-.0023	.0463
	L. saxatilis	.11200(*)	.01237	.000	.0877	.1363
	L. inconspicuus var inconspicuus	.18300(*)	.01237	.000	.1587	.2073
	L. sphaericus	.35795(*)	.01237	.000	.3336	.3823
	L. nissolia	.02650(*)	.01237	.033	.0022	.0508
	L. aphaca var. biflorus	-.19300(*)	.01237	.000	-.2173	-.1687
	L. aphaca var affinis	-.18600(*)	.01237	.000	-.2103	-.1617

* The mean difference is significant at the .05 level.

Table 32. Multiple comparisons for *L.chloranthus.*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. chloranthus	L. aureus	.02500(*)	.01237	.044	.0007	.0493
	L. incurvus	.17000(*)	.01237	.000	.1457	.1943
	L. brachypterus	.07000(*)	.01237	.000	.0457	.0943
	L. haussknechtii	.04750(*)	.01237	.000	.0232	.0718
	L. armenus	.15350(*)	.01237	.000	.1292	.1778
	L. digitatus	-.02550(*)	.01237	.040	-.0498	-.0012
	L. tukhtensis	.18300(*)	.01237	.000	.1587	.2073
	L. spathulatus	.18000(*)	.01237	.000	.1557	.2043
	L. cilicicus	.24250(*)	.01237	.000	.2182	.2668
	L. pratensis	.01950	.01237	.116	-.0048	.0438
	L. laxiflorus subsp laxiflorus	-.00450	.01237	.716	-.0288	.0198
	L. czeczottianus	-.10450(*)	.01237	.000	-.1288	-.0802
	L. roseus	-.08750(*)	.01237	.000	-.1118	-.0632
	L. tuberosus	.09850(*)	.01237	.000	.0742	.1228
	L. cassius	-.13450(*)	.01237	.000	-.1588	-.1102
	L. hirsutus	-.13550(*)	.01237	.000	-.1598	-.1112
	L. sativus	-.13300(*)	.01237	.000	-.1573	-.1087
	L. cicera	-.11350(*)	.01237	.000	-.1378	-.0892
	L. saxatilis	-.02350	.01237	.058	-.0478	.0008
	L. inconspicuus var inconspicuus	.04750(*)	.01237	.000	.0232	.0718
	L. sphaericus	.22245(*)	.01237	.000	.1981	.2468
	L. nissolia	-.10900(*)	.01237	.000	-.1333	-.0847
	L. aphaca var. biflorus	-.32850(*)	.01237	.000	-.3528	-.3042
	L. aphaca var. affinis	-.32150(*)	.01237	.000	-.3458	-.2972

* The mean difference is significant at the .05 level.

Table 33. Multiple comparisons for *L.sativus*

I taxa	j taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. sativus	L. aureus	.15800(*)	.01237	.000	.1337	.1823
	L. incurvus	.30300(*)	.01237	.000	.2787	.3273
	L. brachypterus	.20300(*)	.01237	.000	.1787	.2273
	L. haussknechtii	.18050(*)	.01237	.000	.1562	.2048
	L. armenus	.28650(*)	.01237	.000	.2622	.3108
	L. digitatus	.10750(*)	.01237	.000	.0832	.1318
	L. tukhtensis	.31600(*)	.01237	.000	.2917	.3403
	L. spathulatus	.31300(*)	.01237	.000	.2887	.3373
	L. cilicicus	.37550(*)	.01237	.000	.3512	.3998
	L. pratensis	.15250(*)	.01237	.000	.1282	.1768
	L. laxiflorus subsp laxiflorus	.12850(*)	.01237	.000	.1042	.1528
	L. czeczottianus	.02850(*)	.01237	.022	.0042	.0528
	L. roseus	.04550(*)	.01237	.000	.0212	.0698
	L. tuberosus	.23150(*)	.01237	.000	.2072	.2558
	L. cassius	-.00150	.01237	.904	-.0258	.0228
	L. hirsutus	-.00250	.01237	.840	-.0268	.0218
	L. chloranthus	.13300(*)	.01237	.000	.1087	.1573
	L. cicera	.01950	.01237	.116	-.0048	.0438
	L. saxatilis	.10950(*)	.01237	.000	.0852	.1338
	L. inconspicuus var inconspicuus	.18050(*)	.01237	.000	.1562	.2048
	L. sphaericus	.35545(*)	.01237	.000	.3311	.3798
	L. nissolia	.02400	.01237	.053	-.0003	.0483
	L. aphaca var. biflorus	-.19550(*)	.01237	.000	-.2198	-.1712
	L. aphaca var. affinis	-.18850(*)	.01237	.000	-.2128	-.1642

* The mean difference is significant at the .05 level.

Table 34. Multiple comparisons for *L. cicera*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. cicera	L. aureus	.13850(*)	.01237	.000	.1142	.1628
	L. incurvus	.28350(*)	.01237	.000	.2592	.3078
	L. brachypterus	.18350(*)	.01237	.000	.1592	.2078
	L. haussknechtii	.16100(*)	.01237	.000	.1367	.1853
	L. armenus	.26700(*)	.01237	.000	.2427	.2913
	L. digitatus	.08800(*)	.01237	.000	.0637	.1123
	L. tukhtensis	.29650(*)	.01237	.000	.2722	.3208
	L. spathulatus	.29350(*)	.01237	.000	.2692	.3178
	L. cilicicus	.35600(*)	.01237	.000	.3317	.3803
	L. pratensis	.13300(*)	.01237	.000	.1087	.1573
	L. laxiflorus subsp laxiflorus	.10900(*)	.01237	.000	.0847	.1333
	L. czeczottianus	.00900	.01237	.467	-.0153	.0333
	L. roseus	.02600(*)	.01237	.036	.0017	.0503
	L. tuberosus	.21200(*)	.01237	.000	.1877	.2363
	L. cassius	-.02100	.01237	.090	-.0453	.0033
	L. hirsutus	-.02200	.01237	.076	-.0463	.0023
	L. chloranthus	.11350(*)	.01237	.000	.0892	.1378
	L. sativus	-.01950	.01237	.116	-.0438	.0048
	L. saxatilis	.09000(*)	.01237	.000	.0657	.1143
	L. inconspicuus var inconspicuus	.16100(*)	.01237	.000	.1367	.1853
	L. sphaericus	.33595(*)	.01237	.000	.3116	.3603
	L. nissolia	.00450	.01237	.716	-.0198	.0288
	L. aphaca var. biflorus	-.21500(*)	.01237	.000	-.2393	-.1907
	L. aphaca var. affinis	-.20800(*)	.01237	.000	-.2323	-.1837

* The mean difference is significant at the .05 level.

Table 35. Multiple comparisons for *L. saxatilis*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. saxatilis	L. aureus	.04850(*)	.01237	.000	.0242	.0728
	L. incurvus	.19350(*)	.01237	.000	.1692	.2178
	L. brachypterus	.09350(*)	.01237	.000	.0692	.1178
	L. haussknechtii	.07100(*)	.01237	.000	.0467	.0953
	L. armenus	.17700(*)	.01237	.000	.1527	.2013
	L. digitatus	-.00200	.01237	.872	-.0263	.0223
	L. tukhtensis	.20650(*)	.01237	.000	.1822	.2308
	L. spathulatus	.20350(*)	.01237	.000	.1792	.2278
	L. cilicicus	.26600(*)	.01237	.000	.2417	.2903
	L. pratensis	.04300(*)	.01237	.001	.0187	.0673
	L. laxiflorus subsp laxiflorus	.01900	.01237	.125	-.0053	.0433
	L. czeczottianus	-.08100(*)	.01237	.000	-.1053	-.0567
	L. roseus	-.06400(*)	.01237	.000	-.0883	-.0397
	L. tuberosus	.12200(*)	.01237	.000	.0977	.1463
	L. cassius	-.11100(*)	.01237	.000	-.1353	-.0867
	L. hirsutus	-.11200(*)	.01237	.000	-.1363	-.0877
	L. chloranthus	.02350	.01237	.058	-.0008	.0478
	L. sativus	-.10950(*)	.01237	.000	-.1338	-.0852
	L. cicera	-.09000(*)	.01237	.000	-.1143	-.0657
	L. inconspicuus var inconspicuus	.07100(*)	.01237	.000	.0467	.0953
	L. sphaericus	.24595(*)	.01237	.000	.2216	.2703
	L. nissolia	-.08550(*)	.01237	.000	-.1098	-.0612
	L. aphaca var. biflorus	-.30500(*)	.01237	.000	-.3293	-.2807
	L. aphaca var affinis	-.29800(*)	.01237	.000	-.3223	-.2737

* The mean difference is significant at the .05 level.

Table 36. Multiple comparisons for *L. inconspicuus* var. *inconspicuus*

(I) taxa	(j)taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. inconspicuus var inconspicuus	L. aureus	-.02250	.01237	.070	-.0468	.0018
	L. incurvus	.12250(*)	.01237	.000	.0982	.1468
	L. brachypterus	.02250	.01237	.070	-.0018	.0468
	L. haussknechtii	.00000	.01237	1.000	-.0243	.0243
	L. armenus	.10600(*)	.01237	.000	.0817	.1303
	L. digitatus	-.07300(*)	.01237	.000	-.0973	-.0487
	L. tukhtensis	.13550(*)	.01237	.000	.1112	.1598
	L. spathulatus	.13250(*)	.01237	.000	.1082	.1568
	L. cilicicus	.19500(*)	.01237	.000	.1707	.2193
	L. pratensis	-.02800(*)	.01237	.024	-.0523	-.0037
	L. laxiflorus subsp laxiflorus	-.05200(*)	.01237	.000	-.0763	-.0277
	L. czeczottianus	-.15200(*)	.01237	.000	-.1763	-.1277
	L. roseus	-.13500(*)	.01237	.000	-.1593	-.1107
	L. tuberosus	.05100(*)	.01237	.000	.0267	.0753
	L. cassius	-.18200(*)	.01237	.000	-.2063	-.1577
	L. hirsutus	-.18300(*)	.01237	.000	-.2073	-.1587
	L. chloranthus	-.04750(*)	.01237	.000	-.0718	-.0232
	L. sativus	-.18050(*)	.01237	.000	-.2048	-.1562
	L. cicera	-.16100(*)	.01237	.000	-.1853	-.1367
	L. saxatilis	-.07100(*)	.01237	.000	-.0953	-.0467
	L. sphaericus	.17495(*)	.01237	.000	.1506	.1993
	L. nissolia	-.15650(*)	.01237	.000	-.1808	-.1322
	L. aphaca var. biflorus	-.37600(*)	.01237	.000	-.4003	-.3517
	L. aphaca var. affinis	-.36900(*)	.01237	.000	-.3933	-.3447

* The mean difference is significant at the .05 level.

Table 37. Multiple comparisons for *L. sphaericus*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. sphaericus	L. aureus	-.19745(*)	.01237	.000	-.2218	-.1731
	L. incurvus	-.05245(*)	.01237	.000	-.0768	-.0281
	L. brachypterus	-.15245(*)	.01237	.000	-.1768	-.1281
	L. haussknechtii	-.17495(*)	.01237	.000	-.1993	-.1506
	L. armenus	-.06895(*)	.01237	.000	-.0933	-.0446
	L. digitatus	-.24795(*)	.01237	.000	-.2723	-.2236
	L. tukhtensis	-.03945(*)	.01237	.002	-.0638	-.0151
	L. spathulatus	-.04245(*)	.01237	.001	-.0668	-.0181
	L. cilicicus	.02005	.01237	.106	-.0043	.0444
	L. pratensis	-.20295(*)	.01237	.000	-.2273	-.1786
	L. laxiflorus subsp laxiflorus	-.22695(*)	.01237	.000	-.2513	-.2026
	L. czeczottianus	-.32695(*)	.01237	.000	-.3513	-.3026
	L. roseus	-.30995(*)	.01237	.000	-.3343	-.2856
	L. tuberosus	-.12395(*)	.01237	.000	-.1483	-.0996
	L. cassius	-.35695(*)	.01237	.000	-.3813	-.3326
	L. hirsutus	-.35795(*)	.01237	.000	-.3823	-.3336
	L. chloranthus	-.22245(*)	.01237	.000	-.2468	-.1981
	L. sativus	-.35545(*)	.01237	.000	-.3798	-.3311
	L. cicera	-.33595(*)	.01237	.000	-.3603	-.3116
	L. saxatilis	-.24595(*)	.01237	.000	-.2703	-.2216
	L. inconspicuus var inconspicuus	-.17495(*)	.01237	.000	-.1993	-.1506
	L. nissolia	-.33145(*)	.01237	.000	-.3558	-.3071
	L. aphaca var. biflorus	-.55095(*)	.01237	.000	-.5753	-.5266
	L. aphaca var. affinis	-.54395(*)	.01237	.000	-.5683	-.5196

* The mean difference is significant at the .05 level.

Table 38. Multiple comparisons for *L. nissolia*

(I) taxa	(j) taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. nissolia	L. aureus	.13400(*)	.01237	.000	.1097	.1583
	L. incurvus	.27900(*)	.01237	.000	.2547	.3033
	L. brachypterus	.17900(*)	.01237	.000	.1547	.2033
	L. haussknechtii	.15650(*)	.01237	.000	.1322	.1808
	L. armenus	.26250(*)	.01237	.000	.2382	.2868
	L. digitatus	.08350(*)	.01237	.000	.0592	.1078
	L. tukhtensis	.29200(*)	.01237	.000	.2677	.3163
	L. spathulatus	.28900(*)	.01237	.000	.2647	.3133
	L. cilicicus	.35150(*)	.01237	.000	.3272	.3758
	L. pratensis	.12850(*)	.01237	.000	.1042	.1528
	L. laxiflorus subsp laxiflorus	.10450(*)	.01237	.000	.0802	.1288
	L. czeczottianus	.00450	.01237	.716	-.0198	.0288
	L. roseus	.02150	.01237	.083	-.0028	.0458
	L. tuberosus	.20750(*)	.01237	.000	.1832	.2318
	L. cassius	-.02550(*)	.01237	.040	-.0498	-.0012
	L. hirsutus	-.02650(*)	.01237	.033	-.0508	-.0022
	L. chloranthus	.10900(*)	.01237	.000	.0847	.1333
	L. sativus	-.02400	.01237	.053	-.0483	.0003
	L. cicera	-.00450	.01237	.716	-.0288	.0198
	L. saxatilis	.08550(*)	.01237	.000	.0612	.1098
	L. inconspicuus var inconspicuus	.15650(*)	.01237	.000	.1322	.1808
	L. sphaericus	.33145(*)	.01237	.000	.3071	.3558
	L. aphaca var. biflorus	-.21950(*)	.01237	.000	-.2438	-.1952
	L. aphaca var. affinis	-.21250(*)	.01237	.000	-.2368	-.1882

* The mean difference is significant at the .05 level.

Table 39. Multiple comparisons for *L. aphaca* var. *biflorus*

I taxa	j taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. aphaca var. biflorus	L. aureus	.35350(*)	.01237	.000	.3292	.3778
	L. incurvus	.49850(*)	.01237	.000	.4742	.5228
	L. brachypterus	.39850(*)	.01237	.000	.3742	.4228
	L. haussknechtii	.37600(*)	.01237	.000	.3517	.4003
	L. armenus	.48200(*)	.01237	.000	.4577	.5063
	L. digitatus	.30300(*)	.01237	.000	.2787	.3273
	L. tukhtensis	.51150(*)	.01237	.000	.4872	.5358
	L. spathulatus	.50850(*)	.01237	.000	.4842	.5328
	L. cilicicus	.57100(*)	.01237	.000	.5467	.5953
	L. pratensis	.34800(*)	.01237	.000	.3237	.3723
	L. laxiflorus subsp laxiflorus	.32400(*)	.01237	.000	.2997	.3483
	L. czeczottianus	.22400(*)	.01237	.000	.1997	.2483
	L. roseus	.24100(*)	.01237	.000	.2167	.2653
	L. tuberosus	.42700(*)	.01237	.000	.4027	.4513
	L. cassius	.19400(*)	.01237	.000	.1697	.2183
	L. hirsutus	.19300(*)	.01237	.000	.1687	.2173
	L. chloranthus	.32850(*)	.01237	.000	.3042	.3528
	L. sativus	.19550(*)	.01237	.000	.1712	.2198
	L. cicera	.21500(*)	.01237	.000	.1907	.2393
	L. saxatilis	.30500(*)	.01237	.000	.2807	.3293
	L. inconspicuus var inconspicuus	.37600(*)	.01237	.000	.3517	.4003
	L. sphaericus	.55095(*)	.01237	.000	.5266	.5753
	L. nissolia	.21950(*)	.01237	.000	.1952	.2438
	L. aphaca var affinis	.00700	.01237	.572	-.0173	.0313

* The mean difference is significant at the .05 level.

Table 40. Multiple comparisons for *L. aphaca* var. *affinis*

I taxa	j taxa	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower bound	Upper bound
L. aphaca var. affinis	L. aureus	.34650(*)	.01237	.000	.3222	.3708
	L. incurvus	.49150(*)	.01237	.000	.4672	.5158
	L. brachypterus	.39150(*)	.01237	.000	.3672	.4158
	L.haussknechtii	.36900(*)	.01237	.000	.3447	.3933
	L. armenus	.47500(*)	.01237	.000	.4507	.4993
	L. digitatus	.29600(*)	.01237	.000	.2717	.3203
	L. tukhtensis	.50450(*)	.01237	.000	.4802	.5288
	L. spathulatus	.50150(*)	.01237	.000	.4772	.5258
	L. cilicicus	.56400(*)	.01237	.000	.5397	.5883
	L. pratensis	.34100(*)	.01237	.000	.3167	.3653
	L. laxiflorus subsp laxiflorus	.31700(*)	.01237	.000	.2927	.3413
	L. czeczottianus	.21700(*)	.01237	.000	.1927	.2413
	L. roseus	.23400(*)	.01237	.000	.2097	.2583
	L. tuberosus	.42000(*)	.01237	.000	.3957	.4443
	L. cassius	.18700(*)	.01237	.000	.1627	.2113
	L. hirsutus	.18600(*)	.01237	.000	.1617	.2103
	L. chloranthus	.32150(*)	.01237	.000	.2972	.3458
	L. sativus	.18850(*)	.01237	.000	.1642	.2128
	L. cicera	.20800(*)	.01237	.000	.1837	.2323
	L. saxatilis	.29800(*)	.01237	.000	.2737	.3223
	L. inconspicuus var inconspicuus	.36900(*)	.01237	.000	.3447	.3933
	L. sphaericus	.54395(*)	.01237	.000	.5196	.5683
	L. nissolia	.21250(*)	.01237	.000	.1882	.2368
	L. aphaca var. biflorus	-.00700	.01237	.572	-.0313	.0173

* The mean difference is significant at the .05 level.

3.2.1.2 Pollen grains Apertures

The studied taxa showed a heterogenic aperture system. *L. brachypterus, L. haussknechtii, L. armeus, L. tukhtensis, L. spathulatus, L. cilicicus, L. hirsutus* and,*L. incurvus* have an apertures with an intine protrusion.*L. roseus* subsp. *roseus, L. tuberosus,L. cassius, L. chloranthus, L. sativus, L cicera, L. saxatilis, L. sphaericus, L. inconspicuus, L. sphaericus, L. nissolia, L. aureus, , L. czeczottianus, L. pratensis, L. laxiflorus* subsp. *laxiflorus, L. aphaca var affinis, L. aphaca var biflorus* and *L. digitatus* have an aperture with an operculum (Figure 28 to Figure 40).

The species belong to the same section have similiar aperture system except for the *L. digitatus, L. hirsutus* and*, L. incurvus*.

Ectoapertures-colpi of all the taxa are long, straight, and border distinct. They are lined up symmetrically and narrowing towards to the poles and their ends are obtuse

(Figure 30, Figure 32) or acute (Figure 31, Figure 40). *L. tukhthensis*, members of sect. *Aphaca*, *L. laxiflorus* subsp. *laxiflorus* have short ectoapertures-colpi. The ectoapertures-colpi of other taxa is long. The colpus length is longest (42.15 µm) in *L. brachypterus* and is shortest (22.87 µm) in *L. laxiflorus* subsp. *laxiflorus* (Table 7).

Endoapertures-pori is large, border distinct, and ranges from lalongate, circular or lolongate with an annulus and costae. Except for the *L. spathulatus* , all the members of sect. *Lathyrostylis*, sect. *Aphaca*, sect. *Nissolia* and sect. *Pratensis* have lalongolate endoaperture-pori. *L. spathulatus* has circular endoaperture-pori. L. tuberossu and L: sphaericus have lolongolate endoaperture-pori.

The porus length regarding the poles (plg) value ranges from 16.98 µm (in *L: spathulatus*) and 4.02 µm (in *L. hirsutus*). The porus width regarding the equatorial diameter ranges from 18.19 µm (in *L. brachypterus*) and 5.67 µm (in *L. tuberosus*) (Table 7).

3.2.1.3. Pollen grains Surface Sculpturing (ornamentation)

The ornamentation of studied taxa is perforate (perforations different in size and shape), foveolate or slightly reticulates in the mesocolpium. Generally, the aperture area and the apocolpium area are psilate, reticulate or slightly reticulate (Figure 28 to Figure 40).

The range of the exine thickness (Ex) is between 1.81-0.67 µm. Among the taxa examined, the thinnest exine, on average, is observed in *L. czeczottianus* (0.89 µm) and the thickest exine, on average, is observed in *L. cicera* (1.21 µm) (Table 7).

The pollen grains surface ornamentation of the studied taxa is as follows;

L. aureus is suprareticulate. The size and shape of lumina is variable. The apocolpium is slightly reticulate. The reticulate pattern is not present around the colpus area; *L. incurvus* is slightly perforate to pisilate.

L. brachypterus ranges from perforate, foveolate to slightly reticulate. Mesocolpium, colpus area and polar area have small-scattered perforations; *L. haussknechtii* is perforate-foveolate-slightly reticulate. Polar area is almost pisilate. Mesocolpium and colpus area have small-scattered perforations; *L. armenus* is perforate – foveolate. Perforation is different in size and shape in the mesocolpium and decreasing towards the apocolpum and colpus area. Aperture area and apocolpium are pisilate; *L. digitatus* is reticulate. Reticulation is intense at the center of mesocolpium. Apocolpium and colpus area is almost pisilate; *L. tukhtensis* is perforate. Perforation is different in size and shape in the mesocolpium and decreasing towards the apocolpium and aperture area. Apocolpium and aperture area is almost pisilate. The concavity of polar triangle and mesocolpium area are reticulate-granulate; *L. spathulatus* is slightly perforate. The aperture area is pisilate. The concavity of polar triangle is reticulate-granulate; *L. cilicicus* is slightly perforate. The apocolpium area and the aperture area are pisilate.

L. pratensis is perforate – foveolate. The colpus area and apocolpium is slightly perforate; *L. laxiflorus* subsp. *laxiflorus* is perforate- foveolate and low relief reticulate. Reticulation is slightly distinct and rought. Colpus area and mesocolpium are slightly perforate. *L. czeczottianus* is is perforate-foveolate and low relief reticulate. Reticulation is intense in an area of mesocolpium. Apocolpium is pisilate. Colpus area is slighyly perforate.

L. roseus subsp. *roseus* is perforate – foveolate and reticulate. Colpus area and apocolpium are pisilate.

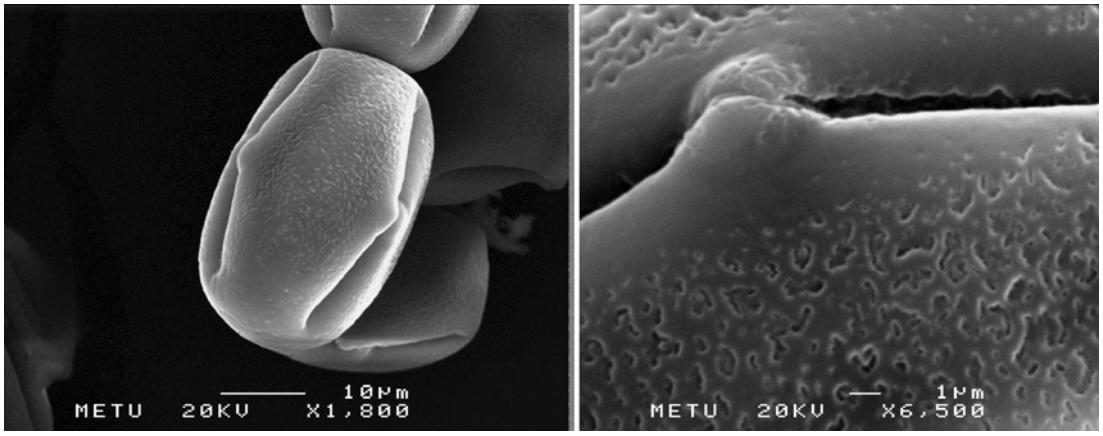
L. tuberosus is slightly reticulate – foveolate. Reticulation is slightly irregular and slightly distinct. Apocolpium and aperture area are scarcely perforate; *L. cassius* is reticulate – foveolate. Aperture area and apocolpium are pisilate; *L. hirsutus* is perforate. Perforation is different in size and shape, decreasing towards the apocolpium and colpus area; *L. chloranthus* is reticulates. Reticulation is big, distinct and regular. Apocolpium is also reticulate. Aperture area is slightly reticulate; *L. sativus* perforate, foveolate and mesocolpium area is slightly reticulate. Apocolpium and aperture area are pisilate; *L. cicera* is perforate - foveolate and reticulate. Reticulation is scarce ate the central part of mesocolpium. Apocolpium and aperture area are pisilate.

L. saxatilis is foveolate and slightly reticulate. Reticulation is scattered towards to the apocolpium. Aperture area is slightly reticulate. Apocolpium is pisilate.

L. inconspicuus var. *inconspicuus* is perforate – slightly reticulate. Perforation is different in size and shape in the mesocolpium and decreasing towards the apocolpium. The polar triangle and the concavity of mesocolpium area is reticulate-granulate; *L. sphaericus* is perforate – reticulate. Reticules are regular and distinct. Apocolpium and aperture area are slightly perforate.

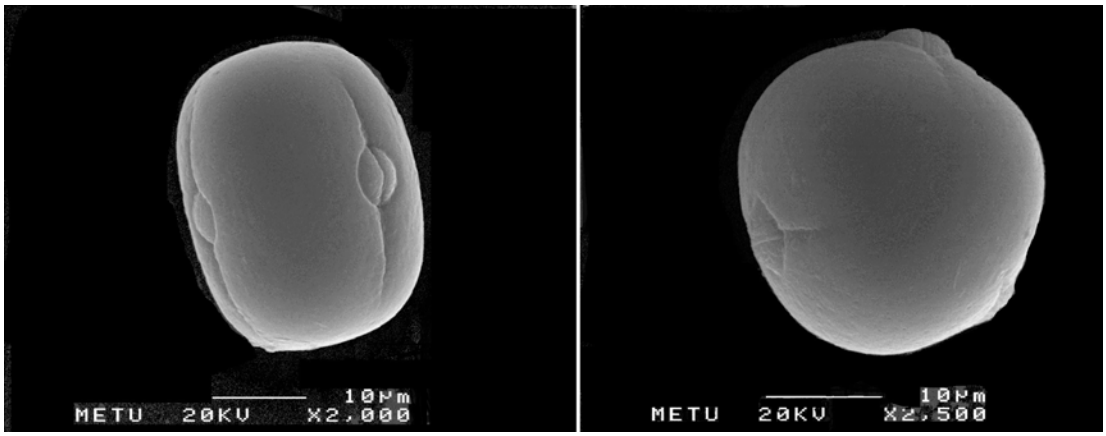
L. nissolia is reticulates. Reticules are distinct and regular. Aperture area is pisilate and apocolpium slightly perforate.

L. aphaca var. *biflorus* is reticulate. Reticules are medium in size, distinct and irregular. Apocolpium and aperture area are pisilate. *L. aphaca* var. *affinis* is perforate-foveolate and reticulate. Reticules are small and distinct. Aperture area is pisilate. Apocolpium is slightly perforate.



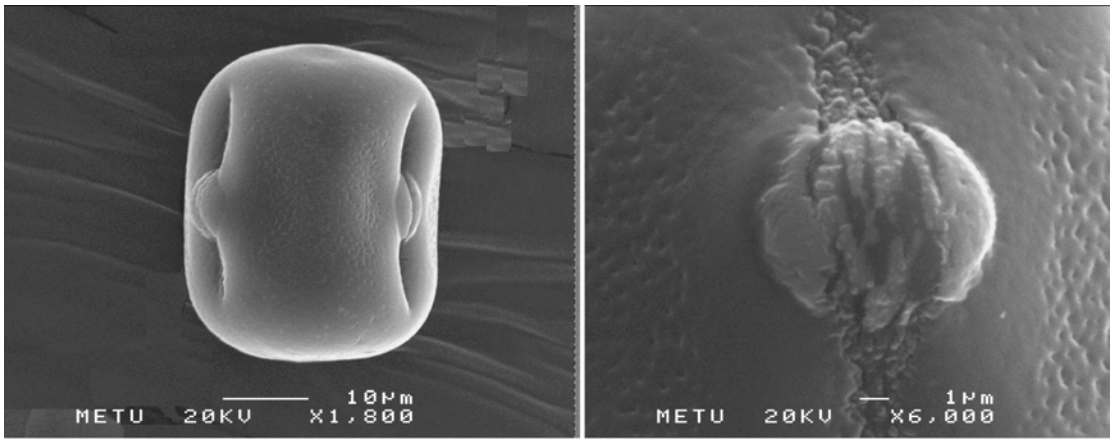
A B

Figure 28. SEM micrographs of pollen grains of *L. aureus*. A: equatorial view. B: ornamentation.



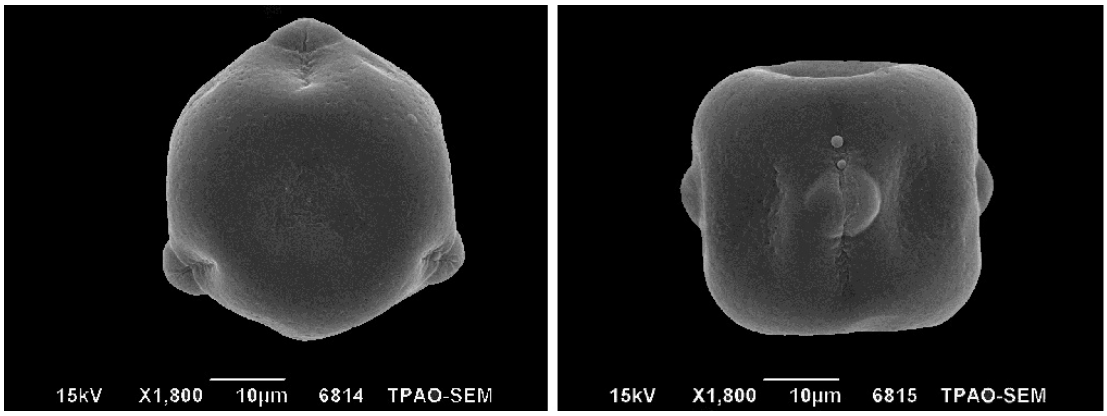
A B

Figure 29. SEM micrographs of pollen grains of *L. incurvus.* A: equatorial view. B: polar view.



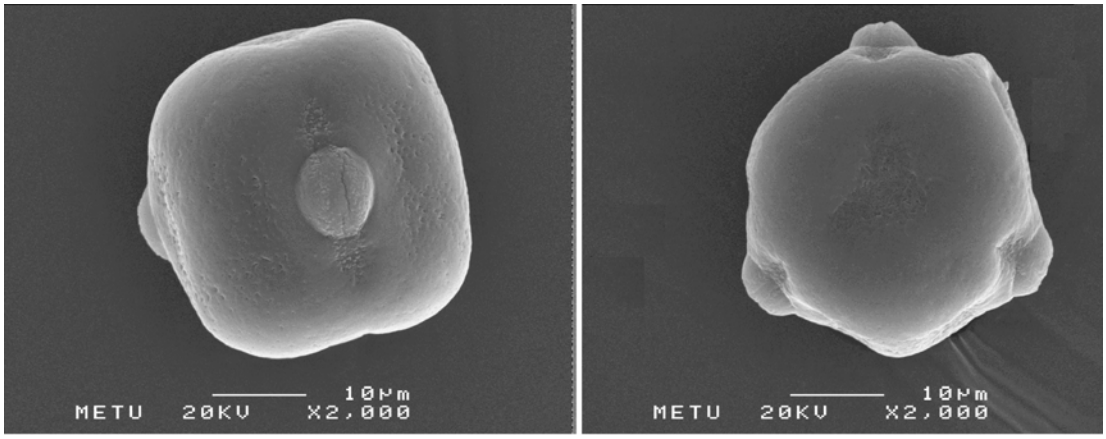
A B

Figure 30. SEM micrographs of pollen grains of *L. armenus.* A: equatorial view. B: ornamentation around aperture.



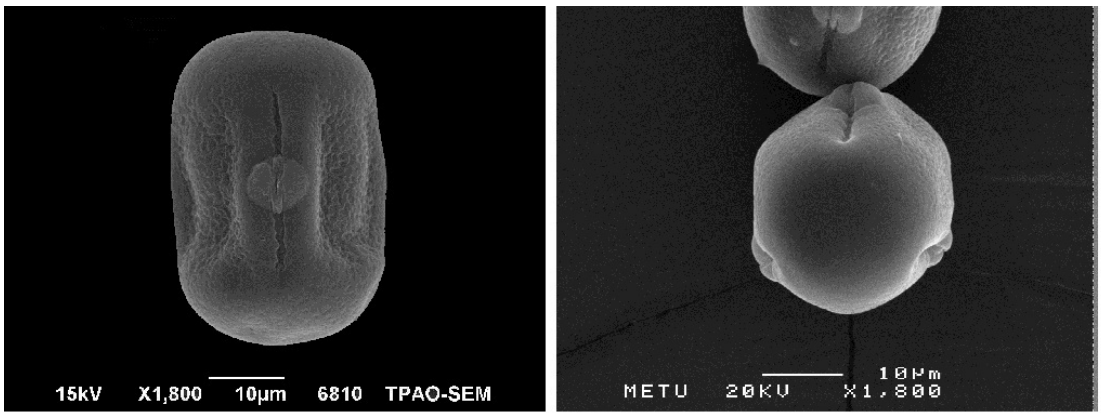
A B

Figure 31. SEM micrographs of pollen grains of *L. tukhtensis.* A: polar view. B: equatorial view.



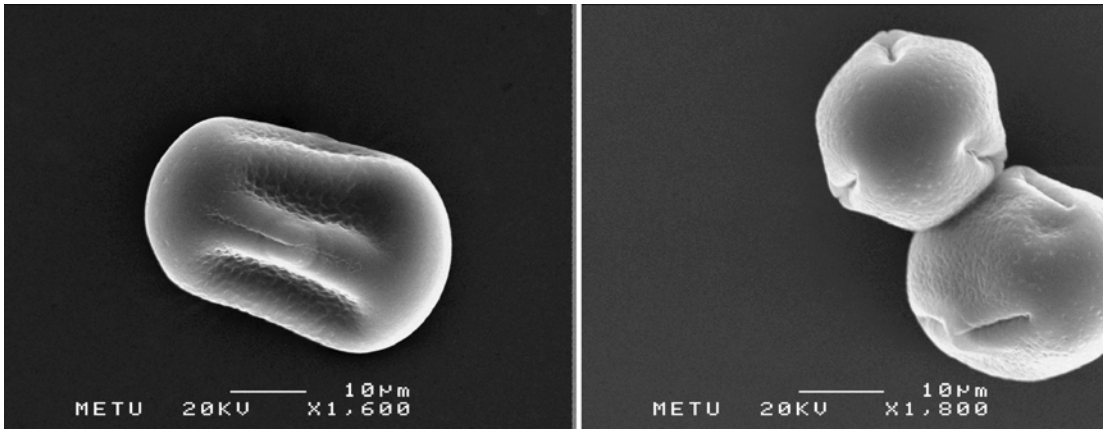
A B

Figure 32. SEM micrographs of pollen grains of *L. spathulatus.* A: equatorial view. B: polar view.



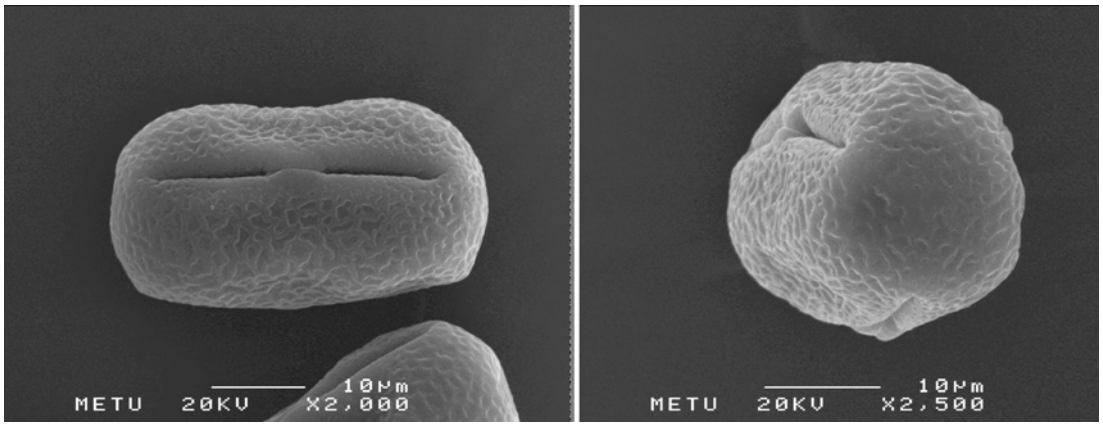
A B

Figure 33. SEM micrographs of pollen grains of *L. czeczottianus.* A: equatorial view. B: polar view.



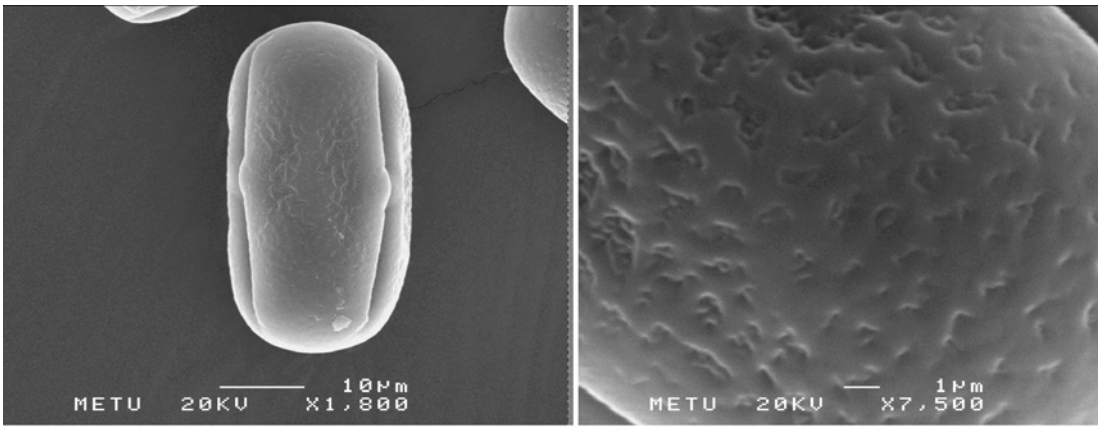
A B

Figure 34. SEM micrographs of pollen grains of *L. tuberosus.* A: equatorial view. B: polar view.



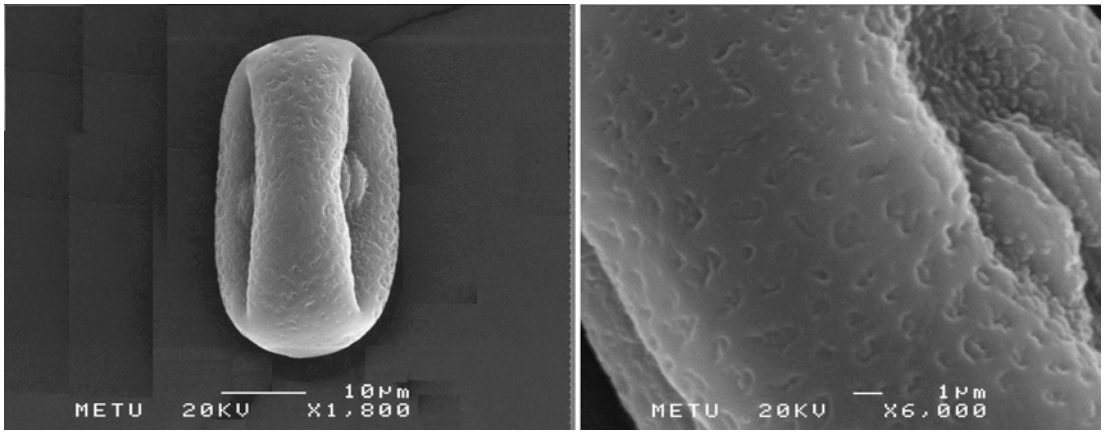
A B

Figure 35. SEM micrographs of pollen grains of *L. chloranthus.* A: equatorial view. B: polar view



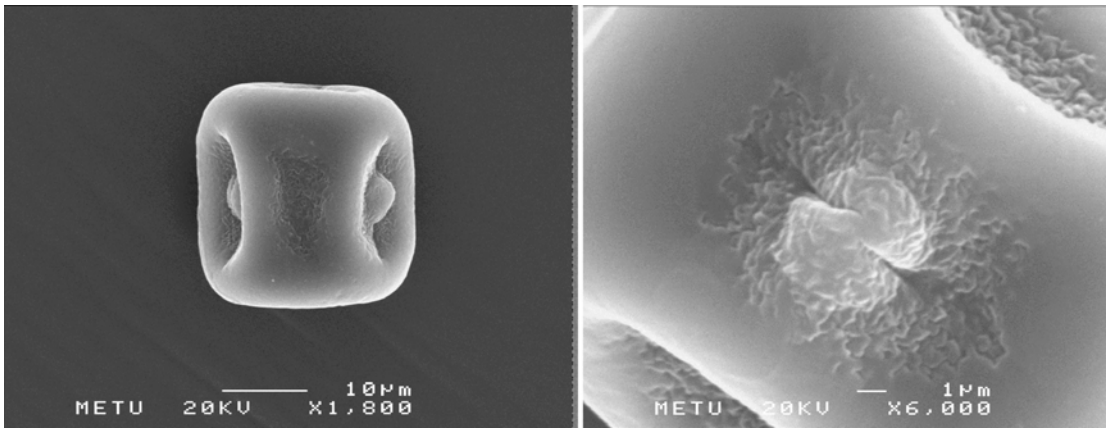
A B

Figure 36. SEM micrographs of pollen grains of *L. sativus.* A: equatorial view. B: ornamentation.



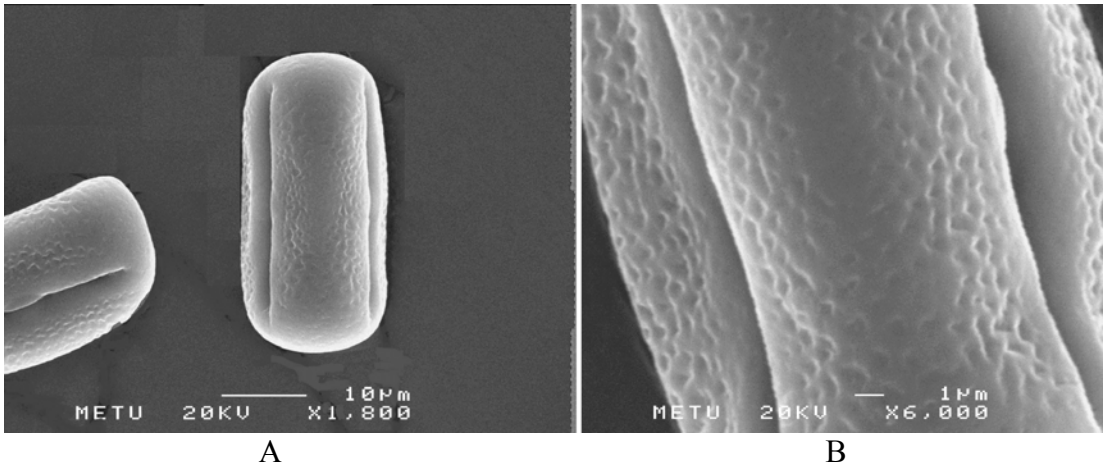
A B

Figure 37. SEM micrographs of pollen grains of *L. saxatilis.* A: equatorial view. B: ornamentation.



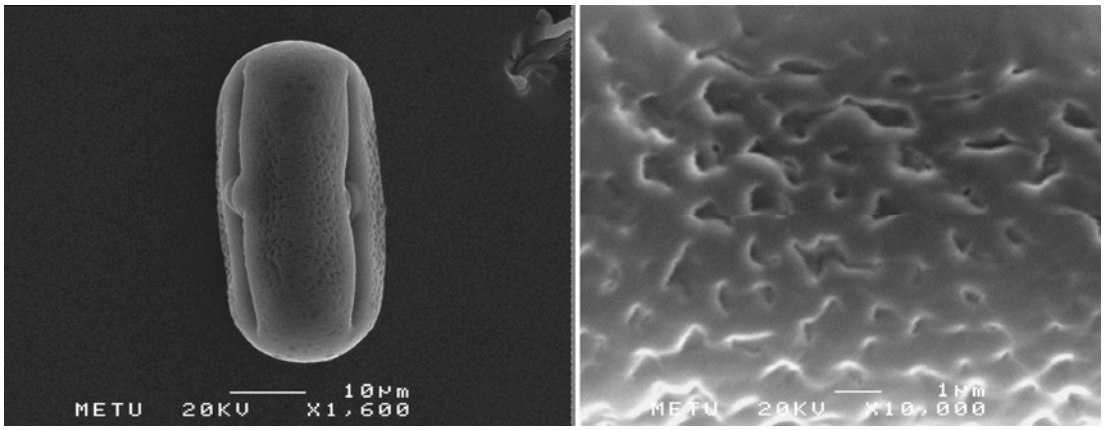
A B

Figure 38. SEM micrographs of pollen grains of *L. inconspicuus* var.*inconspicuus.* A: equatorial view. B: ornamentation around aperture.



A B

Figure 39. SEM micrographs of pollen grains of *L. nissolia.* A: equatorial view. B: ornamentation.



A B

Figure 40. SEM micrographs of pollen grains of *L. aphaca* var. *biflorus.* A: equatorial view. B: surface ornamentation.

3.3. Anatomy

The measurements taken from cross-sections of the roots, stems and leaves of 25 *Lathyrus* taxa are presented in Table 41 and Table 42. The photographs of the given species in LM are given in Figure 42 to Figure 72.

Table 41. Measured anatomical characters of the Stem and Root of the taxa. Numbers refer to mean±standard deviation.All sizes are in µm.

		Stem anatomy						Root anatomy	
		Epidermis		Tracheal cell diameter	Wing		Pith cell diameter	Number of pith ray	Tracheal cell diameter
		Length	Width		Lenght	Width			
1.	*L. aureus*	35.84 ±1.21	29.88±1.44	20.82±2.12	X	X	26.65±1.21	1 - 3	26.18±2.01
2.	*L. incurvus*	29.43±2,12	26.32±2.21	39.35±3.05	945.05±12.32	127.38±8.54	43.69±2.43	?	?
3.	*L. brachypterus*	13.48±1.43	9.49±1,43	13.43±1.32	X	X	24.10±1.55	2 - 4	28.40±1,54
4.	*L. haussknechtii*	15.59±1.65	11.34±1.65	14.34±2.04	X	X	29.45±1.98	2-4	30.32±1.32
5.	*L. armenus*	44.28±3.21	29.25±2.45	28.79±3.01	X	X	42.03±2.03	1 – 4	28.78±1.43
6.	*L. digitatus*	23.43±2.32	19.98±2.08	27.26±2.43	X	X	45.76±2.07	2 – 4	42.88±2.19
7.	*L. tukhtensis*	24.24±2.43	24.15±2,34	26.14±2.76	X	X	53.87±2.15	3 – 5	26.73±1.08
8.	*L. spathulatus*	28.76±3,23	13.69±1.65	39.13±3.09	X	X	49.25±1.18	?	?
9.	*L. cilicicus*	22.06±1,98	8.40±1.05	41.06±2.43	X	X	69.41±2.01	2 – 4	14.74±1.58
10.	*L. pratensis*	40.58±3.12	12.96±2.32	21.22±2.78	X	X	57.59±1.32	1 – 4	35.65±2.04
11.	*L. laxiflorus* subsp. *laxiflorus*	22.76±2.76	16.92±2.56	34.35±2.93	X	X	45.55±2.02	1 – 5	32.64±2.06
12.	*L. czeczottianus*	42.16±1.65	31.93±3.54	37.83±3.43	X	X	55.65±2.18	3 – 4	38.70±1.28
13.	*L. roseus* subsp. *roseus*	18.40±1.89	16.16±1.68	22.54±2.65	X	X	57.50±2.08	?	?
14.	*L. tuberosus*	28.54±2.98	13.17±2.72	31.26±2.47	X	X	31.73±1.43	1 – 3	40.48±2.03
15.	*L. saxatilis*	25.542.78	14.21±2.41	30.67±2.91	X	X	31.89±1.21	?	?
16.	*L. sphaericus*	31.37±1.79	15.82±2.04	26.92±1.29	X	X	60.51±2.03	1 – 3	37.16±1.91
17.	*L. inconspicuus* var. *inconspicuus*	22.75±2.23	12.86±1.47	28.15±2.54	X	X	52.89±2.01	1 – 6	37.33±2.89
18.	*L. cassius*	49.74±3.45	18.56±2.42	40.79±3.43	594.22±8.43	148.35±7.54	78.84±1.76	2 – 5	55.30±1.38
19.	*L. cicera*	33.06±2.32	22.89±1.32	26.34±3.21	436.47±10.76	199.24±9.21	55.31±2.09	1 – 4	22.98±1.27
20	*L. sativus*	44.36±3.54	26.33±3.04	33.44±2.54	681.90±10.35	82.72± 9.54	51.74±2.43	1 – 3	55.57±1.32
21.	*L. hirsutus*	28.89±3.27	19.88±1.22	35.55±2.06	729.08±8.12	206.52±8.65	77.92±2.14	1 – 3	29.98±1.02
22.	*L. chloranthus*	25.94±2.29	24.95±2.39	41.82±1.89	1060.85±7.67	102.30±6.87	91.46±1.56	1 – 3	59.07±2.04
23.	*L. nissolia*	32.65±3.56	19.37±2.06	31.50±2.31	X	X	59.14±2.04	2 – 5	44.08±1.38
24	*L. aphaca var.biflorus*	27.34±1.55	21.56±2.65	32.89±3.21	X	X	70.32±1.32	1 - 2	42.20±1.22
25.	*L. aphaca var. affinis*	26.38±1.43	20.56±2.21	31.39±2.33	X	X	72.43±2.42	1 – 2	43.60±1.76

3.3.1 Root Anatomy

The periderm layer on the outermost surface is generally dark-coloured. Under periderm, 1-2-(4) layered parenchymatic cortexes are present. Sclerenchyma groups covering sparsely on the well developed phloem. Cambium is not distinguishable. The pith rays consist of 1 – 6 layered cells. Pith and tracheal cell diameter are variable. (Figure 43 to Figure 50, Table 41)

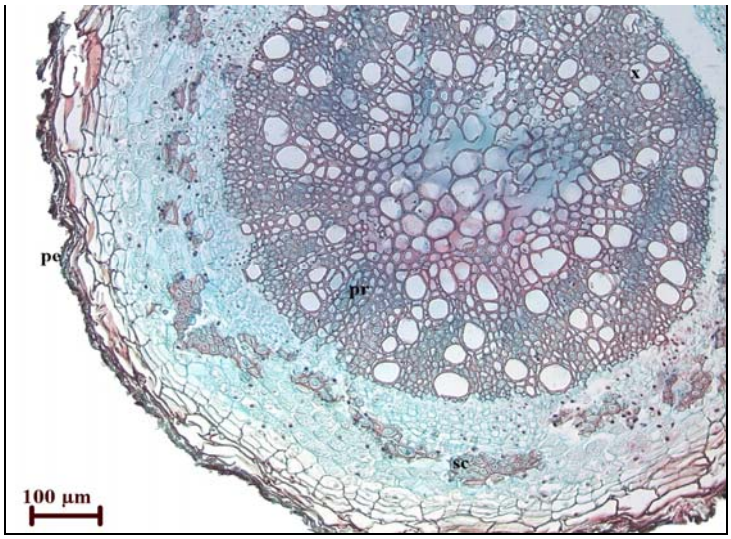


Figure 41. The transverse section of the root of the *L. brachypterus*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

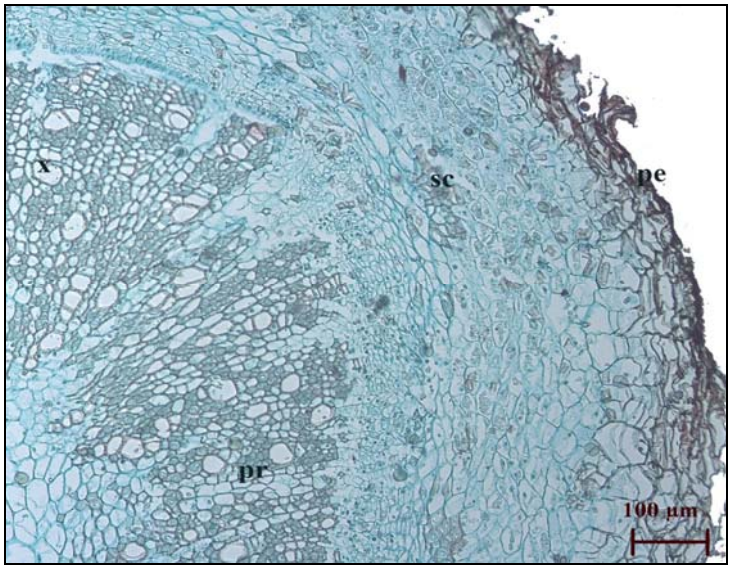


Figure 42. The transverse section of the root of the *L. armenus*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

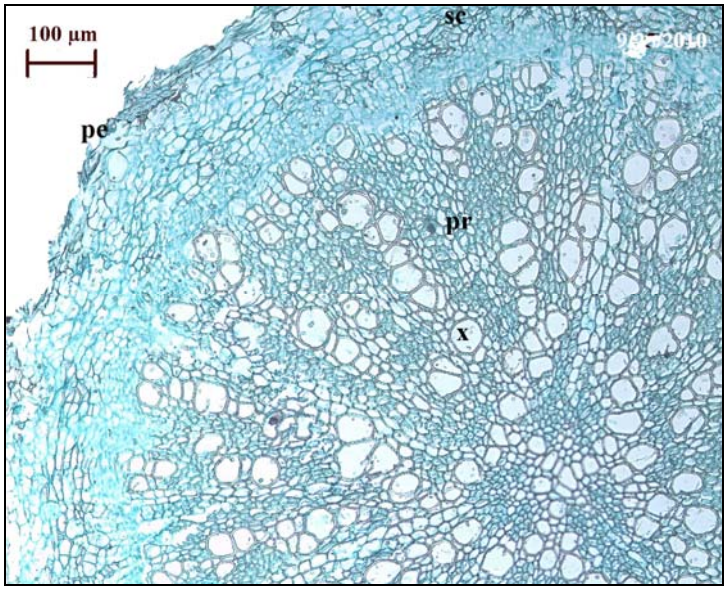


Figure 43. The transverse section of the root of the *L. digitatus*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

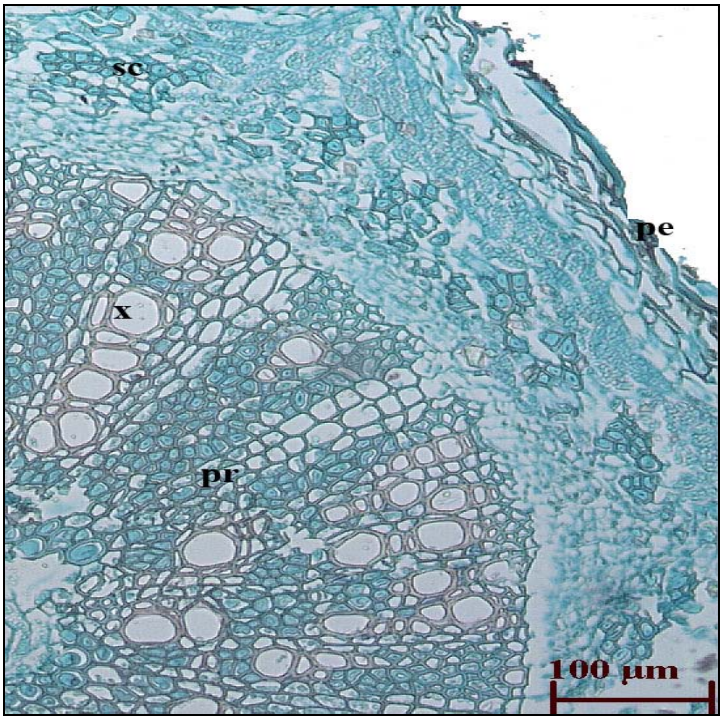


Figure 44. The transverse section of the root of the *L. tukhtensis*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

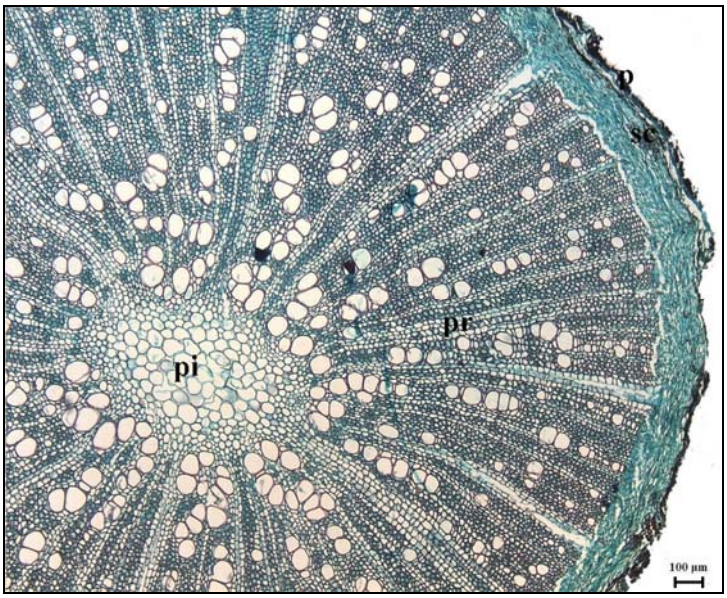


Figure 45. The transverse section of the root of the *L. cilicicus*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

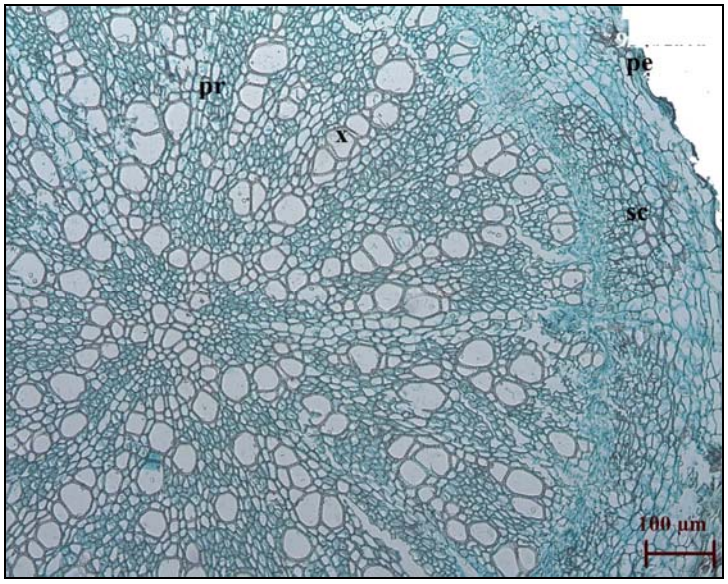


Figure 46. The transverse section of the root of the *L. inconspicuus* var *inconspicuus*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

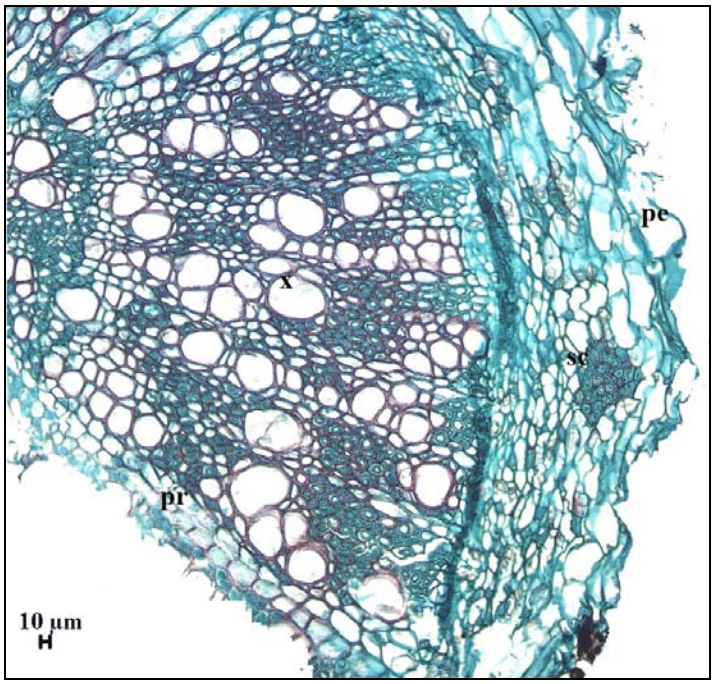


Figure 47. The transverse section of the root of the *L.cassius*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

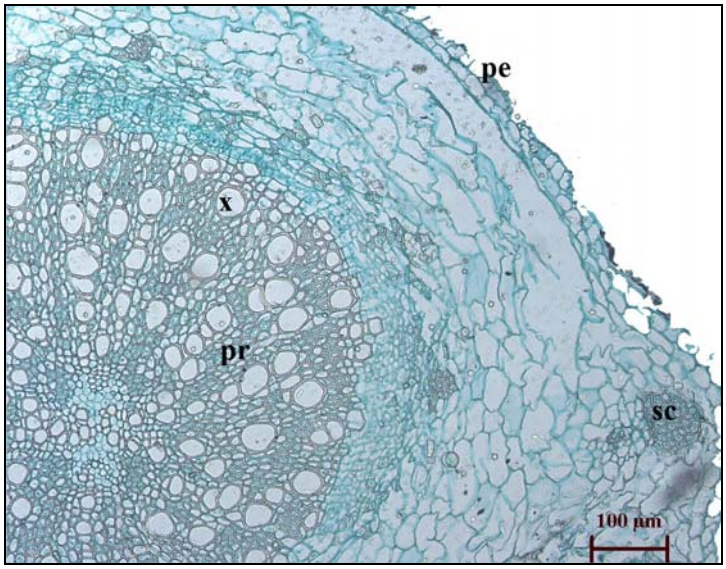


Figure 48. The transverse section of the root of the *L. hirsutus*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

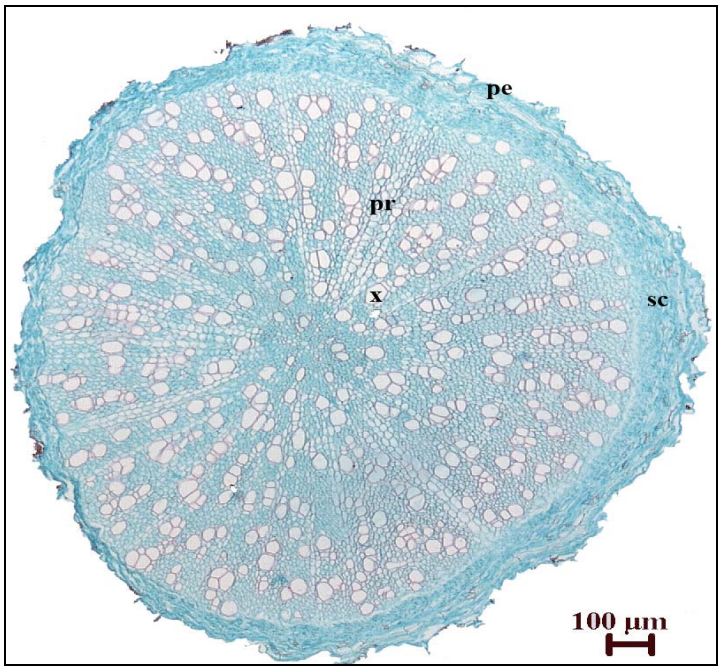


Figure 49. The transverse section of the root of the *L. nissolia*; pe: Periderm, sc: Sclerenchyma, x: Xylem, pr: Pith ray.

3.2.2. Stem Anatomy

The stem transverse sections are circular, angeled or winged. Winged stem feature is made possible by the presence of corticle bundles. The wings are longer or shorter then the stem diameter. The epidermis is one or two layered and mainly consists of rectangular or spherical cells with a thin or thick cuticle. The upper and lower walls of the epidermis cells are generally thicker than the lateral walls. Above the phloem, many sclerenchymatous cells are present. Some of the species have hole at the center of the stem. Cambium is not clearly distinguishable. The trachea cells are mainly angular, oval or slightly elliptical. The pith is relatively large and composed of slightly polygonal parenchmatic cells and and often with large intercellular space. (Figure 51 to Figure 67, Table 41). *L. aureus, L. armenus, L. laxiflorus* subsp. *laxiflorus, L. roseus* subsp. *roseus* and *L. cilicicus* (Celep et al., 2011) have hollow at the center of their stem.

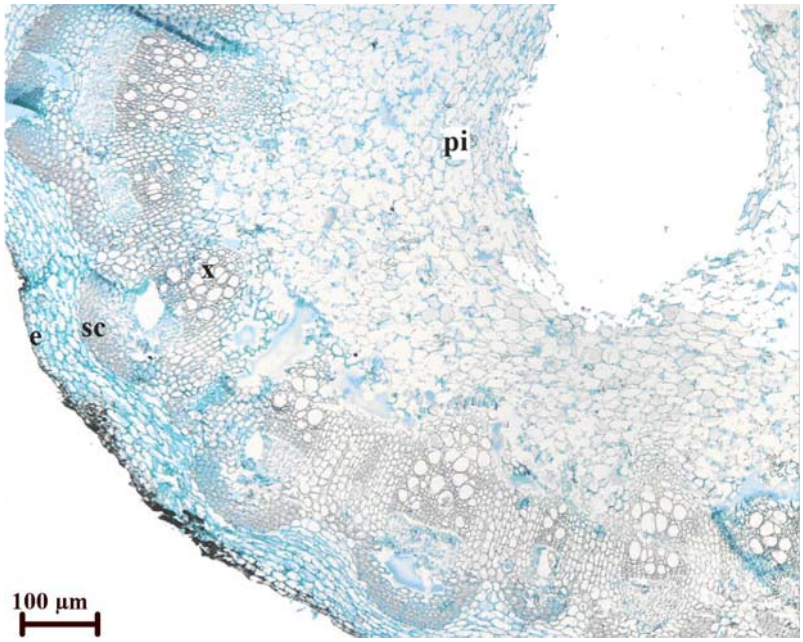


Figure 50. The transverse section of the stem of *L. aureus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

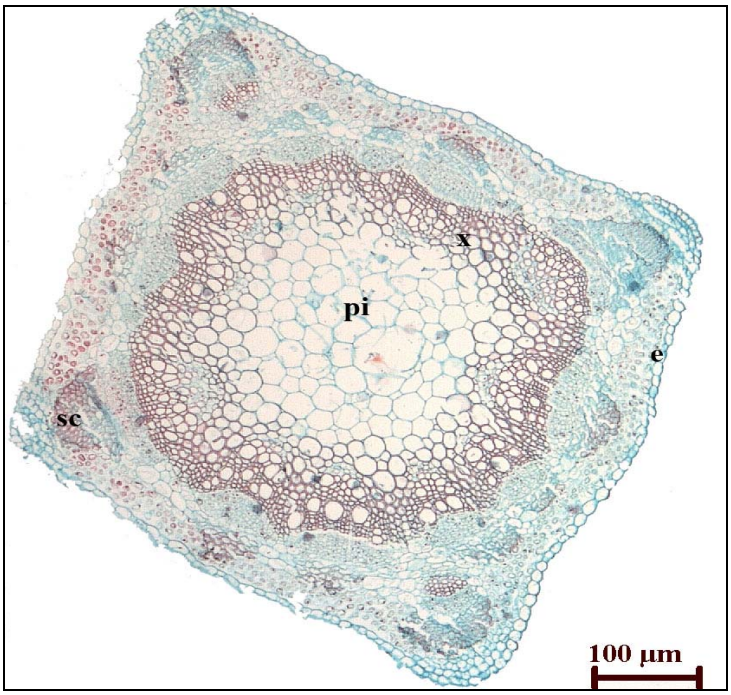


Figure 51. The transverse section of the stem of *L. brachypterus* var *brachypterus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

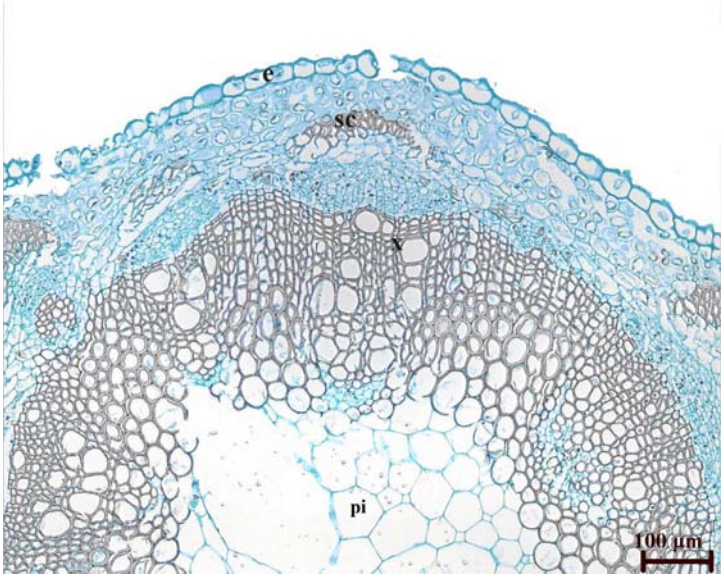


Figure 52. The transverse section of the stem of *L.armenus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

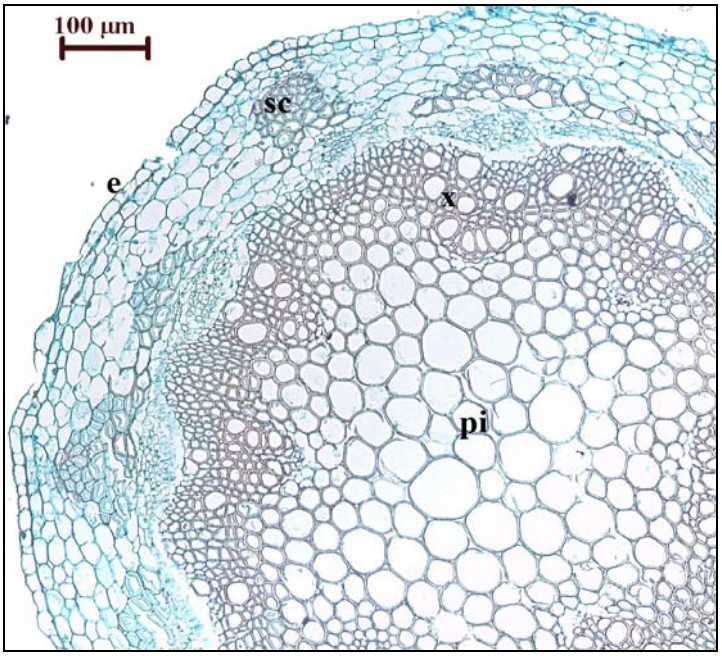


Figure 53. The transverse section of the stem of *L.digitatus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

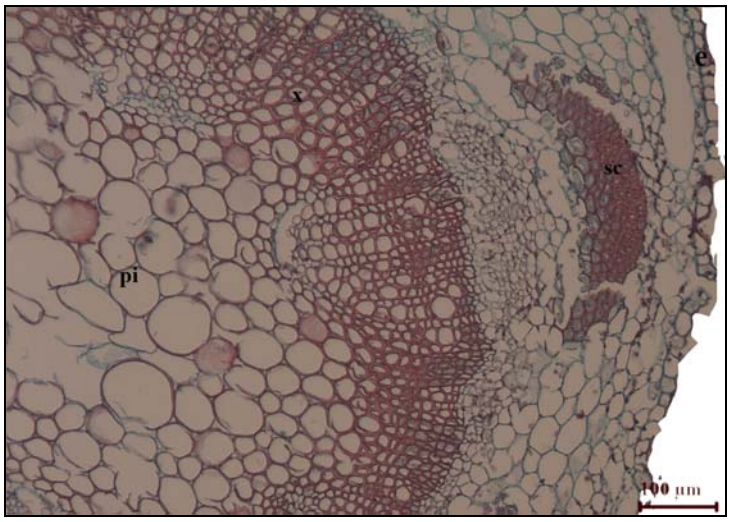


Figure 54. The transverse section of the stem of *L.tukhtensis*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

Figure 55. The transverse section of the stem of *L.cilicicus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

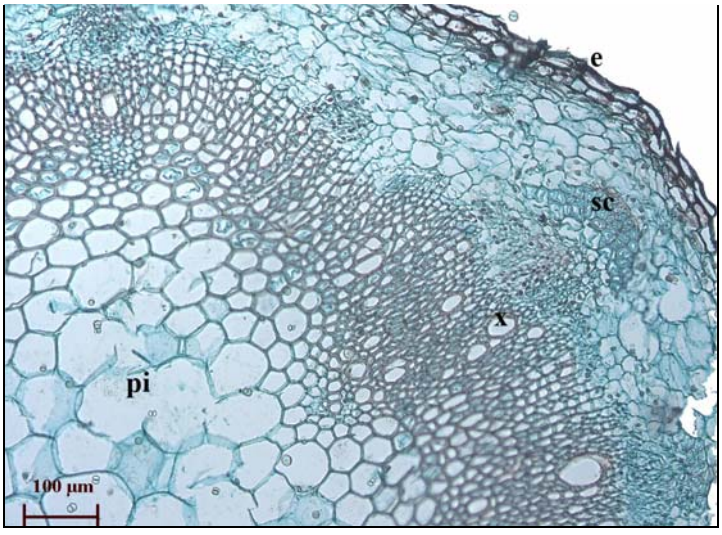


Figure 56. The transverse section of the stem of *L.pratensis*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

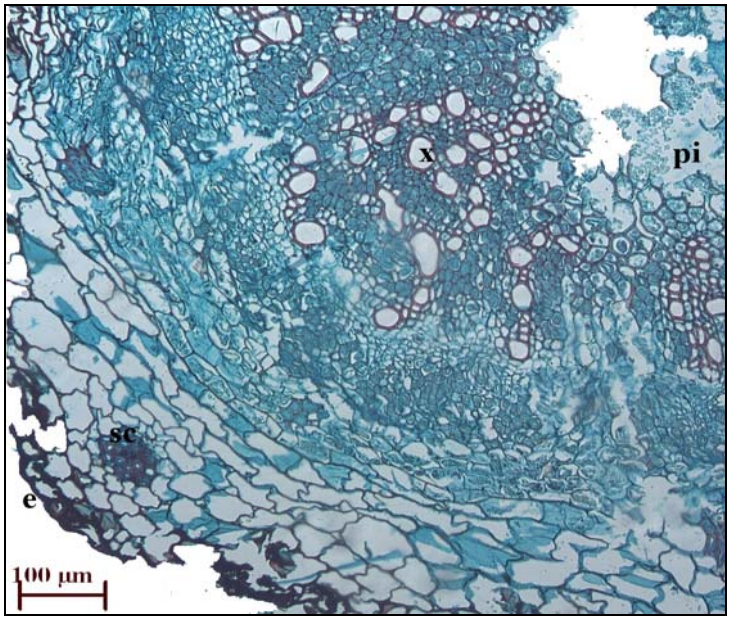


Figure 57. The transverse section of the stem of *L. laxiflorus* subsp. *laxiflorus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

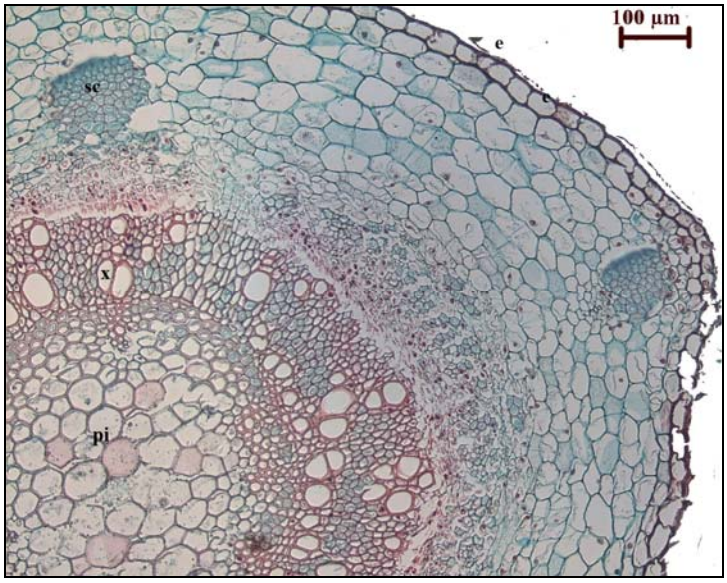


Figure 58. The transverse section of the stem of *L. czeczottianus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

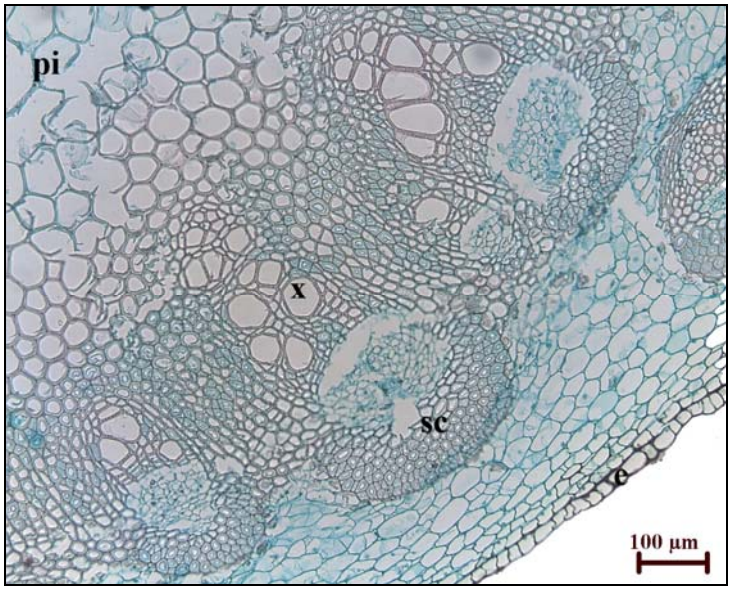


Figure 59. The transverse section of the stem of *L.roseus* subsp. *roseus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

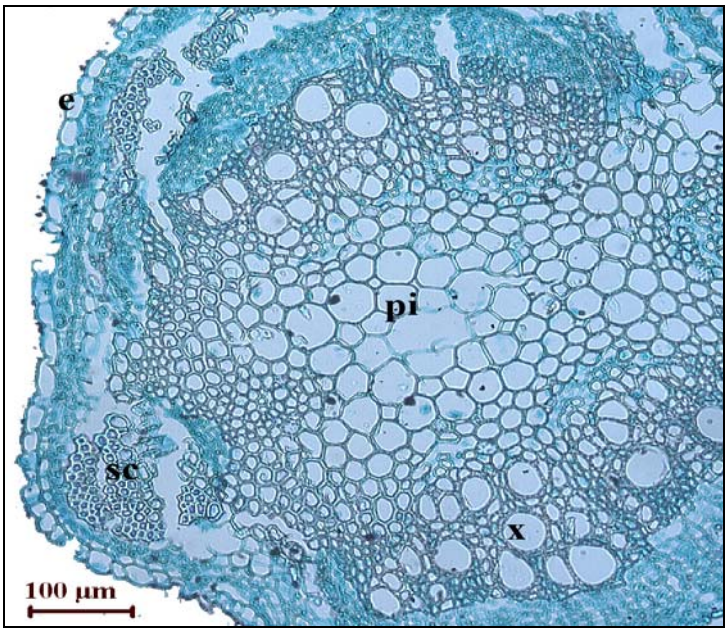


Figure 60. The transverse section of the stem of *L.tuberosus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

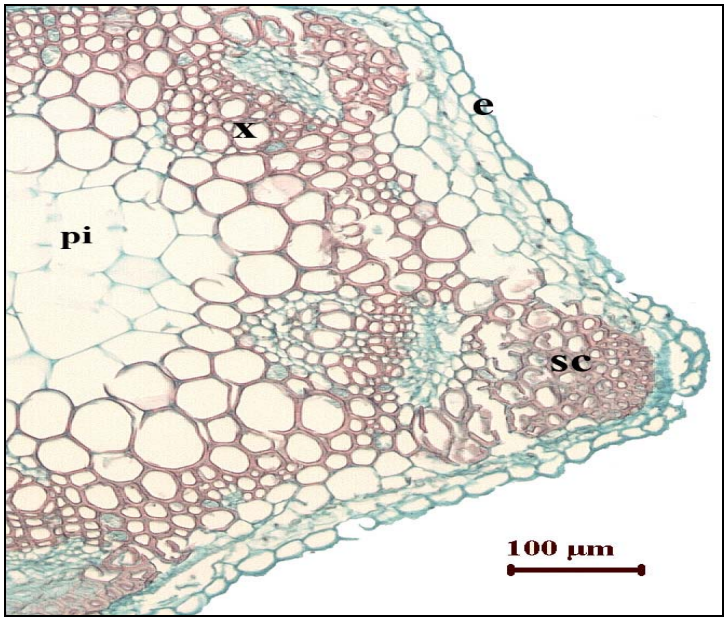


Figure 61. The transverse section of the stem of *L.sphaericus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

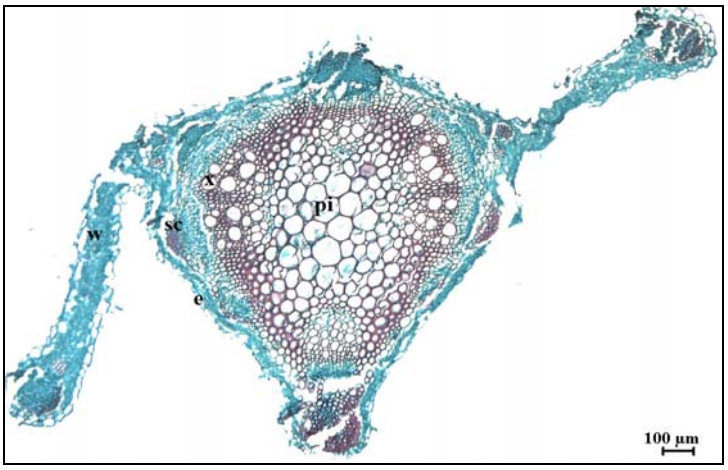


Figure 62. The transverse section of the stem of *L. cassius*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

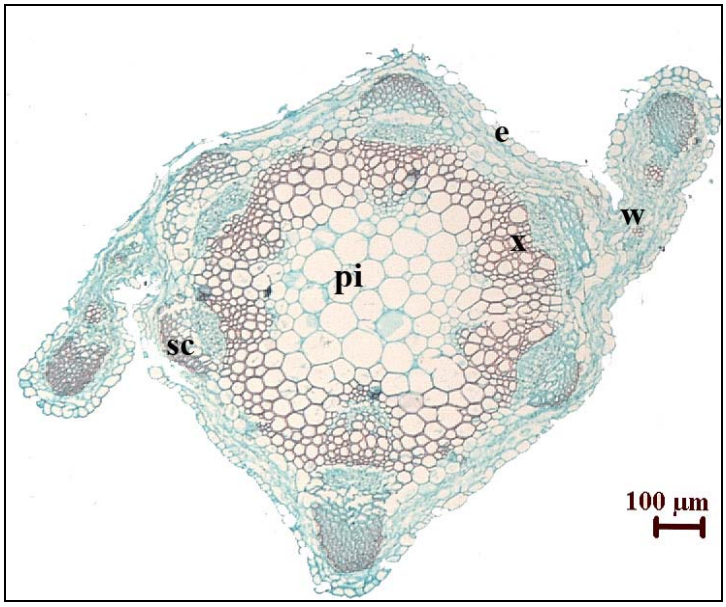


Figure 63. The transverse section of the stem of *L. cicera*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

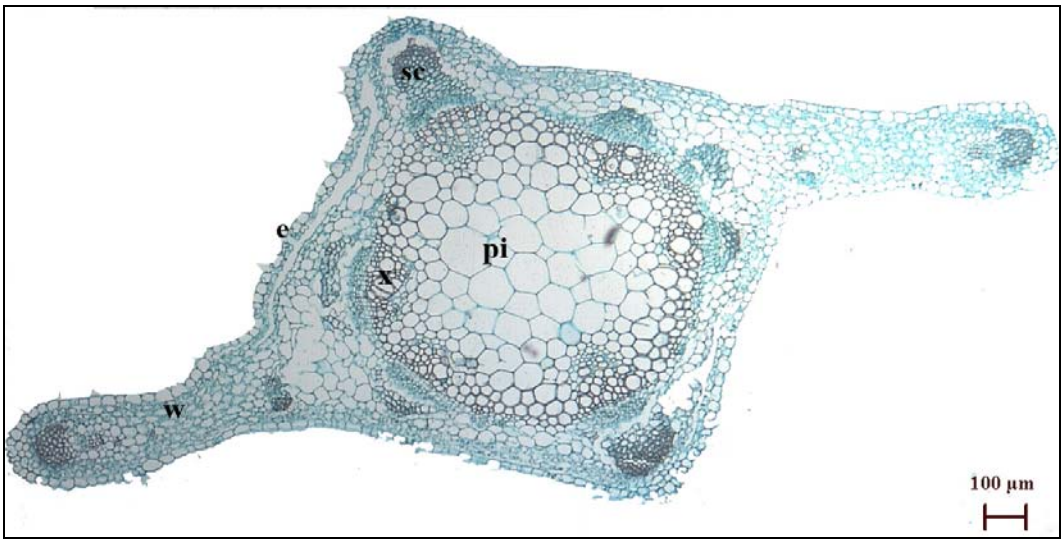


Figure 64. The transverse section of the stem of *L. hirsutus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

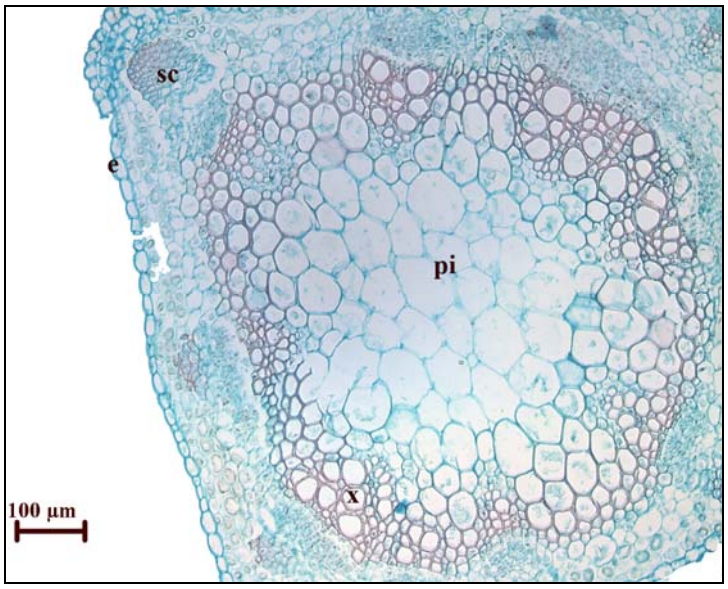


Figure 65. The transverse section of the stem of *L. aphaca* var *biflorus*. e: epidermis, s: Sclerenchyma, p: phloem, x: xylem, pi: pith region.

3.2.3. Leaf Anatomy

Epidermis cells are rectangular or polygonal shaped. The upper and lower epidermises are made up of uniseriate, isodiametric or rectangular cells (Table 42). The palisade parenchyma has generally small intercellular space, but the spongy parenchyma cells have large air spaces between them. Stoma number and size are variable. In most of the species, the spongy tissue is twice as thick as the palisade tissue. Some species have palisade paranchyma tissue abaxial and adaxial side of the leaf. Above the xylem and phloem, well-developed screnchyma tissue is present (Figure 67 to Figure 77)

L. roseus subsp. *roseus* and *L. laxiflorus* subsp. *laxiflorus* have hypostomatic leaves and *L. incurvus*, *L. pratensis*, *L. czeczottianus, L. sphaericus*, *L. cassius*, *L. cicera* have amphistomatic leaves.

Table 42. Measured anatomical characters of the Leaf. Numbers refer to mean±standard deviation.All sizes are in µm.

		Leaf anatomy					
		Mesophyll thickness	Tracheal cell diameter	Upper epidermis cell		Lower epidermis cell	
				Length	Width	Length	width
1.	*L. aureus*	274.21 ± 3.12	11.61 ± 1.78	35.45 ± 2.11	33.55 ± 1.78	27.10 ± 2.15	23.63 ± 2.04
2.	*L. incurvus*	73.07 ± 1.45	24.45 ± 1.32	27.67 ± 2.05	27.30 ± 1.16	27.99 ± 1.78	19.29 ± 1.32
3.	*L. brachypterus*	302.19 ± 4.41	12.28 ± 2.01	35.05 ± 1.71	29.29 ± 3.21	35.97 ± 1.43	24.70 ± 1. 35
4.	*L. haussknectii*	289.92 ± 3.75	8.98 ± 1.05	30.78 ± 1. 65	26.23 ± 1.23	30.56 ± 1.97	20.88 ± 2. 75
5.	*L. armenus*	231.68 ± 3.49	8.19 ± 0.98	26.75 ± 2.09	19.45 ± 1.61	24.26 ± 1.16	17.80± 2.05
6.	*L. digitatus*	194.13 ± 2.78	7.89 ± 1.13	41.67 ± 2.72	24.03 ± 2.51	21.25 ± 2.14	20.78 ± 1.91
7.	*L. tukhtensis*	202.91 ± 2.63	6.19 ± 0.89	29.79 ± 1.21	19.65 ± 2.62	36.45 ± 2.36	19.05 ± 2.45
8.	*L. spathulatus*	66.72 ± 2.02	8.67 ± 1.42	29.79 ± 1.54	9.01 ± 1.45	13.10 ± 2.67	10.96 ± 2.79
9.	*L. cilicicus*	194.55 ± 3.98	15.74 ± 1.89	30.04 ± 2.06	11.80 ± 3.06	19.55 ± 2.43	11.52 ± 1.19
10.	*L. pratensis*	119.46 ± 1.19	10.11 ± 1.57	32.31 ± 1.05	21.76 ± 2.32	28.33 ± 2.24	28.05 ± 1.05
11.	*L. laxiflorus* subsp. *laxiflorus*	124.97 ± 2.64	10.37 ± 1.64	29.80 ± 2.81	20.01 ± 2.54	18.16 ± 1.31	15.70 ± 2.08
12.	*L. czeczottianus*	152.48 ± 2.35	9.13 ± 0.97	31.84 ± 1.34	20.03 ± 1.43	26.67 ± 1.23	24.51 ± 3.65
13.	*L. roseus* subsp. *roseus*	118.80 ± 1.98	18.77 ± 2.86	28.78 ± 2.67	19.01 ± 2.77	22.92 ± 1. 67	18.99 ± 1.34
14.	*L. tuberosus*	184.75 ± 5.76	12.79 ± 2.12	42.88 ± 1.09	21.01 ± 2.76	34.32 ± 1.09	26.89 ± 2.45
15.	*L. saxatilis*	80.23 ± 3.57	13.67 ± 3.54	35.27 ± 2.05	19.48 ± 1.41	32.51 ± 1.24	25.26 ± 2.27
16.	*L. sphaericus*	53.31 ± 1.76	11.92 ± 1.75	25.38 ± 1.56	14.84 ± 1.49	23.83 ± 2.47	18.12 ± 1.64
17.	*L. inconspicuus* var. *inconspicuus*	258.14 ± 2.44	13.98 ± 1.09	28.71 ± 1.87	18.85 ± 1.87	28.18 ± 2.08	19.48 ± 1.34
18.	*L. cassius*	235.87 ± 3.18	15.09 ± 2.67	38.99 ± 2.08	27.52 ± 2.07	36.26 ± 2.01	31.35± 1. 07
19.	*L. cicera*	114.06 ± 3.09	10.78 ± 1.66	18.49 ± 3.12	15.59 ± 1.83	32.60 ± 1. 98	18.69 ± 2.66
20.	*L. sativus*	31.26 ± 1.02	11.19 ± 2.97	15.46 ± 1.89	8.30 ± 2.03	24.78 ± 1. 57	8.03 ± 1.41
21.	*L. hirsutus*	138.86 ± 2.46	13.18 ± 2.77	43.39 ± 2.13	23.70 ± 2.41	30.18 ± 1.91	26.94 ± 3.57
22.	*L. chloranthus*	46.53 ± 1.37	9.43 ± 2.07	17.64 ± 2.04	7.82 ± 1.05	13.97 ± 2.33	8.85 ± 1.89
23.	*L. nissolia*	127.16 ± 1.07	14.29 ± 1.75	20.89 ± 2.36	16.16 ± 2.24	20.34 ± 1. 68	9.90 ± 1.11
24.	*L. aphaca* var *biflorus*	102.96 ± 3.03	9.47 ± 2.06	19.65 ± 1.82	13.70 ± 1.78	19.36 ± 1.45	14.58 ± 2.03
25.	*L. aphaca* var *affinis*	100.32 ± 1.16	9.98 ± 1.97	20.21 ± 2.15	14.25 ± 2.45	21.71 ± 1.08	13.89 ± 1.67

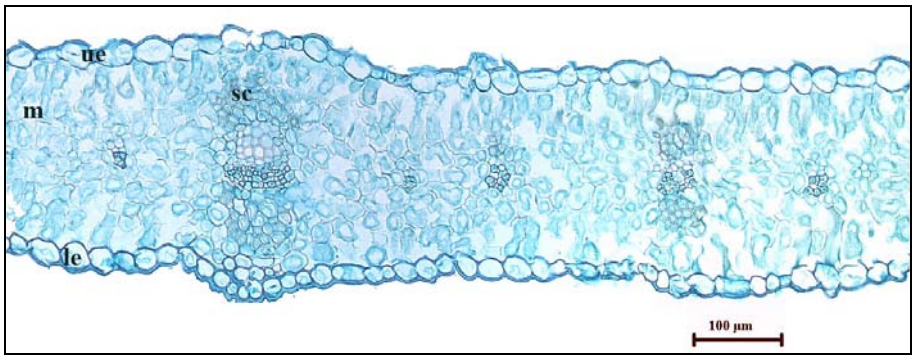


Figure 66. The transverse section of the leaf of *L. aureus*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

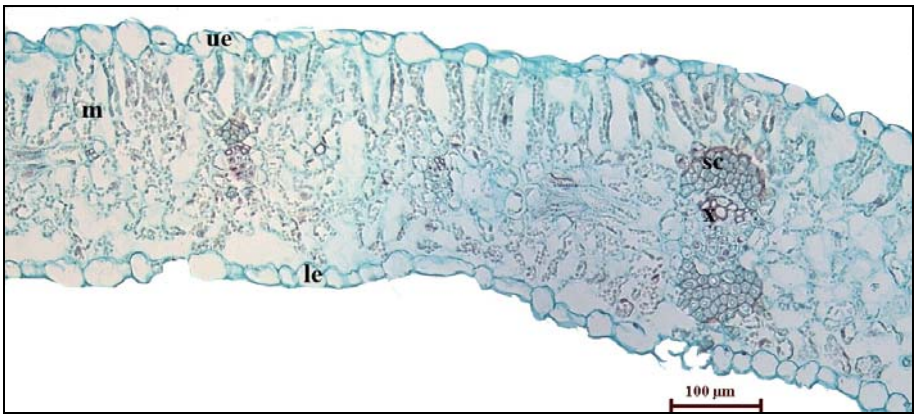


Figure 67. The transverse section of the leaf of *L. brachypterus* ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

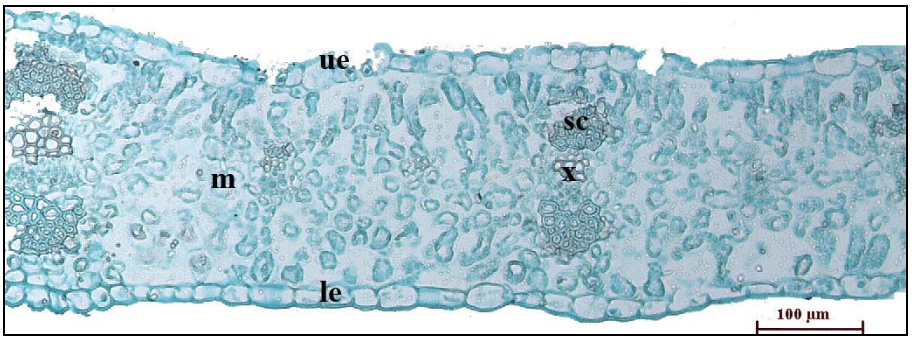


Figure 68. The transverse section of the leaf of *L. armenus*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

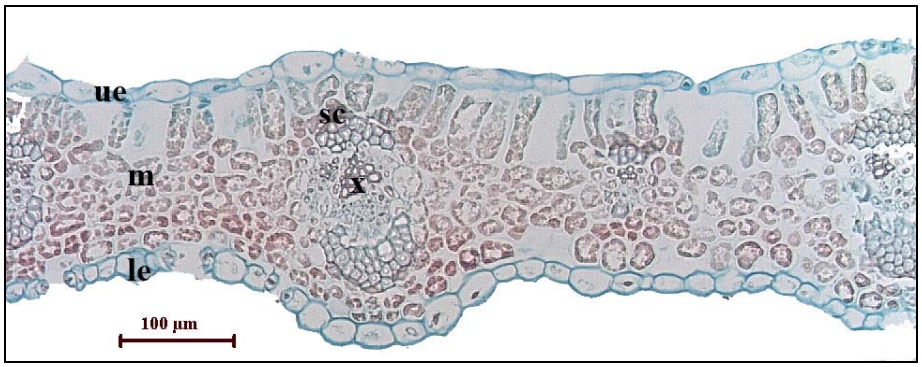


Figure 69. The transverse section of the leaf of *L. digitatus*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

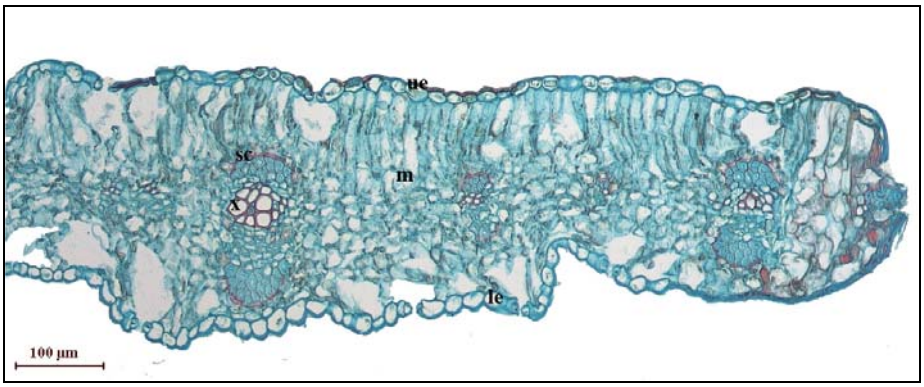


Figure 70. The transverse section of the leaf of *L.cilicicus*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

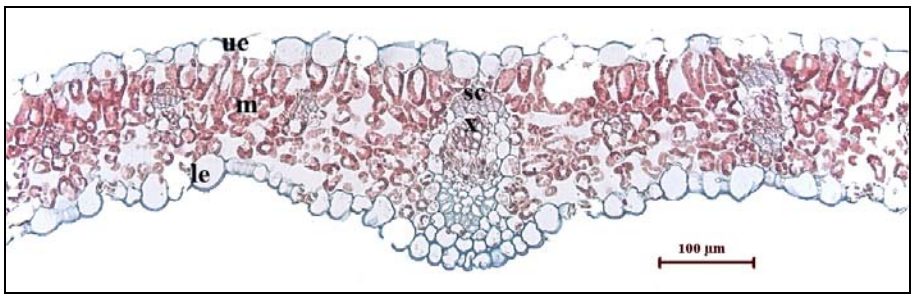


Figure 71. The transverse section of the leaf of *L. pratensis*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

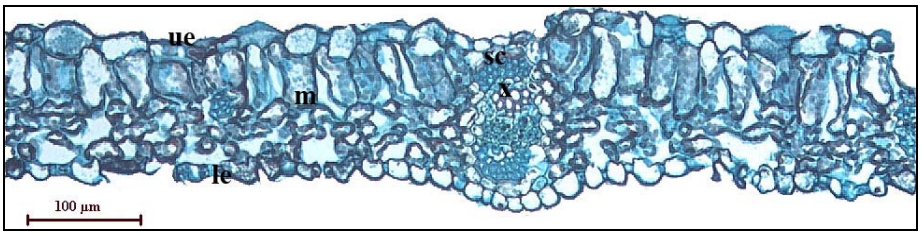


Figure 72. The transverse section of the leaf of *L. laxiflorus* subsp. *laxiflorus*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

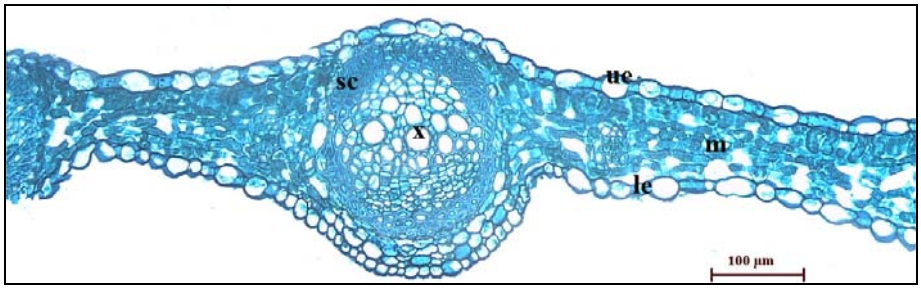


Figure 73. The transverse section of the leaf of *L. roseus* subs. *roseus* ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

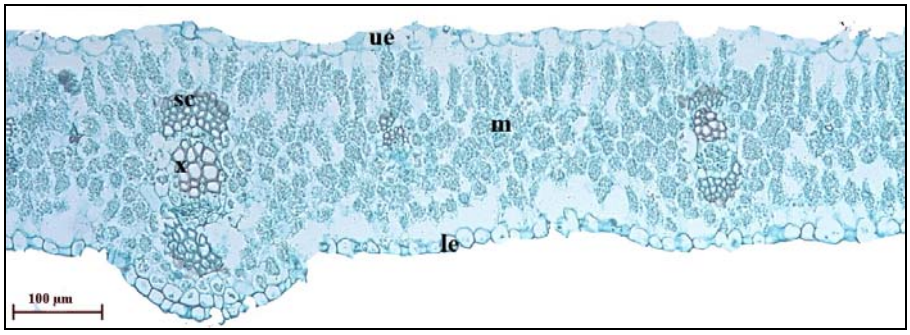


Figure 74. The transverse section of the leaf of *L. inconspicuus* var *inconspicuus* ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

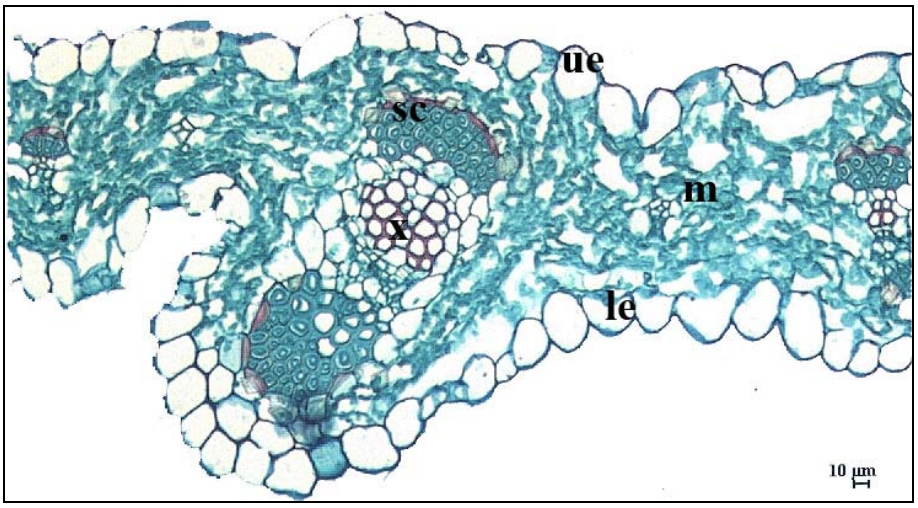


Figure 75. The transverse section of the leaf of *L. cassius*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

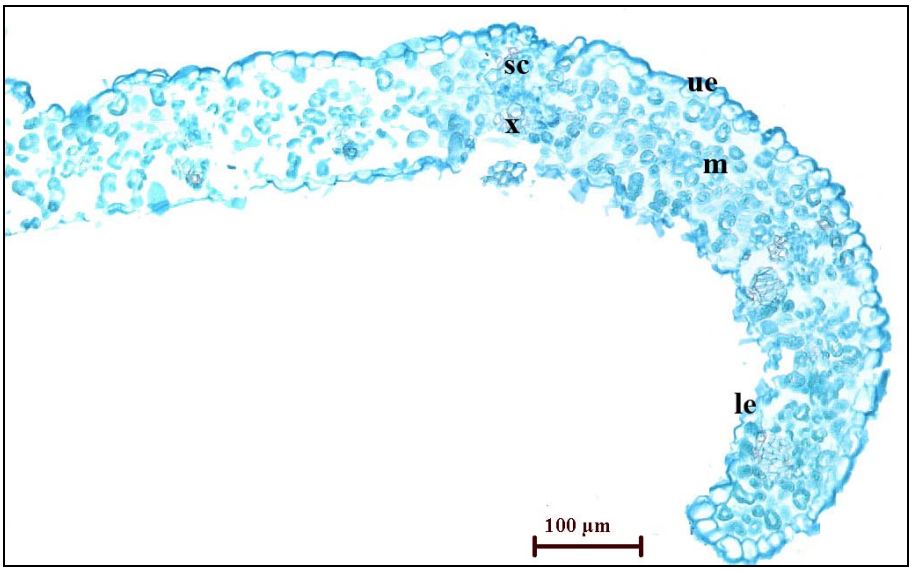


Figure 76. The transverse section of the leaf of *L. nissolia*. ue: upper epidermis, le: lower epidermis, sc: sclerenchyma, m: mesophyll, x: xylem

3.4. Ecology, Endemism and Phytogeography of the Genus *Lathyrus*

3.4.1. Habitat, Phenology and Altitude Disribution of the Species

The studied species in this account grow in a very wide range of different habitats such as forests, shrubs, meadow, pasture, rocky slopes, forest and fallow fields. For example, *L. tukhtensis, L. digitatus, L. roseus* subsp. *roseus, L. sphaericus, L. laxiflorus* subsp. *laxiflorus,* and *L. nissolia* are common on pinus forest. While, *L. brachypterus, L. czeczottianus,* and *L. saxatilis,* prefer to live rocky slopes.

Figure 77. Habitat of *L. brachypterus*

Flowering time varies among *Lathyrus* taxa in Central Anatolia (Figure 79, Table 43). Flowering starts at March and ends at August. Most of the taxa are in flower between April and July. Flowering times shift slightly due to climatic change. *Lathyrus* taxa are limited to elevations of about 600 – 2500 meters in Central Anatolia (Figure 80, Table 43).

Table 43. Distribution, Endemism, Phytogeography and Altitudinal range of the taxa

No	Taxa	Distribution in the study area according to Davis's grid square system (1965)	Endemism	Phytogeography	Phenology	Altitudinal range
1	*L. aureus*	A4, B3, B5, B6	Non-endemic	Euxine	5-7	15-2000
2	*L. incurvus*	A4, A5, B4	Non-endemic	Unk. or Multi.	6-8	600-2000
3	*L. brachypterus*	A4, A5, B4, B5	Endemic	Ir.-Tur.	4-7	1500-2000
4	*L. haussknechtii*	B5	Endemic	Ir.-Tur.	4-7	1500-2500
5	*L. armenus*	A6, B6	Endemic	Ir.-Tur.	6-7	1270-2500
6	*L. digitatus*	A4, B3, B4, B5	Non-endemic	E. Medit.	4-6	200-1550
7	*L. tukhtensis*	A4	Endemic	Euro-Sib.	5-7 (-8)	700-2000
8	*L. spathulatus*	A4, B3	Non-endemic	E. Medit.	4-5	400-1520
9	*L. cilicicus*	C4	Endemic	E. Medit.	5	600-1300
10	*L. pratensis*	A3, A4, B3, B4, B5, B6	Non-endemic	Euro-Sib.	6-7	0-2300
11	*L. laxiflorus* subsp *laxiflorus*	B3, B6,	Non-endemic	Unk. or Multi.	5-7	0-1900
12	*L. czeczottianus*	A4, B3, B5, B6, C4	Endemic	Unk. or Multi.	6-7	1150-2200
13	*L. roseus* subsp. *roseus*	A6, B5, B6	Non-endemic	Hyrcano-Eux.	5-7	30-1800
14	*L. tuberosus*	A4, B6	Non-endemic	Euro-Sib.	6-7	1000-2150
15	*L. cassius*	B5	Non-endemic	E. Medit	5-6	1000-1650
16	*L. hirsutus*	A4, C4	Non-endemic	Unk. or Multi.	5-7	1000
17	*L. chloranthus*	A4, B3, B4	Non-endemic	Ir.-Tur.	6-7	600-1800
18	*L. sativus*	A4, B3, B4, B5	Non-endemic	Unk. or Multi.	4-6	1-1520
19	*L. cicera*	B4, B5, C4	Non-endemic	Unk. or Multi.	4-5	5-2000
20	*L. saxatilis*	A4, B4, B6	Non-endemic	Medit	4-5	30-600
21	*L. inconspicuus* var *inconspicuus*	A4, A5, B4, B5, B6, B7	Non-endemic	Unk. or Multi.	4-5	0-1500
22	*L. sphaericus*	B4, B5	Non-endemic	Unk. or Multi.	4-5	10-2000
23	*L. nissolia*	A4, B4	Non-endemic	Unk. or Multi.	5-7	0-1900
24	*L. aphaca* var. *biflorus*	A5, B4	Non-endemic	Unk. or Multi.	4-6 (7)	0-1900
25	*L. aphaca* var. affinis	A4	Non-endemic	E. Medit	(3-) 4-6	0-1700

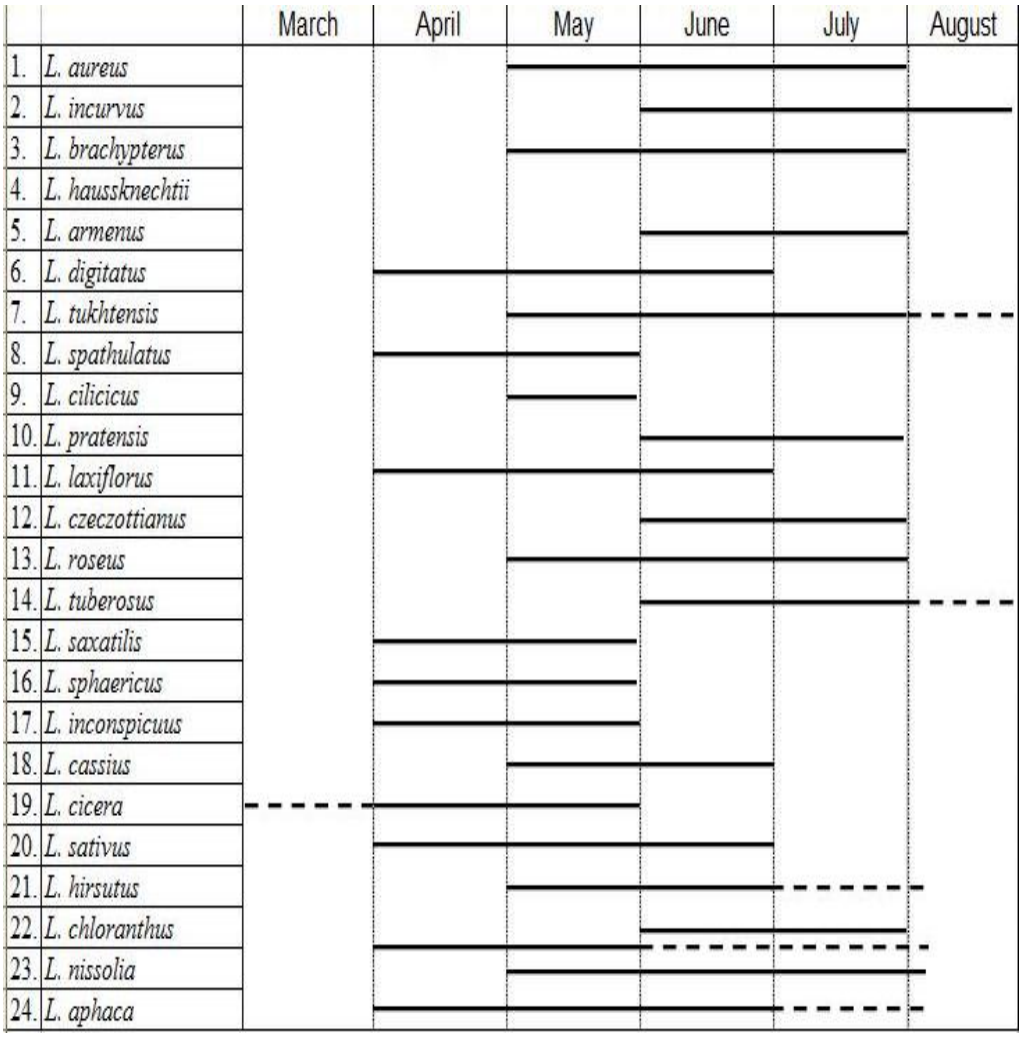


Figure 78. Flowering period of species

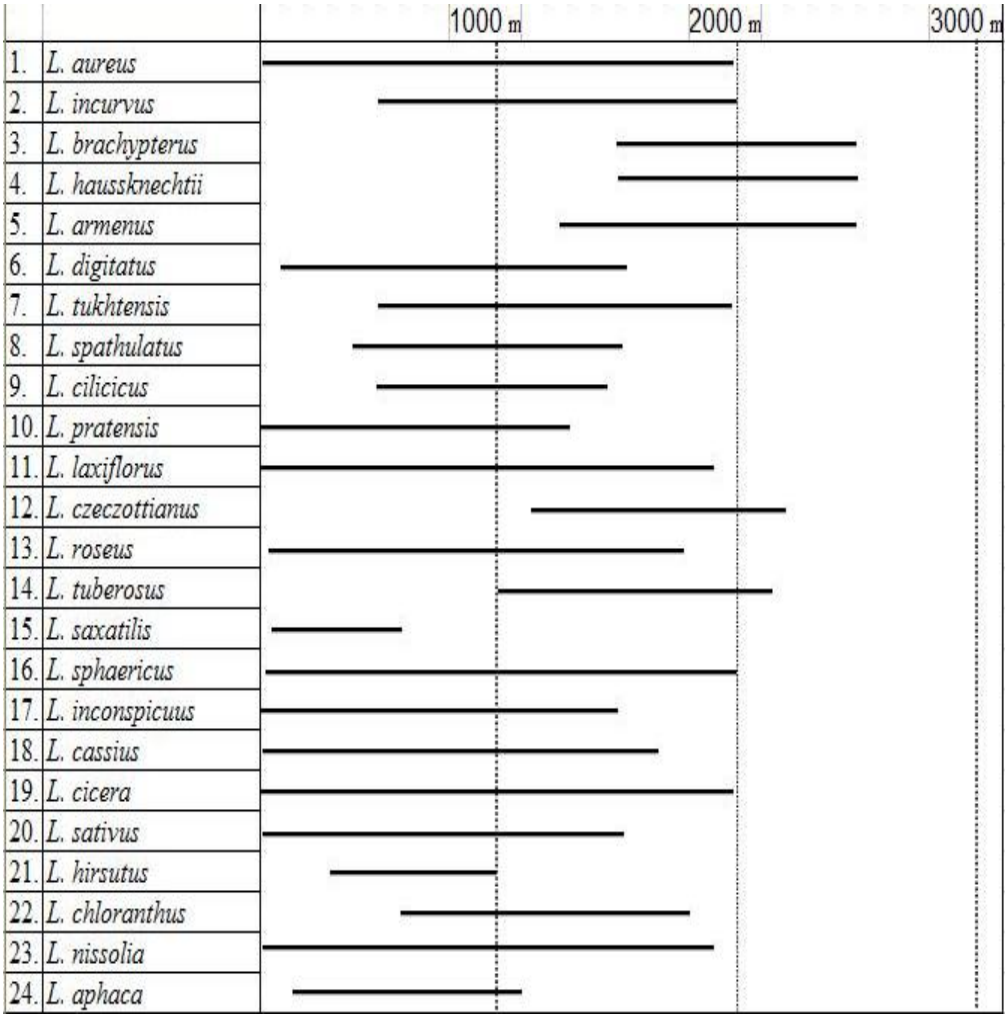


Figure 79. Altitude distribution of the species

3.4.3. Endemism, Phytogeography and IUCN Threat Categories of the Species

The rate of endemism of *Latyrus* is 24 % in the study area (Figure 81) and c. 35 % in Turkey. According to geographical distribution of the species, 25 taxa grow in Central Anatolia geographic region of Turkey, six of which are endemic.

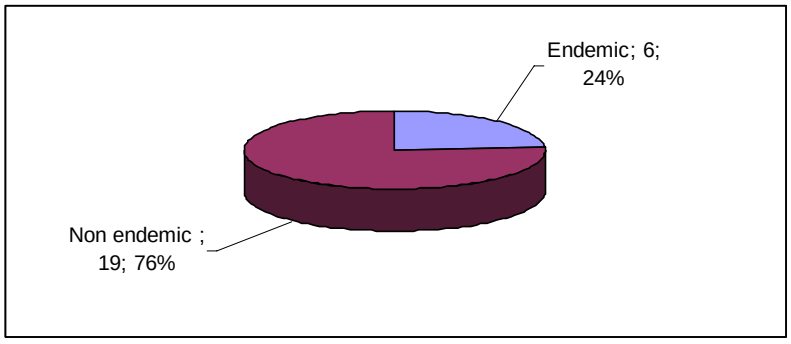


Figure 80. The rate of endemism of *Lathyrus* taxa in the study area.

During the field study, 25 taxa were collected from 250 different populations. According to the conducted taxonomic revision in this study, Central Anatolia geographic region of Turkey have 25 taxa six of which are endemic. According to Davis's grid square system, the A4 Grid square has highest number of species. There are 15 (22% of total) species live in this square (Figure 82 and Table 43). The rate of endemism is also highest in the A4 grid square. There are 4 (30%) of total endemic species) endemic species live in this gid square (Figure 83 and Table 43).

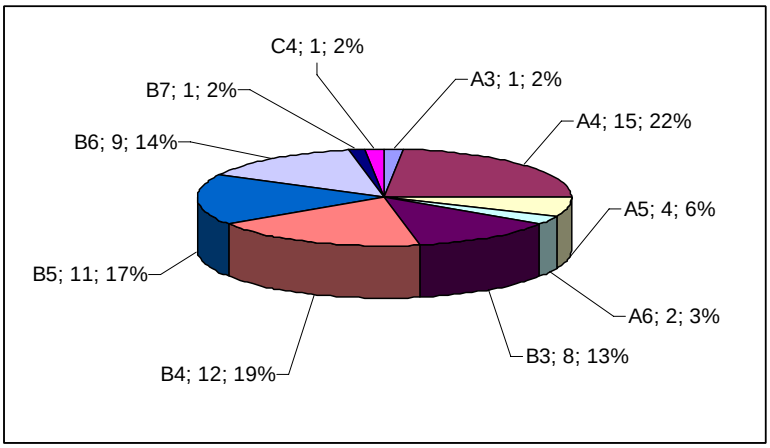


Figure 81. Distribution of the taxa in the study area according to Davis's grid square system.

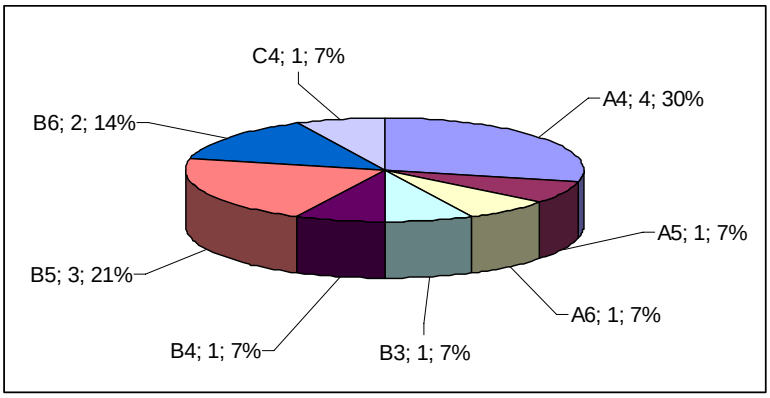


Figure 82. Distribution of the endemic species in the study area according to Davis's grid square system.

The distribution of the taxa in terms of the phytogeographical regions is as follows (Figure 84 and Table 43); Irano-Turanian elements 4 taxa (16%), Mediterranean elements 1 taxon (4%), East Mediterranean elements 5 taxa (20%), Euro Siberianelements 3 taxa (12%), Euxine elements 1 taxon (4%), Hyrcano Euxine elemets 1 taxon (4%), Unknown or Multiregional elements 10 taxa (40%). Mediterranean and East Mediterranean elements are distributed mainly in lower altitude than Irano-Turranian elements. Irano-Turanian elements mostly distibuted northeast part of the study area.

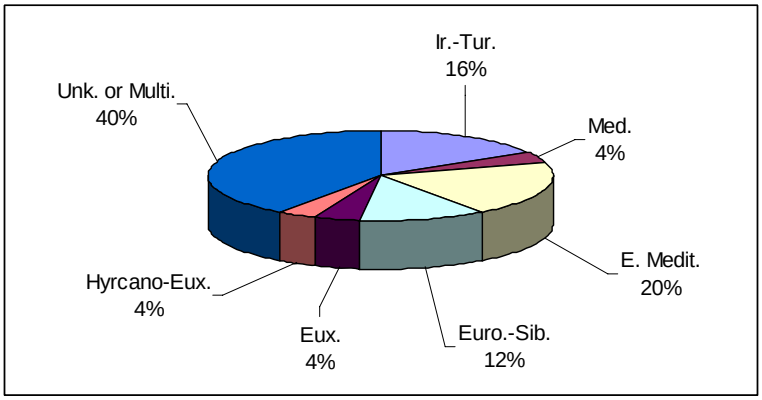


Figure 83. The distribution of the taxa in terms of the phytogeographical regions.

Table 44. The species of the study area and their IUCN threat categories and criteria. (*) indicates that the taxa endemic, ([Ir-tur.]) Irano-Turanian element, ([Med.]) Mediterranean element, ([E. Medit.]) East Mediterranean, ([Euro-Sib.]) Euro-Siberian element, ([Eux.]) Euxine, ([Hyrcano-eux]) Hyrcano-Euxine, ([Unk. or multi.]) unknown or multiregional. 1. according to Turkish Red Data Book 2. Recommended Threat Categories for Regional Level; 3. IUCN Red List Criteria (2001).

	Species	1	2	3
1.	[Eux.] *L. aureus*	-	LC	Widely distributed
2.	[Unk. or multi.] *L. incurvus*	-	EN	B1 a,b (i, iii, iv)
3.	*, [Ir-tur] *L. brachypterus*	LC	LC	Widely distributed
4.	*, [Ir-tur] *L. haussknechtii*	LC	LC	Widely distributed
5.	*, [Ir-tur] *L. armenus*	LC	LC	Very local
6.	[E. Medit.] *L. digitatus*	-	LC	Widely distributed
7.	*, [Euro-Sib] *L. tukhtensis*	LC	NT	Widely distributed
8.	[E. Medit.] *L. spathulatus*	-	VU	B1 a,b (iii, iv)
9.	*, [E. Medit.] *L. cilicicus*	VU	VU	B1 a,b (i, iii, iv)
10.	[Euro-Sib.] *L. pratensis*	-	LC	Widely distributed
11.	[Unk. or multi.] *L. laxiflorus* subsp. *laxiflorus*	-	LC	Widely distributed
12.	*, [Unk. or multi.] *L. czeczottianus*	LC	LC	Local

Table 44. (Continued)

	Species	1	2	3
13.	Hyrcano-eux *L. roseus* subsp. *roseus*	-	LC	Widely distributed
14.	Euro-Sib. *L. tuberosus*	-	LC	Widely distributed
15.	E. Medit. *L. cassius*	-	LC	Widely distributed
16.	Unk. or multi. *L. hirsutus*	-	LC	Widely distributed
17.	Ir-tur. *L. chloranthus*	-	EN	B1 a,b (i, iii, iv)
18.	Unk. or multi. *L. sativus*	-	LC	Widely distributed
19.	Unk. or multi. *L. cicera*	-	LC	Widely distributed
20.	Med. *L. saxatilis*	-	EN	B1 a,b (i, iii, iv)
21.	Unk. or multi. *L. inconspicuus* var. *inconspicuus*	-	LC	Widely distributed
22.	Unk. or multi. *L. sphaericus*	-	VU	B1 b (i, ii, iv)
23.	Unk. or multi. *L. nissolia*	-	LC	Widely distributed
24.	Unk. or multi. *L. aphaca* var. *biflorus*	-	LC	Widely distributed
25	E. Medit.. *L. aphaca* var. *affinis*	-	LC	Widely distributed

Table 45. The principle threats and comment on the taxa. (*) indicates the endemic species. 1. urbanizaton; 2. Constructions (Roads); 3. Overgrazing; 4. Land clearing and fire.

	Species	1	2	3	4	Comments
1.	*L. aureus*		x			Widespread and common where suitable habitat exist
2.	*L. incurvus*	x	x			In the area, the species is very rare.
3.	**L. brachypterus*			x		Widespread and common where suitable habitat exist
4.	**L. haussknechtii*		x			It is known from Hasan Da in Central Anatolia, and only 4 population.
5.	**L. armenus*		x			Very local to the east part of Central Anatolia
6.	*L. digitatus*			x		Widespread and common where suitable habitat exist
7.	**L. tukhtensis*		x		x	Restricted to the north and adjacent Inner Anatolia.
8.	*L. spathulatus*	x	x			In the area, the species is very rare.
9.	**L. cilicicus*	x	x			It is restricted to the south Anatolia and local.
10.	*L. pratensis*		x			Widespread and common where suitable habitat exist
11.	*L. laxiflorus* subsp. *laxiflorus*		x			Widespread and common where suitable habitat exist
12.	**L. czeczottianus*		x			Local to inner Anatolia and adjacent parts of north Anatolia

Table 45. (Continued)

	Species	1	2	3	4	Comments
13.	*L. roseus* subsp. *roseus*		x			Widespread and common where suitable habitat exist
14.	*L. tuberosus*		x	x		Restricted to a east part of Central Anatolia.
15.	*L. cassius*		x			Although it is south and south Anatolian species, it is found in the north east of Central Anatolia as small isolated population.
16.	*L. hirsutus*		x			It is found in the north part of Central Anatola and local.
17.	*L. chloranthus*	x		x		Inspide of many expeditions, the species did not found. Overgrazing likely to be a major factor limiting the distribution. More information require to reach any conclusion.
18.	*L. sativus*		x			Widespread and common where suitable habitat exist
19.	*L. cicera*			x		Widespread and common where suitable habitat exist
20.	*L. saxatilis*	x	x			In the area, only known a few small isolated population.
21.	*L. inconspicuus* var. *inconspicuus*	x	x			Widespread and common where suitable habitat exist
22.	*L. sphaericus*	x	x			The species didnt found its type location. Overgrazing likely to be a major factor limiting the distribution. More information require to reach any conclusion.
23.	*L. nissolia*		x			Widespread and common where suitable habitat exist
24.	*L. aphaca* var. *biflorus*	x	x			Widespread and common where suitable habitat exist
25	*L. aphaca* var. *affinis*	x				Widespread and common where suitable habitat exist

Most of the taxa are least concern (72%) and widely distributed in the study area. Three taxa (12%) are facing a high risk of extinction in the wild. Three taxa (12%) are facing a very high risk of extinction in the wild. One taxon is (4%) likely to be threatened in the near future (Table 44, Table 45, Figure 85).

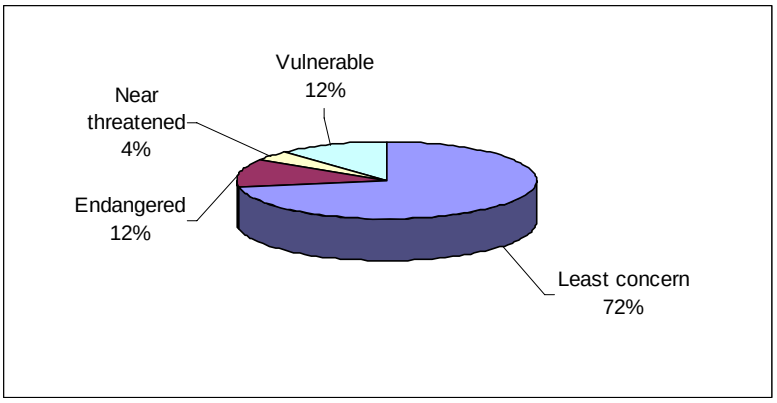


Figure 84. Distribution of the studied taxa according to IUCN Red List Categories Vesion 3.1 (2001)

The principle threats are mainly urbanization, constructions (especially new roads), overgrazing, and land clearing. Among these, contruction have heighest rate of threat for the species (Figure 86, Table 44, Table 45).

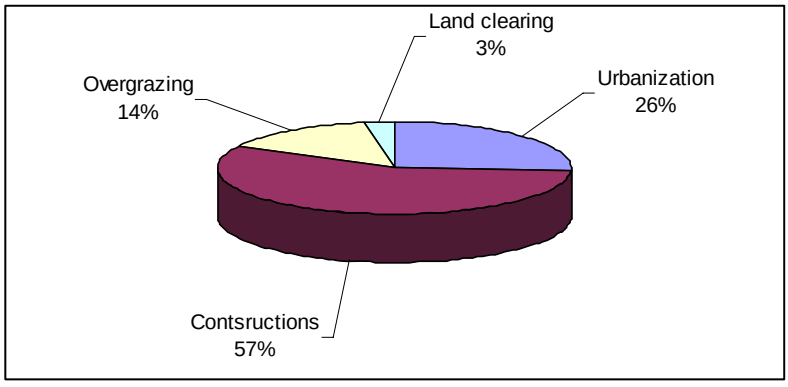


Figure 85. Principle threats in the study area.

3.5. Numerical Analysis

There are 39 vegetative and reproductive characters used to investigate the genus taxonomic delimitations (Table 46).

Table 46. Morphological characters screened for the numerical taxonomic analysis.

Number	Characters	Scoring
1.	Annual	0
	Perennial	1
2.	Growth habit climbing	0
	Growth habit erect	1
	Growth habit procumbent	2
3.	Stem winged	0
	Stem not winged	1
4.	Stem glabrous	0
	Stem sparsely pubescent	1
	Stem densely pubescent	2
5	Tuberous rootstock present	0
	Tuberous rootstock absent	1
6	Petiole length	
7	Petiole longer than stipule	0
	Petiole as long as or shorter than stipule	1
	Petiole absent	2
8.	Leaves tendrilous	0
	Leaves not tendrilous	1
9.	Leaves aristate	0
	Leaves not aristate	1
10.	At least median leaves pinnate	0
	Leaves subdigitate	1
	Leaves phyllodic	2
	Leaves absent	3
11	Leaflet length (cm)	0
12	Leaflet width (cm)	1
13.	Leaflets absent	0
	Leaflets 1 pair per leaf	1
	Leaflets 2 – 3 pairs	2
	Leaflets more than 3 pairs	3

Table 46. (Continued)

Number	Characters	Scoring
14.	Leaf venation pinnate	0
	Leaf venation reticulate	1
	Leaf venation parallele	2
15.	Leaflet hairy	0
	Leaflet glabrous	1
16.	Stipule margin entire	0
	Stipule margin toothed	1
	Stipule absent	2
17.	Stipule length (mm)	
18.	Stipule base semihastate	0
	Stipule base sagittate	1
	Stipule base semisagitate	2
	Stipule absent	3
19	Stipule wider than stem	0
	Stipule as long as or narrower than stem	1
	Stipule absent	2
20.	peduncle's length (cm)	
21.	Number of flowers per inflorescence	
22.	Flower axillary raceme	0
	Flower solitary	1
23.	Flower length	
24.	Calyx teeth equal	0
	Calyx teeth unequal	1
25.	Calyx length (mm)	
26	Calyx hairy	0
	Calyx glabrous	1
27	Standard color white	0
	Standard color cream	1
	Standard color purple	2
	Standard color violet-lilac	3
	Standard color blue	4
	Standard color gingery orange	5
	Standard color lavender	6
	Standard color yellow	7
	Standard color pink	8
	Standard color red	9

Table 46. (Continued)

Number	Characters	Scoring
28.	Style linear	0
	Style spathulate	1
29	Style twisted	0
	Style not twisted	1
30.	Peduncle very short	0
	Peduncle up to as long as leaf	1
	Peduncle longer than leaf	2
31	Legume linear	0
	Legume not linear	1
32.	Legume length (mm)	
33	Legume width (mm)	
34	Legume hairy	0
	Legume glabrous	1
35	Legume wingless	0
	Legume winged	1
36	Legume upper suture not keeled	0
	Legume Upper suture keeled	1
37	Legume linear	0
	Legume oblong	1
	Legume linear oblong	2
	Legume linear ensiform	3
	Legume linear lanceolate	4
	Legume linear oblanceolate	5
	Legume linear suboblanceolate	6
37.	Number of seed in each legume	
38.	Pollen grains polar length (µm)	
39.	Pollen grains equatorial length (µm)	

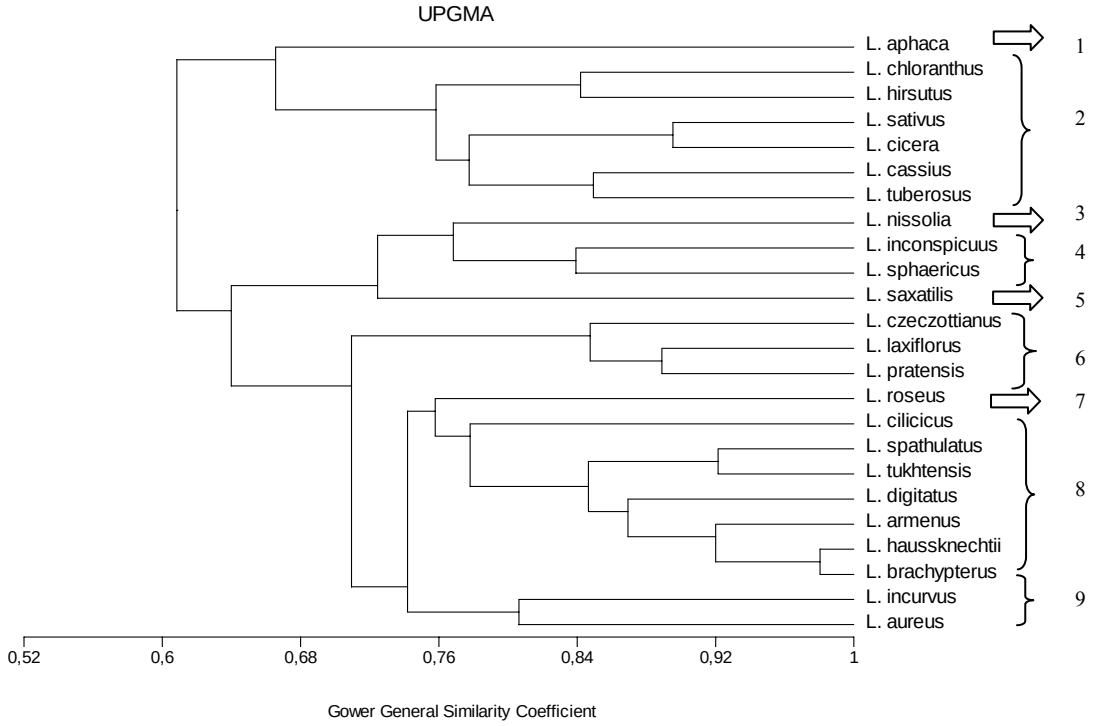


Figure 86. The phenogram results from the numerical analysis.

As a result of the analysis, the phenogram shown in Figure 87 was obtained. The cut-off line across the phenogram at 0.78 similarity level distinguishes the sections.

According to the phenogram (Figure 87), nine major clusters can be differenciated. In these clusters, we found all those sections that were shown by 1-sect. *Aphaca*, 2-sect. *Lathyrus*, 3-sect. *Nissolia*, 4-sect. *Linearicarpus*, 5-sect. *Viciopsis*, 6-sect. *Pratensis*, 7-sect. *Orobon*, 8-sect. *Latyhrostylis*, and 9-sect. *Orobon*.

1- sect. *Aphaca* is represented by two varieties in the study area.

L. aphaca var. *biflorus*

L. aphaca var. *affinis*

2- sect. *Lathyrus* is represented by six species in the study area.

L. tuberosus

L. cassius

L. hirsutus

L. chloranthus

L. sativus

L. cicera

3- sect. *Nissolia* is represented by one species in the study area.

L. nissolia

4- sect. *Linearicarpus* is represented by two species in the study area.

L. inconspicuus var. inconspicuus

L. sphaericus

5- sect. *Viciopsis* is represented by one species in the study area.

L. saxatilis

6- sect. *Pratensis* is represented by three species in the study area.

L. pratensis

L. laxiflorus subsp *laxiflorus*

L. czeczottianus (endemic to Turkey)

7-sect. *Orobon* is represented by one species in the study area.

L. roseus subsp. *roseus*

8- sect. *Latyhrostylis* is represented by seven species in the study area.

L. brachypterus (endemic to Turkey)

L. haussknechtii (endemic to Turkey)

L. armenus (endemic to Turkey)

L. digitatus

L. tukhtensis (endemic to Turkey)

L. spathulatus

L. cilicicus (endemic to Turkey)

9- sect. *Orobon* is represented by two species in the study area.

L. aureus

L. incurvus

The results support the Kupicha's (1983) taxonomic decisions on tribal delimitation, Kenicer et al. (2005) and Kenicer (2007). In contrast to Asmussen & Liston (1998) findings, sect. *Orobon* is not sunk into sect. *Lathyrus* and it remains separate section (Table 4, Figure 87)

3.6. Taxonomic Treatment

3.6.1. The Genus *Lathyrus* L.

Annual or perennial herbs; eglandular; erect or climbing by means of tendrils; stem winged or wingless; Leaves paripinnate or subdigitate, ending in mucro or well-developed tendril, rarely reduced to a tendril or grass-like phyllodes; leaflets 1-8 paired, with venation ranging from parallel and basal to pinnate and anastomosing; stipules herbaceous, entire or rarely tooted, often semisagittate; Peduncle shorter or longer than leaves; Flower solitary or in axillary raceme; Calyx regular, or frequently asymmetrical with the tube gibbous above at the base; teeth sub-equal or often the upper pair much shorter; Standard ovate to oblong, with a short, broad claw; Wings free or coherent to keel; Keel incurved, oblong or obtuse. Style dorsally compressed, linear to spathulate, with a thin line of hairs on the inner surface or rarely glabrous, twisted or not; legume compressed two to many seeded, upper suture winged or not.

3.6.2. Sectional key

1a. All leves phyllodic	**sect. *Nissolia***
1b. None of the leaves phyllodic	2
2a. Stipules hastate (in adult leaves)	3
2b. Stipules semisaggitate	5
3a. Leaves without leaflets	**sect. *Aphaca***
3b. All leaves with leaflets	4

4a Leaves with two or more pairs of pinnate-veined leaflets **sect. *Orobus***

4b. Leaves unijugate, leaflets parallel veined **sect. *Pratensis***

5a. Style contorted; standard always stenonychioid 6

5b. Style not contorted, (if style contorted, limb of standard narrower than claw annuals 8

6a. Tendrils absent; perennials 7

6b. Tendrils present or if absent then plants annual **sect. *Lathyrus***

7a. Leaves unijugate, hypostomatic; leafle broadly ovate, with pinnate venetion **sect. *Orobon***

7b. Leaves 1-7 paired epi-amphistomatic; leaflets lanceolate, with parallel venetion **sect. *Lathyrostylis***

8.a. Leaf venetion pinnate **sect. *Viciopsis***

8.b. Leaf venetion parallel **sect. *Linearicarpus***

3.6.3. Key to Species

1. All leves phyllodic **23. nissolia**

1. None of the leaves phyllodic

2. Stipules hastate (in adult leaves)

3. Leaves without leaflets **24. aphaca**

3. All leaves with leaflets

4 Leaves with two or more pairs of pinnate-veined leaflets

5. Leaves not tendrillous, flowers gingery-orange, 16-20 mm **1. aureus**

5. Leaves tendrillous, flowers lilac, 10-14 mm **2. incurvus**

4. Leaves unijugate, leaflets parallel veined

6. Flower yellow; leaves tendrillious **12. pratensis**

6. Flowers lilac or violet, leaves shortly aristate

7. Leaflets lanceolate; plant densely adpressed-pilose **10. czeczottianus**

7. Leaflets usually broadly elliptic; plant glabrous to spreading-pilose **11. laxiflorus**

2. Stipules semisaggitate

8. Style contorted; standard always stenonychioid

9. Tendrils absent; perennials

10. Leaves unijugate, hypostomatic; leafle broadly ovate, with pinnate venetion **13. roseus**

10. Leaves 1-7 paired epi-amphistomatic; leaflets lanceolate, with parallel venetion

11. Flower sulphur or cream

12. Leaves pinnate **3. brachypterus**

12. Leaves subdigitate **4. haussknechtii**

11. Flowers purple, lilac or pink, wings sometimes whitish

13. Style spathulate, more than 1 mm broad near apex; leaves subdigitate or with 1 pair of leaflets; leaflets 1-2-paired

14. Calyx 8-9 mm, flowers larger, 25-30 mm, **9. cilicicus**

14. Calyx 5-7 mm, flower 13-20 mm

15. Raceme lax; lowest calyx tooth f as long as tube to nearly as long; leaflets always linear **8. spathulatus**

15. Raceme conferted; lowest calyx tooth c. 1/2 as long as tube; leaflets linear to narrowly oblong-elliptic **7. tukhtensis**

13. Style linear, not or scarcely dilated above, less than 1 mm broad near apex; median leaves pinnate, subdigitate or with 1 pair of leaflets; leaflets 1-8-paired

16. Petiole 0.5-1 mm; style c. 0.75 mm broad **6. digitatus**

16 Petiole 1.5-4 mm; style 0.5-0.75 mm broad **5. armenus**

9. Tendrils present or if absent then plants annual

17. Plants with tendrils, perennial **14. tuberosus**

17. Plants with tendrils, annual

18. Ovary and pod glabrous or with small sessile or sub sessile glands only

19. Stipules very narrow and acute, subulate; seeds tuberculate verrucose. **15. cassius**

19. Stipules broader, lanceolate to ovate-lanceolate; seeds smooth

20. Upper margins of the pod with the lateral nerves developed into distinct wings 1.5-2 mm. broad, flowers blue, lilac or white. **18. sativus**

20. Upper margin of the pod with the lateral nerves carinate only, not much more prominent than the suture; flower brick or purplish red, rarely pink **19. cicera**

18. Ovary and pod with simple or tuberculate-based hairs, with or without small sessile or subsesile glands

21. Leaflets broad, oblong to elliptic, densely or sparsely hairy at least along the margins. **17. chloranthus**

21. Leaflet narrow, linear to narrowly lanceolate-oblong, glabrous **16. hirsutus**

8. Style not contorted, (if style contorted, limb of standard narrower than claw annuals

22. Leaf venetion pinnate **20. saxatilis**

22. Leaf venetion parallel

23. Flower larger, crimson; dilated portion of style much shorter than the undilated portion; keel with distinct sharp apicus **22. sphaericus**

23. Flower smaller, pale blue and white; dilated portion of style large, equaling the undilated portion; keel rather blunt

21. inconspicuus

3.6.4. Species descriptions

3.6.4.1. Section *Orobus* (L.) Godron in Grenier & Godron (1848) *Flore de France*. p. 485

Syn.: *Orobus* L., Sp. Pl. 728 (1753); *Lathyrus* subgen. *Orobus* (L) Paterm., Deutschl. Fl 155 (1849); *Lathrus* sect. *Lathyrobus* (Tamamschjan) Czefr. In Novit. Syst. Pl. Vasc. (Leningrad) 8: 192 (1971)

Lectotype; *L. linifolius* (Reichard) Bässler (*Orobus Tuberosus* L.: see Green (1930) and Gun (1969)

Description of the sect. *Orobus*

Perennial, erect or ascending; Stem angled or broadly winged; Leaf pinnate, aristate or tendrillous; Leaflets ovate to linear, with pinnate or pinnate-parallel venation; Stipules broadly semi-sagittate; Inflorescence racemes few-many-flowered; Style not twisted (not cotorted), apex not dilated; Legume linear not stipitate occasionaly gland dotted; Seed smooth; Hilum relatively long.

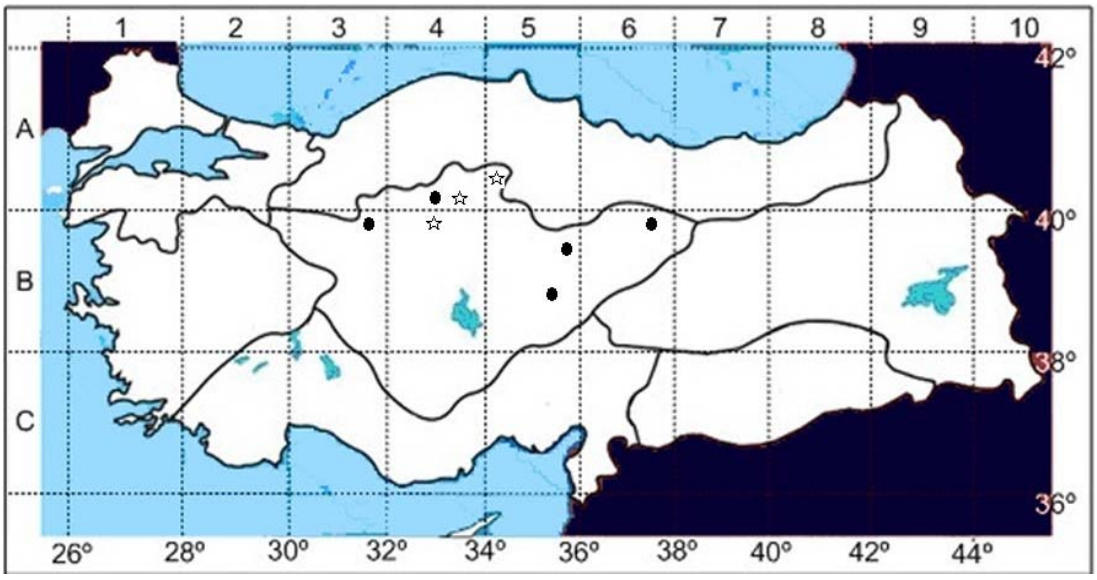


Figure 87. Distribution map of (●) *L. aureus* and (☆) *L. incurvus*

1. *L. aureus* (Steven) Brandza, Prodr. Fl. Roman. 546 (1883). Syn: *Orobus aureus* Stev. in Ind. Sem. Horti Petrop. 3:42 (1837); *O. orientalis* Boiss., Diagn. ser. 1(2): 106 (1843) *O. kolenatii* Koch in Linnaea 24:96 (1851). Ic: Reichb., Ic. Fl. Germ. 22: t. 202 (1903); Fl. Armenii 4: t. 79 (1962). Map 67, p. 335.

Perennial; sturdy, erect, sparsely pubescent; **Stem** not winged, 50 – 85 cm long; **leaves** pinnate, aristate; **Leaflets** 3-5-paired, ovate, acute to acuminate, 50-100 mm long 18-50 mm wide, pinnately veined, dotted with brownish – grayish green glands below; **Stipule** wide, semi-sagittate, hastate in adult leaves, ovate to lanceolate, 8 – 20 mm long, 3 mm wide; **Peduncles** usually shorter than or as long as leaves, raceme (8-)12-25-flowered; pedicels shorter than calyx; **Flowers** gingery-orange, 15-20 mm; **Calyx** 8-12 mm, gibbous, more or less pubesceent; calyx teeth very unequal, lowest tooth 1-3/2 x tube, the upper pair much shorter; corolla wings usually a little longer than keel, blade of standard suborbicular and shorter than claw; **Style** not twisted, apex not dilated; **Legume** linear, 50-72 mm long 7-8 mm wide, gland-dotted when young; **Seeds** 6-12, smooth.

Habitat and phenology: May to July. Mountain, pine and beech forest and scrub, 15-2000 m.

Type: Described from the Crimea

N.W. Turkey & N. Anatolia, rare in Inner Anatolia.

A4 Ankara: Çubuk, Karagöl, 10-8-1958 *F. Markgraf* 11246! Çubuk Karagöl, *S.Erik* 213! Çubuk, Karagöl north of lodging, *Erik* 109! Çubuk, Karagöl, 1512 m, 30-5-2010, 40 24 775 N – 32 54 706 E, *H. Çildir* 132! Kızılcahamam, Soğuksu National Park, Çakmaklı district roadside, 1500 m, 12-6-1990*, Ö. Eyüboğlu* 1661! **B3** Eskişehir: Sündiken Mountains, 1000-1300m, 26-6-1971*, T. Ekim* 606! **B5** Yozgat: Akdağmadeni, june 1960 *Aktaş coll E. W. Curtis. No:* 143! Aksaray: Hasandağı, north, hillside, 1600 m, 17-6-1973, *Peşmen* no 466! Kayseri: Erciyes dağı west hillside, top of köker,

2180 m, 17-7-1974, *R. Çetik,* 4107! **B6** Sivas: Zara to Şerefiye, 1639 m, 22-6-2010, 39 58 281 N – 37 43 434 E, *H. Çildir* 163!

World distribution: Bulgaria, Romania, Crimea, Caucasia; Greece?

Phytogeography: Euxine element.

2. *L. incurvus* (Roth) Willd., Sp. P1. 3:1091 (1802). Syn: *Vicia incurva* Roth, Beitr. 2:98 (1783). Ic: Reichb., Ic. Fl. Germ. 22: t. 212 (1903); Fl. Armenii 4: t. 78 (1962). Map 67, p. 335.

Perennial; scrambling, glabrous or pubescent; **Stem** winged, 30-95 cm long; **Leaves** tendrillous; **Leaflets** 3-5-paired, elliptic-oblong, feebly parallel-veined, 20-60 long and 8-22 mm wide, very obtuse, thick; **Stipules** lanceolate, generally obtusely semi-sagittate, hastate in adult leaves, 45 mm long and 15 mm wide; **Peduncles** nearly as long as leaves, raceme loose 3-9-flowered; pedicels as long as calyx; **Flowers** lilac, 10-14 mm long; **Calyx** 5-6 mm glabrous; calyx teeth unequal, the lowest tooth lanceolate and subequal to tube; Style not twisted, apex not dilated; **Legume** linear, incurved, 25-35 long and 5-6 mm wide; **Seed** 6 – 11, smooth.

Habitat and phenology: June to August. Meadows and scrub near rivers, 600-2000 m.

Type: No type designate

Inner Anatolia, local.

A4: Ankara, Kalecik, Kızılırmak 680 m 6-7-1929 *Boiss Flora Orient II.* 616. 14040! (A4: galatia prope oppidulum kalecik ad ripas fluvii, Halys (kizilirmak), 680m.s.m, 6-7-1929, J Bornmüller, Boiss, Flora Orient. II. 616). Kalecik, Kızılırmak riverbank, 638 m, 20-6-2009, 40 05 018 N – 33 27 088 E, *H Çildir* 118!**A5** Yozgat: Şefaatli to Yerköy Karanlık river, Mustafa bey mountain, east hillside, 950 m steppe, 15-6-2002, *Ü Buda,* 994! **B4** Ankara: Murted plain 850 m 9.8.1961 *Karamanoğlu,* no 6/1961!

World distribution: S. & C. Russia, Caucasia and W. Iran.

Phytogeography: Unk. or Multi.

3.6.4.2. Section *Lathyrostylis* (Grisebach) Bässler (1971) *Feddes Repertorium* 82: 443.

Syn.: *Platystylis* Sweet, Brit. Fl. Gard. Ser. 1. 3: 239 (1828); *Orobus* sect. *Lathyrostylis* Griseb. Spic. 1: 74 (1843); *Lathyrus* sect. *Platystylis* (Sweet) Bässler in Feddes Rep. 72: 88 (1966)

Description of the sect. *Lathyrostylis*

Perennial, erect or ascending; Stem angled; Leaf pinnate ot subdigitate, etendrillous; Leaflet 1-7 paired, pinnate to subdigitate, oblong to linear, parallel-veined from the base; Stipules semisagittate; Inflorescence Racemes few-several-flowered; Style not or rarely twisted, linear to broadly spathulate; Legume linear, not stipitate, not gland dotted; Seed rough or sooth; Hilum relaively long.

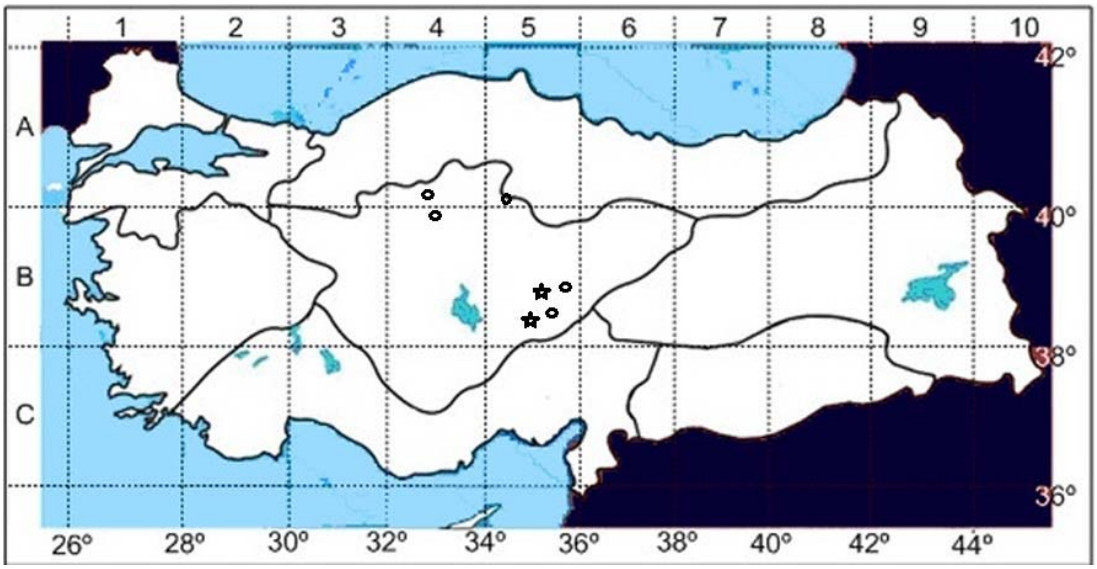


Figure 88. Distribution map of (○) *L. brachypterus* and (☆) *L. haussknechtii*

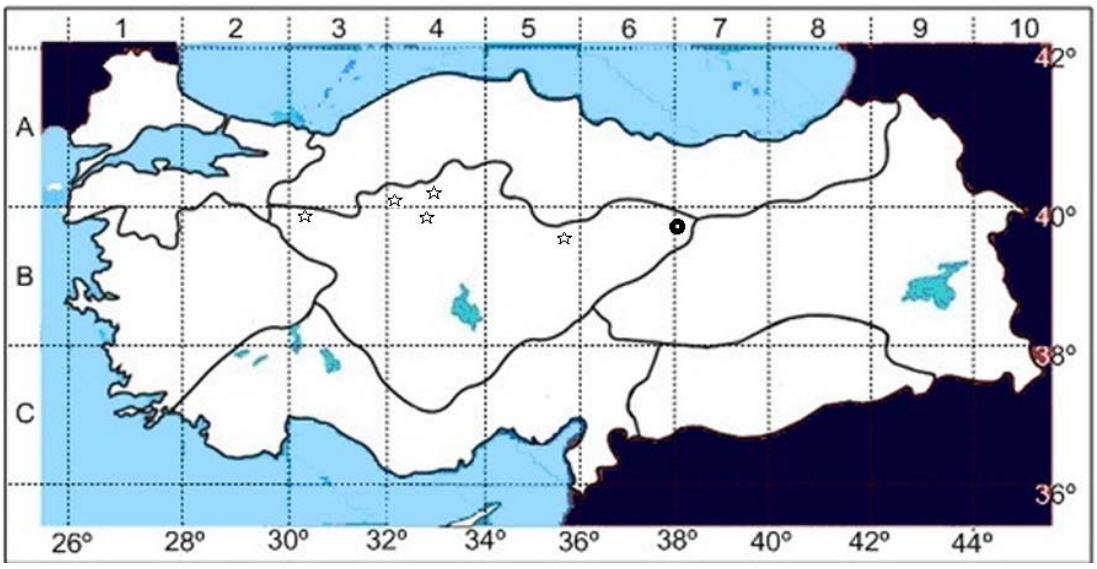


Figure 89. Distribution map of (●) *L. armenus* and (☆) *L. digitatus*

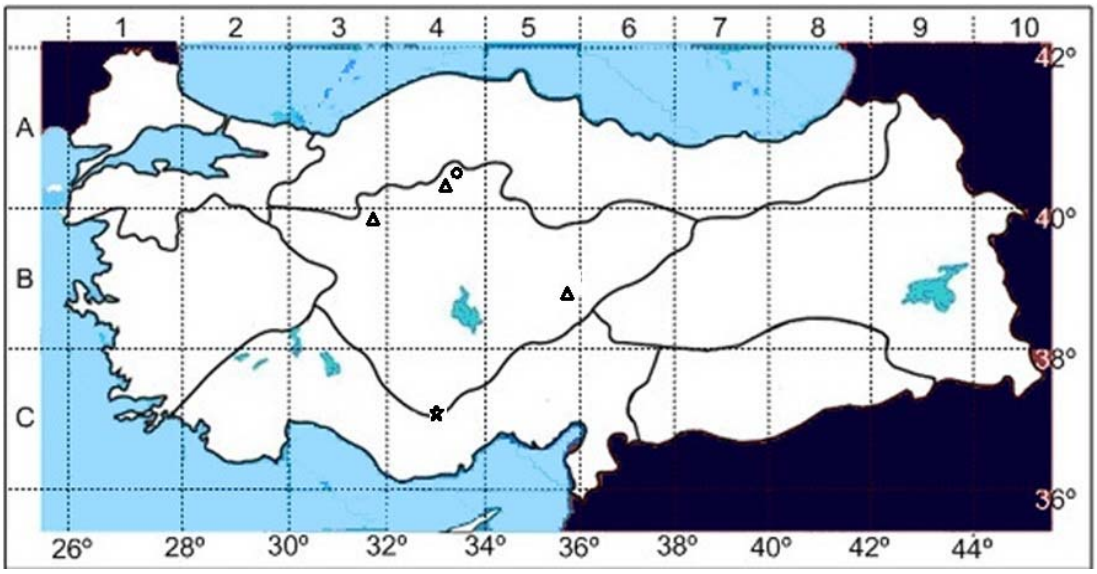


Figure 90. Distribution map of (✪) *L. tukhtensis,* (▲ *L spathulatus* and (✱) *L. cilicicus*

3. *L. brachypterus* Čel. in Öst. Bot. Zeitschr. 38:47 (1888). Syn: L. *spathulatus* sensu Širj. (1936) non Čell. (1888) Map 68, p. 335.

Perennial; erect, glabrous to ± pubescent; **Stems** wingless, 20-40 cm long; median

Leaves pinnate, aristate; **Leaflets** 2-3-paired; linear to oblonglinear, 25-55mm long and (l-) 2-7 mm wide, (3-)5(-7)-parallel-nerved; **Stipules** lanceolate-subulate, longer than the 2-4 mm petiole.; **Peduncles** 1-2 x leaves, and 2-10-flowered; **Flowers** cream or pale sulphur, (15-)18-25 mm; **Calyx** (5-)6-9 mm; Teeth unequal, the lowest slightly shorter than tube; Style filiform except for the slightly dilated apex, (6.5-) 7-10mm long and 0.5-1 mm wide. **Legumes** linear, incurved; **Seed** 6 – 7

Habitat and phenology; May to July. Pastures, rocky slopes, 1500-2500 m.

Type: [Turkey C6 Hatay] 'in monte Lokmanni "Djebel Nur" Ciliciae, inter frutices Quercuum, 300 m, 24 iv 1859, *Kotschy* 15' (K BM; not as represented at G).

C. & S. Anatolia.

B1 Maraş: Göksun, Binboğa dağları, 16-7-1952 davis 20066! ? Cappadocia no 121!, 20 june 1979 Haussknecht **A4** Ankara: Mamak, Kıbrıs village valley, Karataş location, rocky terrain, steppe, 1340 m, 16-6-2005, S.Aslan 2231! Beypazarı, Tekke forest, 1550m, *P. nigra* forest clearance, 8-7-1986, *Z. Aytaç* 2157! Beypazarı Eğriova detour, 1534 m, 28-6-2009, 40 17 960 N – 31 58 724 E, *H Çildir* 112! Kırıkkale: Dinek Da, Yediler hill piedmont, 1400 m, 18-6-2002, *S.A Demir* 2354! **A5** Yozgat: Yozgat National Park, 1380 m, open field, 24.7.1993, *A.A. Dönmez* 3815! **B4** Ankara: Elmadağ, meadow area,1700m, 25-6-1932, Kotte ! Elmadağ, 1687 m, 25-6-2009, 39 48 510 N – 32 58 322 E, *H Çildir* 107a! Elmadağ, calcareous mountain slopes, 1520 m, 25-6-2009, *H. Çildir* 107 b! Tekke village roadside, 1541 m, 12-6-2010, 39 49 338 N – 33 00 559 E, *H. Çildir* 144! Karaman: Karadağ, radar path, quercus forest clearance, 1851 m, 22-5-2010, 37 23 510 N – 33 09 738 E, *H Çildir* 124! **B5** Nevşehir: Göreme, Arılıburun stream 1100–1250 m, 19.5.1989, volcanic tuff, M vural ve ark 4688! Kayseri: Erciyes Mountain, Hisarcık road, N 38 36 819, E 35 30 584, 1650- 1780 m, 6-7- 2000, *C. vural* 2657! Kayseri: Argaeus (Erciyas Da.), 1520 m, *Kotschy* 207. Kayseri:

Hisarcık over, moist valley, N 38 35 900, E 35 30 508, 1932 m, 15-6-2000, *C. vural* 2222! Aksaray: Hasan Da. quercus forest clearance, 1631 m, 23-5-2010, 38 10 263 N – 34 10 708 E, *H. Çildir* 126! Yozgat: Yozgat National Park, 1405 m, 25-6-2010, 39 48 563 N – 34 48 336 E, *H. Çildir* 178!

Endemic

Phytogeography: Ir.-Tur. Element

4. *L. haussknechtii* Syn: Davis, Flora of Turkey Vol. 3 p. 338. *L. haussknechtii* Širj. in Feddes Rep. 35:377 (1934)! Figure 3, p. 323. Map 68, p. 335.

Perennial; erect, glabrous to ± pubescent; **Stems** wingless, 20-30 cm long; median **Leaves** subdigitate, aristate; **Leaflets** linear to oblonglinear, 20-50mm long and 2-6 mm wide, (4-)5(-7)-parallel-nerved; **Stipules** lanceolate-subulate, longer than the 2-4 mm petiole.; **Peduncles** 1-2 x leaves, and 2-10-flowered; **Flowers** cream or pale sulphur, (15-)18-20 mm; **Calyx** (5-)7-9 mm;teeth unequal, the lowest slightly shorter than tube; Style filiform except for the slightly dilated apex, 7-10mm long and 0.5-1 mm wide. **Legumes** linear, incurved; **Seed** 6 – 7

Habitat and phenology; May to July. Pastures, rocky slopes, 1500-2500 m.

Type: [Turkey B7 Erzincan] Egin (Kemaliye), Karaschikuri, in pascuis subalpinis, 23-5-1890, *Sintenis* 2305 (K BM W E).

Holotype: [Turkey B7 Erzincan] Egin (Kemaliye), P. Sintenis: Iter orientale 1890, C. Haussknecht.!

Mainly E. Anatolia.

B5 Aksaray: Hasan Da., *Whittall* 137. Aksaray: Hasan Da., *Whittall* 137! Hasan Da. Quercus forest clearance, 1631 m, 23-5-2010, 38 10 263 N – 34 10 708 E, *H. Çildir* 128!

Endemic

Phytogeography: Ir.-Tur. element.

5. *L. armenus* (Boiss. & Huet) Širj. in Bull. Soc. Bot. Bulg. 6:62 (1934), cum diagn. Syn: *Orobus armenus* Boiss. & Huet in Boiss., Diagn. ser. 2(2):43 (1856)! Map 69, p. 339.

Perennial; erect, glabrous; **Stems** wingless, arising from a scarcely creeping stock, 30-55 cm long; median **leaves** subdigitate, aristate; **Leaflets** 2-paired, linear to lanceolate-linear, 55-80 mm long and 3-6 mm wide, c. 5-parallel-veined; **Stipules** lanceolate-subulate, much longer than the 1.5-4.5 mm petiole; **Peduncles** sturdy, generally shorter than leaves, and 4-11-flowered; **Flowers** bluish-violet, 14-16 mm. **Calyx** 5-7 mm; calyx teeth subequal, the lowest lanceolate, 1/2-3/4 as long as tube. Style linear, scarcely dilated above, 4 mm long, 0.5 mm wide; **Legume** linear, c. 50 mm long 4 mm wide, glabrous; **Seed** 6 – 7.

Habitat and phenology: June to July. Marshy meadows, water channels, fallow fields. 1270-2800 m.

Type: [Turkey B8 Erzurum] ad radices montis Tech Dagh (Palandöken Da., 1830-1980 m) prope Erzeroum, *Huet du Pavilion* (holo. G iso. K BM).

E. and adjacent C. and S. Anatolia, very local.

A6 Sivas: Zara to İmranlı, 1581 m, 22-6-2010, 39 52 985 N – 38 03 701 E, *H. Çildir* 168! **B6** Sivas: Sivas, 1275 m, *Hub.-Mor.* 9222! Pınarbaşı to Şarkışla, 1510 m, 20-6-2010, 38 44 699 N – 36 25 259 E, *H. Çildir* 159! Yozgat:

Akdağmadeni to Şarkışla road, 1565 m, 23-6-2010, 39 37 388 N – 36 01 717 E, *H. Çildir* 175

Endemic

Phytogeography: Ir.-Tur. element.

6. *L. digitatus* (Bieb.) Fiori in Fiori & Paol., Fl. Anal. Ital. 2:109 (1900). Syn:*Orobus digitatus* Bieb., Fl. Taur.-Cauc. 2:153 (1808); *O. sessilifolius* Sibth. & Sm., Prodr. Fl. Graec. 2:64. (1813); *Lathyrus sessilifolius* (Sibth. & Sm.) Ten., Ad. Fl. Nap. Pr. App. 5:21 (1826). Ic: Sibth. & Sm., Fl. Gr. 7: t. 692 (1830); Fiori, Ic. Fl. Ital. f. 2142 (1899). Figure 3, p. 323. Map 69, p. 339.

Perennial; glabrous to sparsely pubescent, ascending-erect; **Stems** slender and wingless, 15-40 cm.; median **leaves** subsessile, subdigitate, aristate; **Leaflets** (l-)2-paired, linear. 20-70(-80) mm long 1-3 mm wide, 3-5-parallel-veined; **Stipules** lanceolate-linear, semi-sagittate, 8-12 mm long and 1-3 mm wide, much longer than the 0.5-1 mm petiole; **Peduncles** as long as or longer than leaves, rather laxly 3-6-flowered; pedicels 2-6 mm; **Flowers** purple or bluish, 14-20(-25) mm.**Calyx** 6-9 mm; lowest tooth slightly shorter than tube. Style linear-subspathulate, 3-4.5 long, c. 0.75 mm wide. **Legume** linear-suboblanceolate, 40-45mm long and 4.5-6 mm wide; **Seed** 5 - 7, smooth.

Habitat and phenology: April to june. Pinus forests (P. brutia, P. nigra), Quercus woods, macchie, rocky slopes, scree, 200-1550 m.

Type: [Crimea] In Tauriae montibus sylvaticis mimine rarus, *Bieberstein.*

Outer and adjacent C. Anatolia.

A4 Ankara: Karagöl 40 ml. N. Of Ankara 1600 m 10.6.1965 No: 2191! *MJE Coode and BMG jones*. Çubuk, Karagöl, 1515 m, 30-5-2010, 40 24 825 N –

32 54 710 E, *H. Çildir* 133! Çubuk, Çubuk II dam, forest interior, 28-5-1983, *B.Çelik 3* 1005! Çubuk, Karagöl, north of lodging,*S.Erik* 108! Çubuk, Karagöl district, 1500 m, *S.Erik* 415! Ayaşbeli, 1000-1150 m, 18-5-1985, *Z. Aytaç* 1993! Çubuk to Karagöl roadside, 1208 m, 30-5-2010, 40 23 417 N – 32 56 663 E, *H. Çildir* 128! Kızılcahamam Soğuksu National Park 5 km west of Kızılcahamam 1000 m, 8-6-1986 *RMA Neshbih* 607 a! Kızılcahamam to Eğerlikuzdere village 950-1000 m, 9-6-1983 *A. Güner- k.sorkun* AG 2988! Kızılcahamam Soğuksu National Park, Yanıksırtı, 1200–1300 m, 12-5-1990, *Ö. Eyüboğlu* 1380! Kızılcahamam, Soğuksu National Park, Keltepe district, 1250–1300m, 29-5-1990, *Ö. Eyüboğlu* 1446! Çubuk, Ovacık to Saraycık village 1250-1380 m, 20-5-1992, *E.Dündar* 1200! Ayaşbeli Çaltepe ca. 1300-1380 m, 13-4-1986, *M.Vural* 4033! Beypazarı, Karaşar İnözü valley, quercus scrub and rocky places, 1100 m, 5-5-1986, *M Vural* 4133! Kırıkkale: Hıdırşeyh village farm field, 1000 m, 2-6-1990, *A.A dönmez* 2248! Çankırı,: Eldivan road, 1381 m, 27-6-2010, 40 29 724 N – 32 29 875 E, *H. Çildir* 179a! **B3** Eskişehir: Sündiken Mountains, above Yarımca village, 5-6-1971, 1000 m, *T Ekim*! Mihalıççık, roadside, 1435 m, 16-6-2010, 39 53 588 N – 31 27 731 E, *H. Çildir* 146! **B4** Ankara: Kıbrıs village, riverside, 1050 m, 12-6-2010, 39 52 247 N – 33 00 092 E, *H. Çildir* 145! Beynam forest, 1200 m, 9-5-1958, *Markgraf* 11052! **B5** Yozgat: Yozgat National Park, 1500 m 13-5-1979 *B. Sayın* no 68!

World distribution: W. Italy, Greece, Crimea, Cyprus.

Phytogeography: E. Medit. element.

7. *L. tukhtensis* Czecz. in Acta Soc. Bot. Pol. 9:36 (1932); Feddes Rep. Beih. 107:168 (1939). Syn: L. verae Širj. in Bull. Soc. Bot. Bulg. 6:60 (1934)! Ic: Feddes Rep. Beih. 107: t. 32 (1939). Figure 3, p. 323. Map 70, p. 339.

Perennial; glabrous or sparsely pubescent erect, slender; **Stems** wingless, 15-30 cm; lower **leaves** with 1 pair of leaflets; Median leaves subdigitate; **Leaflets** 2-paired, linear to linear-oblong, 30-65 mm long, 2-9 mm wide, 5-7-parallel-veined; stipules lanceolate to subulate, equal to the 1-4 mm petiole or longer (but shorter than in L. digitatus); **Peduncles** 1-2 x the leaves, slender, bearing a conferted 3-12- flowered raceme; pedicels 2-4 mm; **Flowers** lavender-blue with paler wings, 14-17 mm; **Calyx** 5-6.5 mm; teeth subequal, triangular, the lowest c. 1/2 as long as tube; Style broadly spathulate, 4-5 x 1.5 mm (as in L. pallescens). **Legume** linear, 50-60 mm long, 5-6 mm wide; **Seed** 5 – 6.

Habitat and phenology: May to August. *Pinus* forests*, Quercus scrub,* mountain pastures, rocky limestone slopes, 700-2000 m.

Type: [Turkey A4 Çankiri] supra opidulum Tukht, in quercetis frutescentibus in montosis loco chirchir-Bunar dicto, c. 1500 m, *Czeczott* 246.
N. and adjacent Inner Anatolia; S.W. Anatolia.
A4 Çankırı: Çankırı to eldivan, 1216 m, 27-6-2010, 40 29 883 N – 32 30 248 E, *H. Çildir* 179a!

Endemic

Phytogeography: Euro-Sib. Element.

8. *L. spathulatus* Čel. in Öst. Bot. Zeitschr. 38:6 (1888). Davis in Notes R.B.G. Edinb. 24:20-21 (1962). Syn: *Orobus sessilifolius* Sibth. & Sm. var. *stenophyllus* Bornm. in Beih. Bot. Centr. 19(2):250(1906)excl. *Sint.* 293; *Lathyrus celakovskyi* Širj. in Bull. Soc. Bot. Bulg. 6:61 (1934) (lectotype: *Kotschy* 15, W) *L. elongatus* (Bornm.) Širj. var. *stenophyllus* (Bornm.) Širj. in Bull. Assoc. Russe Sci. Prague 3(8) Sect. Sci. Nat. Math. no. 18:225 (1936). Figure 3, p. 323. Map 69, p. 339.

Perennial; erect, slender, glabrous; **Stems** wingless, 20-40 cm; **Lower leaves**

with 1 pair of leaflets. **Median leaves** subdigitate; **Leaflets** 2-paired, linear, 35-90 mm long, 1-7 mm wide, c. 5-parallel-veined; **Stipules** lanceolate-subulate, much longer than the 1.5-3.5 mm petiole; **Peduncles** longer than leaves, slender, ending in a lax 3-7-flowered, 3.5-10 cm raceme; pedicels 4-6 mm. **Flowers** purple to lavenderblue, 3-20 mm; **Calyx** 5-7(-8)mm: teeth subequal, the lowest ovate-lanceolate, subequal to the tube to f as long; Style spathulate, 5-6 long, c. 1 .25 mm wide(often narrower when dried, due to incurved margins). **Legume** linear, c. 45 long, 6 mm.wide; **Seed** 5 – 7.

Habitat and phenology: April to may. Pinus brutia forest, deciduous woodlands, Quercus coccifera macchie, 400-1520 m.

Type: [Turkey B5 Kayseri] 'in monte Argaeo (Erciyas Da.) Cappadociae, rariter in devexis oriente soli obversis, 1520 m, 20 v!S59, *Kotschy* 207' (PR. K. BM; not as represented at W).

Isotype: Theodor Kotschy plantae argaei montis Cappadociae1859!

S. Anatolia *(*Amanus, Anti-Taurus).

A4 Ankara: Kızılcahamam Soğuksu National Park, Yanıksırtı road, riverside and roadside, 1240 m, 23-6-2009, 40 26 980 N – 32 36 888 E, *H. Çildir* 101!

B3 Eskişehir: Sündiken Mountains, 1435 m, 16-6-2010, 59 53 588 N – 31 27 731 E, *H. Çildir* 149a!

World distribution: W. Syria.

Phytogeography: E. Medit. element.

9. *L. cilicicus* Hayek & Siehe in Ann. Nat. Hofmus. Wien 28:164, t. 12 f. 1 (1914). Figure 3, p. 323. Map 68, p. 335.

Perennial; tall, erect glabrous; **Stems** wingless, 40-150 cm; **Leaves** linear-lanceolate, 70-160 long, 3-10 mm wide, 5- paralled veined, lower leaves with one pair of leaflets, median leaves subdigitate, aristate. **Stipules** linear-lanceolate, longer than the petiole; **Peduncles** 20-50 cm, laxly, 5-15 –flowered,raceme up to 16 cm; Pedicels (3-) 4-10 (-12) mm. **Flowers** large, 22-32 mm, banner pinkish to purple, wings and keel whitish. **Calyx** tubular to campanulate, 6-10 mm, glabrous. Calyx teeth subequal, ca. 3 mm, broad and margins more or less membranous. Style obovate to spathulate, 2-4 mm wide, densely pilose. **Legume** linear-lanceolate, 40-90 mm long, 4-9 mm wide; **Seed** (3-) 5-13 , glabrous, more or less hook shaped.

Habitat and phenology: May. Macchie, cornfields, cliffs, 600-1300 m.

Type: Turkey [C5 Içel] am Felsen beim Dorfe Ofun, unweit Mersin. 600 m. *Siehe 320 (BM* E)!

S. Anatolia, local.

C4 Konya: 34 km from Karaman to Ermenek. 1300 m. *Hıub.-Mor.* 8501. Karaman Değirmenbaşı köyü civarı, *P. nigra* ormanı, 1450m, 22-6-1979, *M.Vural* 1459!Type speicimen flora orientalis no 320. may 1913 ! Karaman, above Ermenek, 1350m, 27-6-2009, 36 37 59.76 N - 32 54 33.90 E*, M. Dogan, E. Cabi & F. Celep 1714*! deposited in Department of Biological Sciences, Middle East Techincal University, Ankara.

Endemic

Phytogeography: E. Medit. element.

3.6.4.3. Section *Pratensis* Bässler (1966) *Feddes Repertorium*. 72: p.90

Syn.: *Lathyrus* sect. *Orobastrum* Boiss., Fl. Or. 2: 601 (1872) pro parte excl. typ.; *Lathyrus* sect. Eurytrichon Bässler, loc.cit.

Type*: L. pratensis* L., Sp. Pl. 733 (1753)

Descripton of the sect. *Pratensis*

Perennial, procumbent to erect; Stem angled; **Leaf** unijugate, tendrillous or mucronate; **Leaflet** 1- paired, elliptic to lanceolate, parallel-veined from the base; Stipules large, ± unequally sagittate / hastate; **Inflorescence** racemes few-many-flowered; Style linear, not contorted; **Legume** linear, glabrous or hairy; Seed smooth; Hilum short.

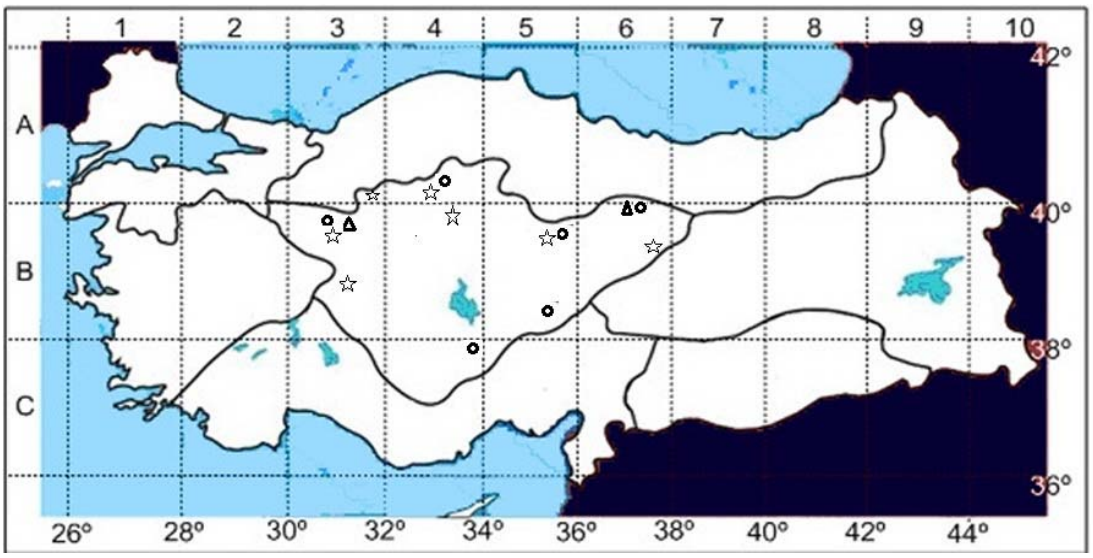


Figure 91. Distribution map of (✪) *L. czeczottianus*, (▲) *L. laxiflorus* subsp. *laxiflorus* and (☆) *L. pratensis*

10. *L. pratensis* L., Sp. Pl. 733 (1753). Ic: Hegi, I11. Fl. Mittel-Eur. 4(3): t. 171 (1924); Ross-Craig, Draw. Brit. Pl. 7: t. 71 (1954). Map 73, p. 345.

Perennial; subglabrous or pubescent; **Stems** angled, arising from a creeping rootstock, 20-65 cm; **Leaves** tendrillous; leaflets 1-paired, narrowly elliptic-lanceolate, 10-40mm long, 1.5-11 mm wide, parallel-veined, lower petioles 1 – 4 cm; **Stipules** 12 – 40 mm, ovatelanceolate, usually broader than the leaflets, unequally sagittate, hastate in adult leaves. **Peduncles** 3-10- (12) flowered, much longer than the leaves; **Calyx** 5-9 mm, calyx teeth somewhat unequal, the lowest tooth 1-2 x as

long as tube. **Corolla** bright yellow, 10-16 mm. **Legume** linear-oblong, 20-30mm long, 5-6 mm wide, glabrous or sometimes pubescent, obliquely nerved. **Seeds** 4-8(-10), smooth.

Habitat and phenology: June to july. Water meadows, streamsides, bushy places, nr. s. 1.-2300 m.

Described from Europe (Hb. Cliff. Hb. Linn. 905/18).

Turkey-in-Europe, N., Inner (mainly E.) &S.W. Anatolia

A3 Ankara: Beypazarı, under abies forest, 1600 m, 19-7-1972, *A. Hub.-Mor* 72-16! Beypazarı Eğriova detour, 1534 m, 28-6-2009, 40 17 960 N – 31 58 724 E, *H Çildir* 113! **A4** Ankara: Çubuk, Karagöl *S.Erik* 505! Mamak, Kıbrıs village valley, dipsiz gölü location, riverside, 1100 m, 12-7-2004, *S. Aslan* 1632! Kıcılcahamam Soğuksu National Park 1111 m, 5-6-2010, 40 27 403 N – 32 37 461 E, *H. Çildir* 135! Kıcılcahamam Soğuksu National Park 1161 m, 5-6-2010, 40 27 282 N – 32 37 478 E, *H. Çildir* 134! **B3** Eskişehir: Yukarı kalabak village roadside and riverside, 1127 m, 27-6-2009, 39 32 617 N – 30 17 614 E, *H Çildir* 108! Mihalıççık, roadside, 1435 m, 16-6-2010, 39 53 588 N – 31 27 731 E, *H. Çildir* 147! **B4** Ankara: Beynam, 1000 m, 12-7-1965, *Ledingham & Ekim* 4316! Kızılcahamam Soğuksu National Park, Yanıksırtı road, riverside and roadside, 1240 m, 23-6-2009, 40 26 980 N – 32 36 888 E, *H. Çildir* 101! Işık dağı, mountain road to the antennas, 1577 m, 23-6-2009, 40 40 980 N – 32 48 838 E, *H. Çildir* 102! **B5** Yozgat: Akdağmadeni to Şarkışla road, 1586 m, 23-6-2010, 39 36 980 N – 35 56 425 E, *H. Çildir* 173! Akdağmadeni to Şarkışla road, 1484 m, 23-6-2010, 39 32 571 N – 36 01 121 E, *H. Çildir* 174! Yozgat National Park, 1492 m, 25-6-2010, 39 48 255 N – 34 48 602 E, *H. Çildir* 179! **B6** Sivas: Divriği to Zara, Yeşildere Beydağ road, 1561 m, 21-6-2010, 39 37 143 N – 37 48 705 E, *H. Çildir* 161! Zara to Şerefiye, 1639 m, 22-6-2010, 39 59 853 N – 37 43 771 E, *H. Çildir* 165! Yıldızeli, near Kızılırmak river, 1368 m, 23-6-2010, 39 51 230 N – 36 32 246 E, *H. Çildir*171!

World distribution: Most of Europe, N.W. Africa, Abyssinia, Lebanon, N. Iraq, Caucasia, east-wards to C. Asia and Himalayas.

Phytogeography: Euro-Sib. element.

11. *L. laxiflorus* Syn: *Orobus laxiflorus* Desf. in Ann. Mus. Paris 12:57, t. 8 (1808); *O. hirsutus* L., Sp. PL 728 (1753) non *Lathyrus hirsutus* L. (1753); *Lathyrus inermis* Rochel ex Friv. in Magyar Tud. Tár. Evkon. 2:250 t. 2 (1835). Ic: Fiori. Ic. Fl. Ital. (1899). *Forest, scrub, shady banks, etc., s. l.-1900 m.*

Perennial; spreading-pilose to glabrous; **Stem** not winged, angled, branched, 15-50 cm, diffusely procumbent, erect or ascending, arising from a tuberous woody stock (D.34578); **Leaves** shortly aristate or sometimes ending in a simple tendril; Leaflets 1-paired, ovate, broadly elliptic or sometimes lanceolate, acute or acuminate, 10-40 mm long, 4-12 mm wide, parallel-veined; **Stipules** ovate-acuminate or sometimes ovatelanceolate, c. as broad as the leaflets or sometimes broader, unequally sagittate, hastate in adult leaves; **Peduncles** slighly longer than the leaves, raceme (2-)3-6-flowered. **Calyx** with parallel nerves, 8-13 mm; calyx teeth narrowly lanceolate, 2-3 x longer than tube. **Corolla** lavender or violet, 15-20 mm; keel whitish. **Legume** broadly linear, 30-45 long, 4-5 mm wide, gland-dotted, subadpressed-pilose or rarely glabrous. **Seed** c. 6.

Habitat and phenology: May to july. *Fore*st, scrub, shady banks, etc., s.l.-1900 m.

Type: [Crete] L'île de Candie et dans le royaume de Pont, *Tournefort* (P)

Mainly Turkey-in-Europe and Outer Anatolia (most common in the N)
B3 Eskişehir: Sündiken Mountains, 1500-1700 m, 12-6-1971 *T. Ekim* 616! Mihalıççık, roadside, 1435 m, 16-6-2010, 59 53 588 N – 31 27 731 E, *H. Çildir* 149! Yukarı kalabak village, roadside and river bank, 1127 m, 27-6-

2009, 39 32 617 N – 30 17 614 E, *H Çildir* 108! **B6** Sivas: Zara to Şerefiye Ya., 1550-1630 m, *Hub.-Mor.* 13348!

World distribution: S. Italy, Balkans, Crimea, Caucasia, N. & N.W. Iran, W. Syria.

Phytogeography: Unk. or Multi

12. L. czeczottianus Bässler in Feddes Rep. 72:91 (1965). Syn: *Orobus sericeus* Boiss. & Bal., Fl. Or. 2:621 (1872)! *Lathyrus sericeus* (Boiss. & Bal.) Čel. in Öst. Bot. Zeitschr. 38:85 (1888)! non Lam. (1790). Map 72, p. 345.

Perennial; subsericeous, densely adpressed-pilose; **Stems** angled, branched, ascending or erect, (10-)25-45 cm long. **Leaves** shortly aristate; **Leaflets** 1-paired, lanceolate, 15-47mm long, 3-12 mm wide, parallel-veined; **Stipules** lanceolate-acuminate, somewhat narrower than the leaflets, unequally sagittate, hastate in adult leaves; **Peduncle** densely 3-7-flowered, longer than leaves. **Calyx** 10-14 mm; teeth subequal. lanceolate-subulate, 2¼-3 x longer than tube. **Corolla** lavender blue, 17-19 mm; Keel whitish; **Legume** broadly linear, c. 35 x 5 mm, densely adpressed-pilose, the hairs hiding sessile glands; **Seed** 7.

Habitat and phenology: June to July. Open forests, rocky slopes, eroded banks, 1150-2200 m.

Syntypes: [Turkey B5 Kayseri] Tchomakli ad basin montis Argaei in Cappadocia, Kotschy suppl. 226 (W), in Armenia [A8/B8] prope Erzerum, Calvert, in collibus herbosis Ponti Lazici [A8 Rize] prope Djimil (Cimil), 1830 m, Balansa

Inner Anatolia and adjacent parts of N. Anatolia, local.
A4 Ankara: Karagöl 40 ml. N. of Ankara 1600 m 10.6.1965 No: 2191! 10-6-1965 no 2166! *MJE Coode and BMG jones.* Kıcılcahamam Soğuksu National Park 1111 m, 5-6-2010, 40 27 403 N – 32 37 461 E, *H. Çildir* 135!

Kıcılcahamam Soğuksu National Park 1186 m, 5-6-2010, 40 27 110 N – 32 37 244 E, *H. Çildir* 136! Kıcılcahamam Soğuksu National Park 1392 m, 5-6-2010, 40 26 746 N – 32 37 398 E, *H. Çildir* 140! Kızılcahamam Soğuksu National Park, Göllü location1400 m, 9-6-1983, *A.Güner & K Sorkun* AG 4994! Kızılcahamam Soğuksu National Park, Yanıksırtı, 1200-1300 m, 12-5-1990, *Ö. Eyüboğlu* 1308! Kızılcahamam Soğuksu National Park, Gölderesi location, 1250m, 11-6-1990, *Ö. Eyüboğlu* 1611! Kızılcahamam Soğuksu National Park, Kuzcapınar district, 1150-1200m, 26-6-1990, *Ö eyüboğlu* 1708! Kızılcahamam Soğuksu National Park, Yanıksırtı road, *P. Nigra* open forest, 1222m, 23-6-2009, 40 27 068 N – 32 37 134 E, *H. Çildir* 100! Işık Montain, mountain peak road, 1651 m, 23-6-2009, 40 40 856 N – 32 43 886 E, *H. Çildir* 103! Çubuk, Karagöl N slope, *S.Erik* 118! Çubuk Dam, 13-7-1960, *R. Çetik* 20783! Çubuk to Karagöl roadside, 1208 m, 30-5-2010, 40 23 417 N – 32 56 663 E, *H. Çildir* 130! Çubuk, Karagöl, 1512 m, 30-5-2010, 40 24 775 N – 32 54 706 E, *H. Çildir* 132! **B3** Eskişehir: Mihalıççık, roadside, 1435 m, 16-6-2010, 39 53 588 N – 31 27 731 E, *H. Çildir* 148! Konya: Akşehir, Sultan da. 1290 m, 17-6-2010, 38 30 603 N – 31 10 950 E, *H. Çildir* 152! **B5** Aksaray: Hasandağ below taşpınar y., 1900 m, 17-6-1952, Davis 19013! Hasan Da. Quercus forest clearance, 1631 m, 23-5-2010, 38 10 263 N – 34 10 708 E, *H. Çildir* 126! Yozgat: Akdağmadeni to Büyük Nalbant Mountain,1800 m 6 june 1965 no 2033! Coode and BMG jones. Kayseri: Erciyes Mountain, Hisarcık road, inside of valley, 1940 m, 14-6-2000, *C.vural* 2194! Erciyes Mountain, east of Sakar farm, N 38 36 311, E 35 24 132, 1700-2200m, *C. vural* 2366! Erciyes da. 1780 m, 19-6-2010, 38 36 907 N – 35 30 840 E, *H. Çildir* 157! **B6** Sivas: Zara to Şerefiye, 1639 m, 22-6-2010, 39 58 281 N – 37 43 434 E, *H. Çildir* 162! **C4** Karaman: Karadagh, nr. Dinek, 1700 m, Andrasovszky 459!

Endemic.

Phytogeography: Unk. or Multi

3.6.4.4. Section *Orobon* Tamamashjan in Takhtadjan (1962) *Flora Armenii* 4: 316.

Type: *L. roseus* Steven in Mem. Soc. Nat. Mosc. 4: 52 (1813)

Description of the sect. *Orobon*

Perennial, erect; Stem terete, striate, unwinged; Leaf aristate, unijugate, etendrillous; Leaflet leaflets 1-paired, obovate to suborbicular, pinnateand strongly reticulate-veined; Stipules semi-sagittate; Inflorescence 1-4 flowers; Style twisted, not dilated above; Legume linear; Seed smooth; Hilum intermediate length.

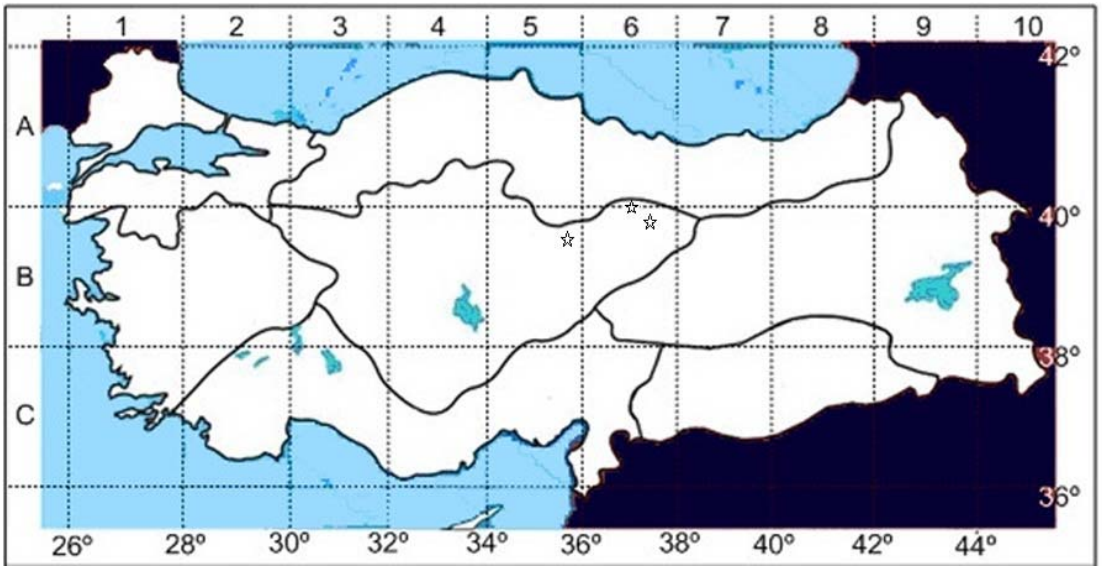


Figure 92. Distribution map of (☆) *L. roseus* subs. *roseus*

13. *L. roseus* Stev. in Mém. Soc. Nat. Mosc. 4:52 (1813). Syn: *Orobus roseus* (Stev.) Ledeb., Fl. Ross. 1:687 (1842). Ic: Fl. Armenii 4: t. 77 (1962). Map 77, p. 353.

Perennial; Erect, glabrous; **Stems** slender, terete and striate, 40-70 cm; **Leaves** unijugate, hypostomatic; leafle broadly ovate, with pinnate venetion, aristate; leaflets 1-paired, broadly obovate to elliptic-orbicular, 15-45mm long,10-30 mm wide, flat, pinnate- and reticulate-veined; **Stipules** 5 – 15 mm long, lanceolate, semi-sagittate, c. as broad as stem. **Peduncles** slender, 1-2 x as long as leaf, 1-4-flowered; **Calyx** 5-7

mm; calyx teeth unequal, triangular to lanceolate, shorter than tube. **Corolla** carmine pink,12-19 mm. **Legumes** broadly linear-oblanceolate, ± incurved, 35-45 mm long, 6-8 mm wide, glabrous. **Seeds** 5-10, smooth.

Habitat and phenology: May to july. Forests (Picea, Pinus), scrub (Quercus, Corylus), 30-1800 m.

Described from Caucasia (LE, photo.)

Mainly N. & E. Anatolia, commonest in the N.E.
A6 Sivas: Yıldız Dağ, Sarıyer,1900 m 14-8-1967, *tobey* 2374! **B5** Yozgat: Çayıralan Tonaman village, 2. km Hamzasultan hill, 1600-1700 m, 17-7-1980, *T. Ekim* 4789! **B6** Sivas: Zara to Şerefiye, 1639 m, 22-6-2010, 39 58 281 N – 37 43 434 E, *H. Çildir* 162 a!

World distribution: Crimea, Caucasia, N. & N.W. Iran.

Phytogeography: Hyrcano-Euxine element.

3.6.4.5. Section *Lathyrus* (1787) Medikus in Vorles. Churpf. Phys. Ges. 2: 358.

Syn.: *Cicercula* Medikus in Vorles. Churpf. Phys. Ges. 2: 358 (1787); *Lathyrus* sect. *Cicercula* (Medicus) Godron in Gren. & Godron, Fl. Fr. 1: 481 (1848); *Lastila* Alef. İn Bonplandia 9: 146 (1861); *N avidura* Alef., op. Cit. 147; *Lathyrus* sect. *Lentiformia* Zoh. İn Zoh., Flora Palaestina 2: 458 (1972)

Lectotype: *L. sylvestris* L. Sp. Pl. 733 (1753)

Description of the sect. *Lathyrus*

Annual and perennial, Procumbent to climbing; Stem angled or winged; Leaf unijugate and tendrillous, rarely with 2-3 pairs of leaflets or etendrillous;

Leaflet suborbicular to narowly lanceolate, venetion pinnate, intermediate or parallel; Stipules semi- sagittate; Inflorescence few to 1-flowered; Style twisted (contorted), always in the same sence, or very rarely straight; Legume variable shaped, sometimes glandular, tuberculate-hairy or with winged structures. Seed often with rough testa; Hilum long to short.

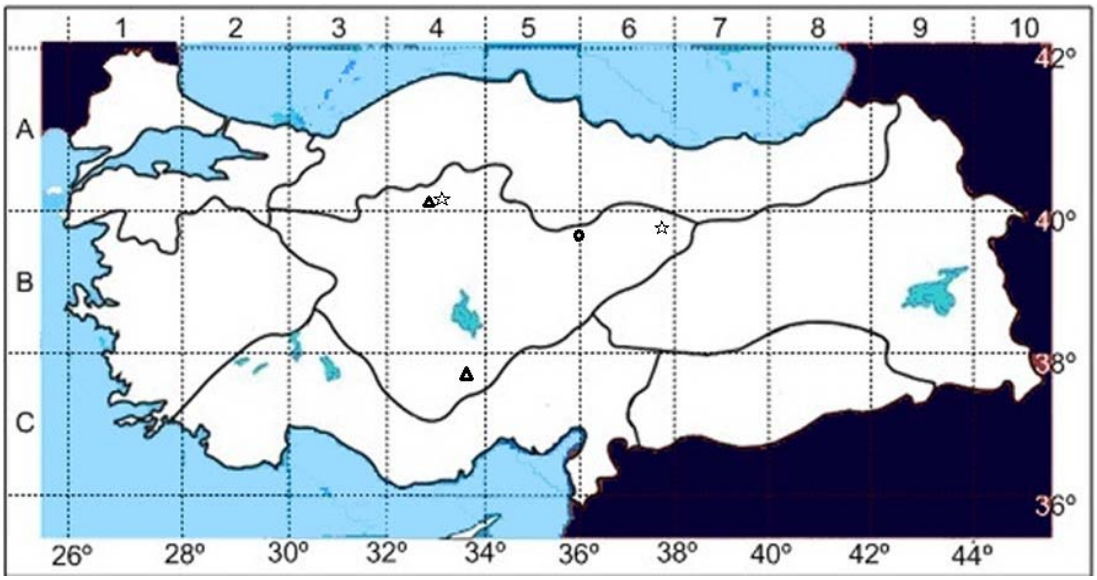


Figure 93. Distribution map of (☆) *L. tuberosus*, (✪) *L. cassius* and (▲) *L. hirsutus*

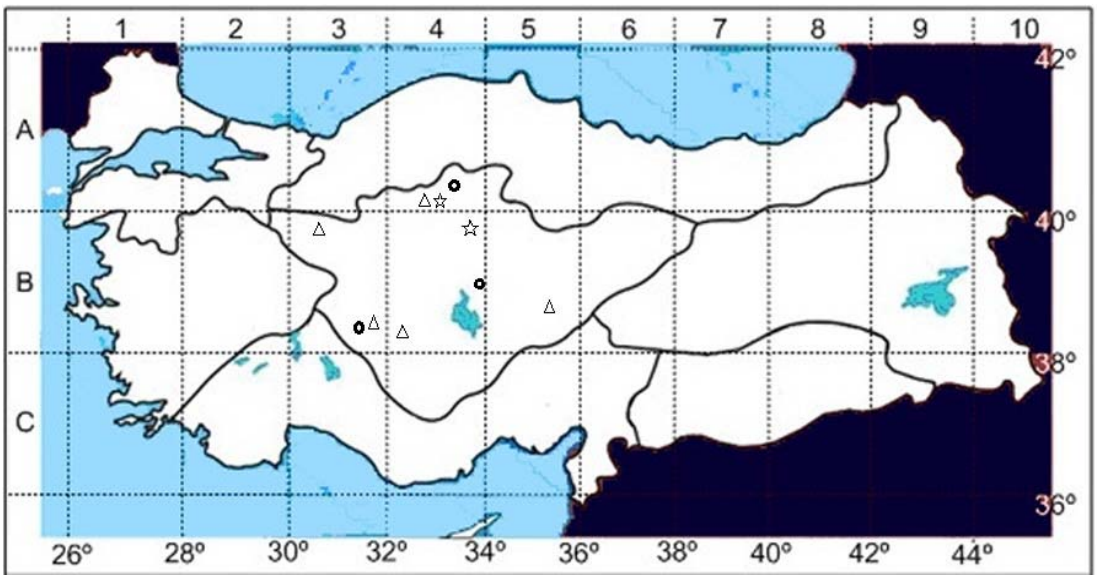


Figure 94. Distribution map of (✪) *L. chloranthus*, (☆) *L. sativus* and (△) *L. cicera*

14. *L. tuberosus* L., *Sp. PL* 732 (1753). Ic: Hegi, I11. Fl. Mittel-Eur. 4(3): t. 171 (1924); Ross-Craig, Draw. Brit. PI. 7: t. 72 (1954). Map 75, p. 353.

Perennial; Scrambling, glabrous or subglabrous; **Stems** not winged, 30-80 cm, arising from tuberous roots. Upper **leaves** strongly tendrillous; leaflets 1-paired, narrowly elliptic,flat; **Stipules** lanceolate, semi-sagittate 5 – 20 mm long.; **Peduncles** 3-9-flowered, much longer than the leaves; Petioles 8 – 10 mm long; **Calyx** 5-7 mm; teeth unequal, the lowest tooth lanceolate and subequal to the tube; **Corolla** bright pink, 11-15 mm. **Legume** linear-oblong, 20-40 x 4-7 mm, glabrous; **Seeds** 3-6, obsoletely tuberculate.

Habitat and phenology: June to August.Water meadows, grassy banks, fallow fields, 1000-2150 m.

Described from Belgium, Switzerland and Tartary (Hb. Cliff.).

Mainly Inner Anatolia, commonest in the East.

A4 Ankara: Karagöl, 1040 m, *Guichard* T/36/60. Lalahan, east part, riverbank *9-7-1954, R. Çelik* 172! Çubuk, Karagöl, 1512 m, 30-5-2010, 40 24 775 N – 32 54 706 E, *H. Çildir* 132a! **B6** Sivas: Yıldızeli, near Kızılırmak river, 1368 m, 23-6-2010, 39 51 230 N – 36 32 246 E, *H. Çildir*172!

World distribution: Most of Europe (except extreme N. & S.), Caucasia, W. Iran, Siberia, C. Asia.

Phytogeography: Euro-Sib, element.

15. *L. cassius* Boiss., Diagn. ser. 1(9): 128 (1849). Syn: *L. annuus* L. var. *cassius* (Boiss.) Post, Fl. Syria 292 (1896)! *L. annuus* L. subsp. *cussius* (Boiss.) Holmboe, Veg. Cyprus 115 (1914)! Map 73, p. 345.

Annual; Scrambling, glabrous annual, glaucescent; **Stems** narrowly winged, (15-)30-60 cm; Median and upper **leaves** bearing mostly 3-sect tendrils; leaflets 1-paired, linear-lanceolate, 30-70 mm long, 2-9 mm wide; **Stipules** c 8 – 15 mm, subulate, semi-sagittate; **Peduncles** 1-2-flowered, shorter or longer than leaves, at least the pedicel bearing dark sessile glands; **Calyx** 4-5 mm, calyx teeth subequal, triangular-acuminate, as long as tube. **Corolla** 9-11 mm; standard pink, wings paler mauve. **Legume** oblong-linear, 28-35 mm long, 5-7 mm wide, upper suture shortly 3-keeled, valves dotted with sessile glands; style 4-5 mm; **Seeds** 5-7, coarsely tuberculate.

Habitat and phenology: May to June. *Pinus brutia* forest, scrub, volcanic outcrops, fallow fields, s.1.-1650 m.

Type: [Turkey C5 Hatay/Syria] in dumosis inter Cassab (Kasab) et Suadieh (Samandağı), vi 1846, *Boissier* (K).

S. & S.E. Anatolia.
B5 Sivas: from Hafik to Bayat, 1346 m, 22-6-2010, 39 46 820 N – 36 41 878 E, *H. Çildir* 170!

World distriburion: W. Syria, Cyprus, N. Iraq.

Phytogeography: E. Medit. element.

16. *L. hirsutus* L.,Sp. Pl. 732 (1753). Ic: Reichb., Ic. Fl. Germ. 22: t. 203 (1903); Jáv. & Csap., Ic. FL Hung. t. 299 (1932).

Annual; Scrambling, subglabrous or sparsely adpressedpilose; **Stems** winged, slender, 40-60 cm; **Leaves** ending in 3-sect or pinnately branched tendrils; leaflets usually 1-paired, linear-elliptic, 30-60 mm long, 3-11 mm wide; **Stipules** 10-18 mm long, 1-2 mm wide, lanceolate-subulate, semi-sagittate. **Peduncles** 1-3-(4) flowered, much longer than leaves. **Calyx** 4.5-5.5 mm; teeth subequal, ovate-acuminate, as

long as tube. **Corolla** bluish purple, 10-14 mm, standard glabrous. **Legume** oblong-linear, 23-35 mm long, 5.5-7.5 mm wide, straight, tuberculate-pilose; style 3-4 mm, twisted. **Seeds** 5-7, tuberculate.

Habitat and phenology: May to July. Bushy and grassy places, cultivated land, s.l.-1000 m.

Described from England and France (Hb. Linn. 905/3).

Mainly N. Turkey, local.
A4 Ankara: Beytepe, back of dormitories,950 m, 9-6-1997, *B Mutlu* 1875!, METU, near Biology department, 850m, 6-5-2010, 39 53 461N-32 46 488E *H. Çildir*! **C4** Konya: Karapınar, 1000m, 10-7-1973, *F. Holtz* 5931!

World distribution: S. & C. Europe, Crimea, Lebanon, N. Africa, Caucasia, N. Iran, Transcaspia.

Phytogeography: Unk. or Multi

17. *L. chloranthus* Boiss., Diagn. ser. 2(6) 67 (1859). Ic: Fl. Azerb. 5: t. 49 (1954). Figure 3, p. 323. Map 79, p. 363.

Annual; Erect or scrambling, spreadingly hairy; **Stems** 17-70 cm, winged, branching from base; **Leaves** ending in 3-sect or pinnately branched tendrils; leaflets elliptic, 20-60 mm long, 7-22 mmwide; **Stipules** small, 7-11 mm long, lanceolate-subulate, shortly semi-sagittate, all much shorter than petioles. **Peduncles** 1-2-flowered, usually aristate, at least as long as the leaflets. **Calyx** 9-11 mm; teeth subequal, ovate-lanceolate acuminate, l½-2 x as long as tube, ± patent; **Corolla** bright yellow or sulphur, 15-24 mm; standard entire, pubescent on back. **Legume** linearoblong, 43-50 mm long, 6-9 mm wide, tuberculate-pilose; Style 7 x 0.4 mm, twisted. **Seeds** 5-9, tuberculate.

Habitat and phenology: June to July. Banks and scrub by streams, igneous slopes, wheatfields, 600-1800 m.

Syntypes: [Turkey B2 Uşak] inter segetes ad Yachamichlar Keui prope Ouchak Phrygiae, *Balansa* (K), circa Erzurum [B8 Erzerum], *Calvert* in Boiss. herb.

Inner Anatolia and periphery, always local.
A4 Ankara: Çubuk barajı, 13-7-1960, *R. Çetik* 52! **B3** Konya: Akşehir, 1000 m, Bornm. 1899:4374! **B4** Ankara: Kezlar-pounare, vi 1906, Frères E.C.! Kırşehir: Kaman, Kalehöyük 5 km east of Kaman fenced of area protechted from Grazing, 10-6-1993, *Nesbitt* 3602!

World distribution: N. Iraq, Iran, Armenia.

Phytogeography: Ir.-Tur. element.

18. *L. sativus* L., Sp. Pl. "30 (1753). Ic: Jáv. & Csap., Ic. Fl. Hung. t. 299 (1932); Villax, Cult. Pl. Fourr. Mèdit. Occid. t. 143 (1963). Figure 3, p. 323.

Annual; ascending, subglabrous; **Stem** with wings as broad as stem, 30-70 cm high. Median and upper **leaves** with mostly 3-sect tendrils; leaflets 1-paired, narrowly lanceolate to narrowly linear, 20-100 mm long, 1.5-11 mm wide, thin; **Stipules** lanceolate acuminate, semi-sagittate,15-20 mm lon. Petiole narrowly winged; 3-4 cm long; **Peduncle** 1-flowered, c. as long as the leaves, shorter or longer than petioles. **Calyx** 7-10 mm; teeth subequal, lanceolate, (l½-.)2-3 x as long as tube, erect or subpatent. **Corolla** sky blue, sometimes violet or white, 14-20 mm; wings broadly obovate. **Legume** broadly oblong, 25-33 mm long, 9-12 mm wide. shortly beaked, eglandular, the upper suture furnished with 2 broad wings 1-2-5 mm wide; style 5-6 mm. **Seeds** (2-)3-4(-5), smooth, 6-8 mm.

Habitat and phenology: April to june. Field crop, waste ground, roadsides and weed, s.1.-1520 m.

Described from Spain and France (Hb. Cliff.! Hb. Linn. 905/6).

Widespread except in the N.E.

A4 Ankara: Lalahan, 31-5-1986, *A yılmaz*, no 3027! **B4** Ankara: Keçiören, Kalaba, behind the General Directorate of Meteorology, rocky slopes 840m, 19-5-1995, *G Akaydın* 3584! Kırıkkale: Sulakyurt Irmakkaralısı village, 5 km doğusu, 1000m, 31-3-1990, *A.A. Dönmez* 1727! Ankara: Lalahan, the new construction areas, 1100 m, 6-5-2009, 39 58 443 N – 33 07 216 E, *H. Çildir* 121a!

World distribution: S. & C. Europe, N. Africa, S. W. Asia

Phytogeography: Euro-Sib. element

19. *L. cicera* L., Sp. PL 730 (1753). Ic: Sibth. & Sm., Fl. Gr. 7: t. 694 (1830); Fiori, Ic. Fl. Ital. t. 2126 (1899). Figure 3, p. 323. Map 78, p. 363.

Annual; Glabrous or more rarely somewhat pilose, diffuse or scrambling; **Stems** with the wings somewhat narrower than the stem, 20-70 cm. Median and upper **leaves** with simple or 3-sect tendrils; leaflets 1-paired, linear-lanceolate or linear, rarely narrowly elliptic, 15-95 mm long, 1-9 mm wide; **Stipules** 10-25 mm long, 2-5 mm wide, ovate-lanceolate acuminate, semi-sagittate, usually 2-3 x as wide as stem. Petiole narrowly winged, 2-3 cm long. **Peduncles** 1-flowered, c. as long as leaves. **Calyx** 7-9 mm; teeth subequal, lanceolate and shortly acuminate, 2-3 x as long as tube, erect or slightly patent. **Corolla** brick-red (rarely pink), 12-16 mm; wings distinctly obovate. **Legume** oblong (sometimes narrowly so), 25-40 mm long, 8-10.5 mm wide, usually not gland-dotted, attenuate-beaked, upper suture flattened and with 2 narrow lateral keels, rarely with sublineate valves; style 3.5-5 mm. **Seeds** 3-5,smooth, 5-6 mm.

Habitat and phenology: March to May. Quercus scrub, Pittas brutia forest, rocky slopes.vineyards, corn and fallow fields, 5-2000 m.

Described from Spain (Hb. Linn. 905/5).

> Turkey-in-Europe. Outer and C. Anatolia, southern part of E. Anatolia **A4** Ankara:(angora) galatiae 2-1892, J. Bornmüller 3150! Ayaş 1000 m, tarla ve yol keranrı, 4-5-1986, *M. Vural* 4099! Ayaşbeli, Pınaryaka village above part, under *Q. pubescent*, 1300 m, 9-6-1975 *A. Hub.-Mor* no 6659! Hacıkadın river, 30-5-1961, *R.çelik*! Keçiören around Hacı Kadın stream, steppe, 960 m, 13-5-1995, *G. Akaydın* 3487! **B3** Konya: Akşehir, Sultan da. 1290 m, 17-6-2010, 38 30 603 N – 31 10 950 E, *H. Çildir* 150! **B4** Ankara: Dikmen Tepe, 8-61933, *Kotte*! Çubuk Dam, 1000-1500 m, 1998, *A.zeren* 1017! Keçiören, steppe, 19-5-198*2 Ertekin* ! Kırıkkale: Keskin, böbrek Mountain, Karaağıl village near farm field, 630 m, 22-5-1992, *Ü. Güler 1*570! Dikmen, Sokullu, Fehmi Pacer streatrocky slopes and steppe, 1100m, 15-5-1995, *G Akaydın* 3521! **B5** Nevşehir: Göreme, Arılıburun river, 1100-1250 m, 19-5-1989, *M. Vural* 4708! Yozgat: Yozgat to Boğazlayan road, 1100m, 25-5-1965, *MJE Coode and BMG jones*1518! Aksaray: Hasan Da. Karbeyaz hotel road, 1510 m, 23-5-2010, 38 10 600 N – 34 10 920 E, *H. Çildir* 125!

World distribution: Greece, Crimea, N. Africa, Cyprus, W. Syria (rare), Syrian Desert, N. Iraq, N. & N.W. Iran, Transcaucasia, C. Asia.

Phytogeography: Unk. or Multi

3.6.4.6. Section *Viciopsis* Kupicha (1983) *Notes from the Royal Botanic Garden Edinburgh* 41: 237.

Syn.: *Lathyrus* sect. *Orobastrum* Boiss., Fl. Or. 2: 601 (1872), pro parte excl. typ.

Type; *L. saxatilis* (Vent.) Vis., Fl. Dalm. 3:330 (1852) (*Orobus saxatilis* Vent., Hort. Cels. t. 94 (1802); *Vicia saxatilis* (Vent.) Tropea Malpighia 21: 41 (1907))

Description of the sect. *Viciopsis*

Annual, erect; Stem not winged; Leaf etendrillous; Leaflet 1-3-paired, 3-toothed above; ovate to linear, pinnate veined; Stipules semisagittate; Inflorescence 1-flowered; Style not twisted- (not cotorted); Legume linear-oblong, rhomboidal, not stipitate; Seed smooth; Hilum short.

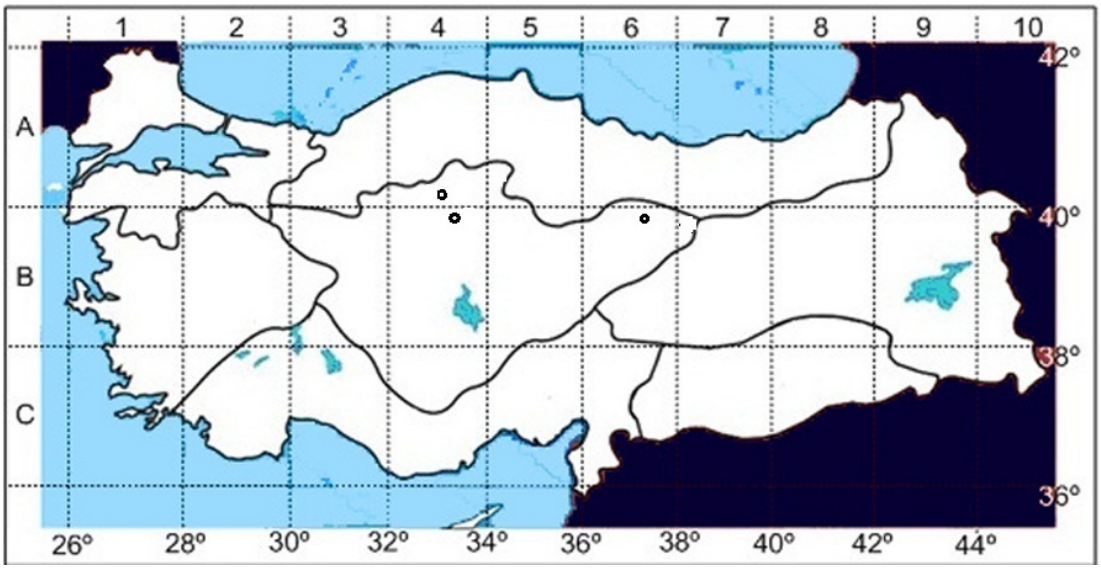


Figure 95. Distribution map of (✪) *L. saxatilis*

20. *L. saxatilis* (Vent.) Vis., Fl. Dalm. 3:330 (1852). Syn: *Orobus saxatilis* Vent., Hort. Cels. t. 94 (1802); *Lathyrus ciliatus* Guss., PL Rar. 296, t. 49 (1826); *Vida saxatilis* (Vent.) Tropea in Malpighia 21:41 (1907). Ic: Reichb., Ic. Fl. Germ. 22: t. 224 (1903); Fiori, Ic. Fl. Ital. f. 2133 (1899).

Annual; Slender, sparsely pubescent; **Stems** not winged, 10-30 cm; **Leaves** all with mucronate rachis; leaflets of lower leaves 1-3-paired, narrowly cuneateoblong, 3-toothed above, leaflets of upper leaves 2-3-paired, narrowly linear, 12-33 mm long, 0.5-1.5 mm wide, leaf venetion pinnate; **Stipules** 2-3 mm long 0.5 mm wide,

subulate, semi-hastate, at least the lower ones also incised. **Peduncle** 2-5 mm, 1-flowered, as long as calyx to c.½ as long as leaf; **Flowers** cream, 7-8 mm; **Calyx** c. 3 mm, glabrous; calyc teeth subequal, shorter than tube; **Legume** linear-oblong, 15-22 mm long, 4.5-5.5 mm wide, glabrous; **Seeds** 3-6, smooth.

Habitat and phenology: April to May. Rocky slopes, in thin pine forest, on calcareous or igneous formations, roadsides, 30-600 m.

Type: The illustration in Ventanat, Hort. Cels. t. 94.

Outer & C. Anatolia, Islands; local.

A4 Ankara: Çubuk De., *Midler.*! **B4** Ankara:Lalahan, the new construction areas, 1084 m, 6-5-2009, 39 58 043 N – 33 07 256 E, *H. Çildir* 121! **B6** Sivas: Zara, *Bornm.* 1892:3322!

World distribution: S. Europe, Crimea, Cyprus, Syrian Desert, Cyrenaica.

Phytogeography: Medit. Element.

3.6.4.7. Section *Linearicarpus* Kupicha (1983) *Notes from the Royal Botanic Garden Edinburgh* 41: 238.

Syn.: Graphiosa Alef. In Bonplandia 9: 128 (1861); *Lathyrus* sect. *Orobastrum* Boiss., Fl. Or. 2: 601 (1872), pro parte excl. typ.; *Lathyrus* sect. *Linearicarpus* [Kupicha ex] Robeson & Harborne in Phytochemistry 19: 2360 (1980), nom. Nud.

Description of the sect. *Linearicarpus*

Annual, Erect or ascending, Stem not winged; Leaf uni- or bijugate, mucronate or with simple tendril; Leaflet narrowly lanceolate, paralled veined; Stipules semi sagittate; Inflorescence 1 flowered; Style not contorted;

Legume narrowly linear, sometimes with membranous septa between the seed; Seed rough or smooth; Hilum short.

Type: *L. inconspicuus* L., Sp. Pl. 730 (1753)

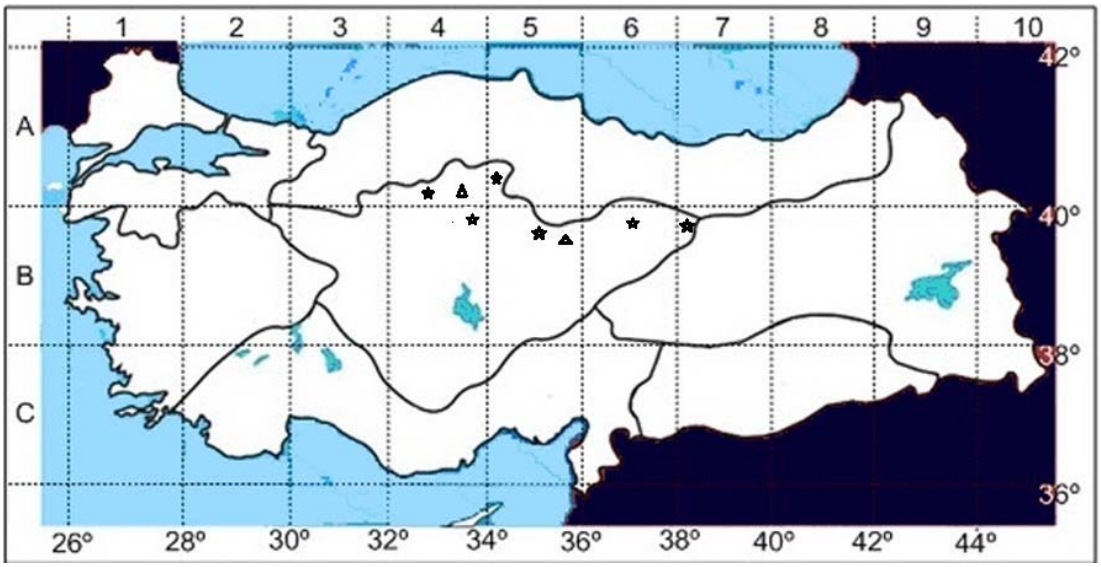


Figure 96. Distribution map of (★) *L. inconspicuus* var *inconspicuus* and (▲) *L. sphaericus*

21. *L. inconspicuus* L. Sp. PL 730 (1753). Syn: L. erectus Lag., Gen. Sp. Nov. 22 (1816). Ic: Hegi, I11. Fl. Mittel-Eur. 4(3): 1567 (1924); Ják. & Csap., Ic. Fl. Hung, t. 299(1932). Figure 3, p. 323.

Annual; Erect, glabrous or pubescent; **Stems**, 10-35 cm, not winged; **Leaves** all aristate, or the upper ones bearing simple tendrils; leaflets 1-paired, linearlanceolate, 15-60 mm long, 1-7 mm wide, leaf venetion parallel; **Stipules** lanceolate acuminate, semi-sagittate, 3-8 mm long; **Peduncle** short, 1-2 mm long, jointed at base; Flowers solitary, small, the stalk usually shorter than the petiole; **Calyx** 4-5 mm; teeth equal, lanceolate, 1-l½ x as long as tube; **Corolla** lavender, often with whitish wings, rarely all white, 7-9 mm; **Legume** linear, 35-50 x 4-5 mm, erect, glabrous or subadpressed-pubescent, obscurely nerved; **Seeds** 7-11, smooth.

Habitat and phenology: April to May. Among shrubs, fallow fields, and corn fileds, nr. s. 1.-1500 m.

Described from the Orient (type in Hb. Linn. 905/7).

Widespread, except in the N and extreme E.
A4 Ankara: Güdül toYeşilöz town, Kirmir stream valley, 750 m, 11-5-2002, *B. Tarıkahya1493*! Çubuk to Karagöl roadside, 1208 m, 30-5-2010, 40 23 417 N – 32 56 663 E, *H. Çildir* 131! Kalecik, 48 km NE of Ankara-Kalecik road near turning to Haydar köy, 1200m, 23-06-1988, *Nesbitt & Samuel* 1745! Beynam forest, the boundry betwen forest and steppe, *R. Çetik* 34! Kırıkkale: Delice to Hacıobası village, steppe 24-6-1990, *A.A. Dönmez* 2556! Sulakyurt to Yeşilyazı village, 850m, 8-4-1989, *A.A. Dönmez* 1039! Keçiören above Hacı Kadın stream, steppe, 950 m, 01-5-1994, *G. Akaydın* 2675! **A5** Çorum: 6 mils Alaca to Sungurlu 1100 m wheatfield 28-5-1965, no 1680! *MJE Coode and BMG jones*. **B4** Ankara: 15-6-1932, *Kotte*! **B5** Yozgat: 45 km south of Yozgat on Boğazlayan road, 1100 m, 25-5-1965, no 1516! *MJE Coode and BMG jones*. Sorgun to Çekerek 2 miles from Sorgun 1100 m, 27-5-1965, no: 1542 ! *MJE Coode and BMG jones.* Kayseri: Develer to Tomarza road, 1503 m, 19-6-2010, 38 24 874 N – 35 45 216 E, *H. Çildir* 158! Sorgun to Çekerek road, 1086 m, 24-6-2010, 39 47 236 N – 35 14 771 E, *H. Çildir* 176! Yozgat:Sorgun to Alaca road, 1322 m, 24-6-2010, 39 54 247 N – 34 56 220 E, *H. Çildir* 177! **B6** Sivas: Zara to Şerefiye, 1639 m, 22-6-2010, 39 58 281 N – 37 43 434 E, *H. Çildir* 164! **B7** Sivas: Zara to İmranlı, 1587 m, 22-6-2010, 39 53 486 N – 38 00 086 E*, H. Çildir* 166!

World distribution: S. Europe, S.W. & C. Asia.

Phytogeography: Unk. or Multi

22. *L. sphaericus* Retz., Obs. Bot. 3:39 (1783). Ic: Bonnier, Fl. Comp. Fr., Suisse et Belg. 3: t. 159 (1914); Jáv. & Csap., Ic. Fl. Hung. t. 301 (1932). Figure

3, p. 323. Map 76, p. 353.

Annual; Slender, glabrous, erect or ascending; **Stems** 30-50 cm, not winged. Upper **leaves** bearing a simple (often short) tendril; leaflets 1-paired, narrowly linear, 25-90 x 0.5-3 mm, leaf venetion parallel; **Stipules** 5-10 mm long, 1-2 mm wide, lanceolate-subulate, semi-sagittate. Flowers solitary, on short; **Peduncles** aristate, 1-12 mm long; **Calyx** 5-6 mm; teeth subequal. l½-2 x as long as tube. **Corolla** brick-red (drying purplish). 8-10 mm; **Legume** linear-ensiform, 30-55 mm long, 4 mm wide, sessile, subcompressed, glabrous, strongly and longitudinally reticulate-nerved. **Seeds** 5-14, smooth.

Habitat and phenology: April to may. Pine forests, on a grassy slope by a stream, hilsides, S. screes, 10-2000 m.

No type designated.

Outer Anatolia, Islands: rare in Inner Anatolia.

B4 Ankara: Çankaya. *Lindsay*! **B5** Nevşehir: Göreme, İçeridere, 1100- 1150 m, 23-6-1989, volkanik tüf, *M. Vural ve ark* 5417!

World distribution: S., W. & C. Europe, Crimea, N. Africa, Cyprus. N. Iraq, Iran, C. Asia.

Phytogeography: Unk. or Multi

3.6.4.8. Section *Nissolia* (Miller) Dumort (1827) *Flora Belgica*. p. 103

Syn.: Nissolia Miller, Gard. Dict. Ed. 4 (1754)

Description of the sect. *Nissolia*

Annual , Erect; Stem angled, not winged; Leaf phyllodic throughout life cycle, grass-like, lanceolate, parallel veined; Stipules minute, subulate; Inflorescence 1-2 flowered; Style Linear, not twisted; Legume linear,

prominently veined, very rarely with septa between the seeds; Seed tyberculate; Hilum short.

Type**:** *L. nissolia* L., Sp. Pl.: 729 (1753)

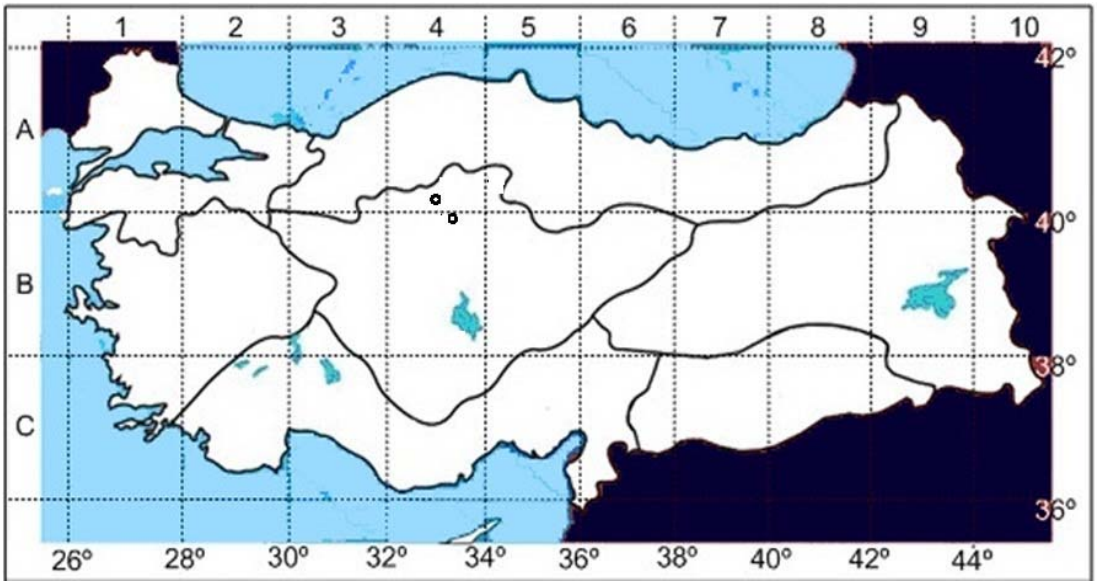


Figure 97. Distribution map of (✪) *L. nissolia*

23. *L. nissolia* L., Sp. PL 729 (1753). Syn: *L. nissolia* subsp. *amanus* Rech. fil. in Ark. Bot. 5(1):268, t. 15 (1957) Ic: Reichb., Ic. FI. Germ. 22: t. 97 (1903); Ross-Craig, Draw. Brit. PL 7: t. 70 (1954).

Annual; Slender, erect, glabrescent or sparsely puberulent; **Stem** 15-50 cm, not winged; **Leaves** lanceolate-linear, phyllodic, mostly 40-100 mm long, 2-6 mm wide, without leaflets or tendril; **Stipules** 0.5-1.5 mm, filiform; **Peduncles** filiform, 1 (-2)-flowered, half as long to rarely longer than the leaves; **Calyx** 4-5 mm; teeth somewhat unequal, lanceolate, the lowest as long or slightly longer than the tube; **Corolla** bright pink, 9-11 mm; **Legume** linear, 32-40 mm long, 2.5-3 mm wide, puberulent or glabrous; **Seeds** 11-16, tuberculate.

Habitat and phenology: May to July. *Pinus nigra* forest, Quercus scrub, grassy places, marshes, nr. s.1.-1900 m.

Described from France (Hb. Cliff.! Hb. Linn. 905/2).

Widespread but very local.
A4 Ankara: Kızılcahamam, *Birand & M. Zohary* 3405! Kızılcahamam Soğuksu National Park, Cehennem stream around, 1060-1100m, *Eyüboğlu* 1853! Kızılcahamam Soğuksu National Park 1111 m, 5-6-2010, 40 27 403 N – 32 37 461 E, *H. Çildir* 134! Kıcılcahamam Soğuksu National Park 1392 m, 5-6-2010, 40 26 442 N – 32 37 272 E, *H. Çildir* 141! Kıcılcahamam Soğuksu National Park, near Davutlar village 1265 m, 5-6-2010, 40 25 486 N – 32 36 950 E, *H. Çildir* 142! Çubuk to Karagöl roadside, 1208 m, 30-5-2010, 40 23 417 N – 32 56 663 E, *H. Çildir* 129! Kırıkkale: Hıdırşeyh village, steppe hillside, 1000 m, 2-6-1990, *.A.A. Dönmez* 2268! Delice, Büyükavşar village, Büyük hemit location, 1190m, 16-6-1990, under quercus forest, *C. birden* 1165! **B4** Ankara: Çankaya, 1200 m, *Alpay* (ANKO 2558)!

World distribution: W., C. & S. Europe, Crimea. Caucasia, N. Iraq, N.W. Africa.

Phytogeography: Unk. or Multi.

3.6.4.9. Section *Aphaca* (Miller) Dumort (1827) *Flora Belgica*. p. 103

Syn.: Aphaca Miller, Gard. Dict. Ed 4 (1754)

Description of the sect. Aphaca

Annual, Procumbent or ascending; Leaf first two seedling leaves with a pair of elliptic, paralle veined leaflets, laeves of adult plant without leaflets but with strong, simple tendril; Stipules hastate; Inflorescence 1-2 flowered; Style linear, not contorted; Legume linear; Seed smooth; Hilum short.

Type: *L. aphaca* L. Sp. Pl. 729 (1753)

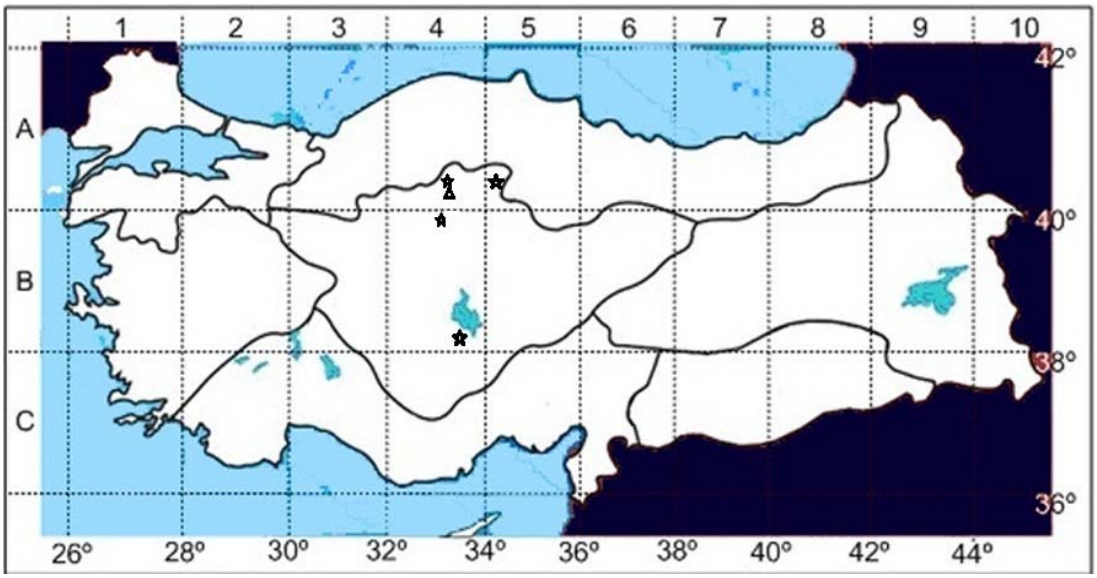


Figure 98. Distribution map of (▲) *L.aphaca* var *affinis* and (★) *L. aphaca* var *biflorus*

24. *L. aphaca* L., Sp. PL 729 (1753).

Annual; Slender trailing or scrambling annual, glabrous. **Stems** 5-50 cm, not winged. Seedling leaves with 1 pair of small leaflets, mature **leaves** without leaflets, but with a simple tendril; Median **stipules** broadly ovate, 5-30 mm, shortly hastate; **Peduncles** 1-2-flowered, 20-50 mm long. **Flowers** 7-13 mm; **Calyx** 3-9 mm; teeth subequal, (l) l -3 x as long as tube; **Corolla** bright to very pale yellow; **Legume** linear-oblong, straight or incurved, 18-35 mm long, 4-6 mm wide, glabrous; **Seeds** smooth, 2-3.5 mm. The *L. aphaca* complex reaches its maximum variability in Anatolia.

1.a. Flowers cream or sulphur	**var. affinis**
1.b. Flowers bright yellow	**var. biflorus**

var. affinis (Guss.) Arc, Comp. Fl. Ital. 195 (1882). Syn: *L. affinis* Guss., Fl. Sic. Syn. 2:853 (1843).

Habitat and phenology: (March) April to june. Rocky limestone slopes, meadows, fields, stream banks, phrygana, s.l-1700 m.
Type: [Sicily] Palermo a Boccadfalco.

Scattered.
A4 Ankara: Kalecik 9-6-1954 *Davis* 21753! Hacıkadın stream, 5-6-1961, *R. Çelik* 7131! Güdül, Karamanağacı location, Kirmir stream valley, steppe, field edge, N 40 13 011, E 32 16 330, 754m, *B. Tarıkahya*, 1194! Kalecik, Kızılırmak riverbank, 638 m, 20-6-2009, 40 05 018 N – 33 27 088 E, *H Çildir* 118 Çankiri to Kalecik, *D.* 21753! Kırıkkale: Koçubaba town auercus scrub, 1300m, 25-5-1990, *A.A. dönemez* 2007!

World distribution: Sicily, Greece, Cyprus and Iran.

Phytogeography: E. Medit

var. ***biflorus*** Post, Fl. Syria 292 (1896). Syn: *L. aphaca* L. *forma subbiflor*a, Azn. in Bull. Soc. Bot. Fr. 44:169 (1897).

Habitat and phenology: April to june (July), Fields (as a common weed), marshy ground,disturbed steppe, roadsides etc., s.l-1900 m. Fl. 4-6{-7}.

Syntypes: [Turkey C6] Maraş: Marash, [Syria] Kessab, [Palestine] Sarada.

Widespread except in N.E. Anatolia.
A4 Ankara: Ankara toKonya Dikmen entry forest understories 970 m, 23-4-1993, *G. Akaydın,* 12906! **A5** Yozgat: 14 miles from Çekerek to Alaca, 900 m, 27-5-1965, no:1628! *Coode and BMG jones.* **B4** Ankara: Beytepe roadside, 950 m, 24-05-1997, *B. Mutlu* 1844! METU Mechanical Engineering, roadside, 935 m, 9-5-2010, 39 53 371 N – 32 46 884 E, *H. Çildir* 115! Elmadağ, farmfield, 11-7-1987, *M ekici* 8379! Gazi University,

Education Faculty garden, 850m, 25-5-1983, *M. Vural*, 2193! Atatürk Orman Çift., nr. Dolapdere, 14-5-1962, *Alinoğlu*! Konya: Sultanhanı to Karapınar, 994 m, 22-5-2010, 37 44 467 N – 33 33 353 E, *H. Çildir* 123!

Phytogeography: Unk. or Multi.

CHAPTER 4

CONCLUSION

In this study, morphology, anatomy and systematics of the genus *Lathyrus* L. (Leguminosae) in Central Anatolia is presented. Comparative morphological characters and their variation in the *genus*; calyx, leaf, corolla and pollen grains micro-morphology of the species; anatomy of the species; ecology, endemism, phytogeography and IUCN threat categories of the species; numerical analysis and Revision of the genus in Central Anatolia were conducted.

Overall, 25 taxa were identified in Central Anatolia of Turkey. According to numerical analysis results, (Figure 97) nine major clusters were differentiated. These major clusters were named as section. Name of these sections are sect. *Aphaca* represented by two variety (*L. aphaca* var. *biflorus*, *L. aphaca* var. *affinis*); sect. *Lathyrus* represented by six species (*L. tuberosus*, *L. cassius*, *L. hirsutus*, *L. chloranthus*, *L. sativus*, *L. cicera*); sect. *Nissolia* represented by one species (*L. nissolia*); sect. *Linearicarpus* represented by two species (*L. inconspicuus* var. *inconspicuous* and *L. sphaericus*); sect. *Viciopsis* represented by one (*L. saxatilis*); sect. *Pratensis* represented by three species (*L. pratensis*, *L. laxiflorus* subsp *laxiflorus, L. czeczottianus*); sect. *Orobon* is represented by one species (*L. roseus* subsp. *roseus*); sect. *Latyhrostylis* represented by seven species (*L. brachypterus*, *L. haussknechtii*, *L. armenus*, *L. digitatus*, *L. tukhtensis*, *L. spathulatus*, *L. cilicicus*) and sect. *Orobon* is represented by two species (*L. aureus* and *L. incurvus*). Among these

taxa, six species were determined to be endemic to Turkey. They are *L. czeczottianus, L. brachypterus, L. haussknechtii, L. armenus, L. tukhtensis, and L. cilicicus.*

The numerical analysis results support the literature survey (Kupicha, 1983; Kenicer et al., 2005; Kenicer 2007). In contrast to Asmussen & Liston (1998) findings, sect. *Orobon* is not included into sect. *Lathyrus* and it remains separate section (Table 4, Figure 87)

Comparative morphological characters such as habit stem morphology, leaf morphology, inflorescence morphology, flowers (calyx, corolla, androecium, and gynoecium), fruit and their variations were compared at infrageneric level. According to the results, important diagnostic morphological characters were leaf shape, corolla color, inflorescence, presence or absence of wings on the stem, and style types.

It is stated that 14 *Lathyrus* taxa are perennial and 11 *Lathyrus* taxa are annual. Nine *Lathyrus* taxa have no tendril and members of these taxa live in more open habitat and forest understoris. The tendrillous species perefer lower vegetation areas, such as roadsides and meadows.

The stem of the members of the genus *Lathyrus* is variable. It can be angeled, winged, terete, striate or quadrate. There are six species having winged stem. Glabrous stem is seen in nine taxa.

Four different epidermal cell types are specified in the *Lathyrus*which are isodiametric with strongly wavy walls, isodiametric or slightly elongated with wavy or straight walls, elongated slightly wavy walled, and elongated with strongly wavy walled.

Micromorphological properties of calyx, leaf, corolla and pollen grains of the species were comprehensively studied and their taxonomic implications were discussed. The

*Lathyrus'*s calyx, corolla and leaf micromorphological studies were conducted for the first time in Turkey. It is determined that the epidermal cell shapes and stomata level and and their distribution on the leaf are important diagnostic micromorphological character of the leaf and calyx.

The micromorphological property of the epidermal surface of corolla is found to be important diagnostic feature for the studied taxa. According to ornamentation of corolla epidermal surface, the studied taxa were grouped as papillose conicals cells with striations, papillose knobby cells with a rugose sculpture, and tabular rugose cells with longitudinal striations (Table 6). The most distinct type of corolla epidermal ornamentation is seen in the *L. choloranthus*. It was suggested that, this species should be grouped as tabular knobby cells with a rugose sculpture as a new ornamentation type for the genus *Lathyrus*.

Morphological and micromorphological characters of pollen grains were revealed. It was determined that the pollen grains size and sculpturing were important diagnostic characters for the species.

In terms of the equatorial view, the pollen grainss of the studied taxa can be clasifed in three main groups, which are elliptical, elliptical to rectangular - obtuse convex and rectangular – obtuse – emarginated (Table 8). In some extent, equatorial view characters can be used to differentiate the genus at species level but it is not useful at sectional level, because there is no consistency of the taxa belongs to the same section. Polar view of the pollen grains ranges from circular-obtuse-convex to rectangular-convex.

The pollen grains surface ornamentation of studied taxa is perforate (perforations differ in size and shape), foveolate or slightly reticulates in the mesocolpium. Generally, the aperture area and the apocolpium area are psilate, reticulate or slightly reticulate.

The studied taxa showed a heterogenic pollen grains aperture system. Seven taxa have an apertures with an intine protrusion and eighteen taxa have an aperture with an operculum. The species belong to the same section have similiar aperture system except for the *L. digitatus, L. hirsutus* and*, L. incurvus.*

The statistical analysis was applied to compare P/E ratios of the pollen grains of studied taxa. According to this analysis, the P/E ratio is important diagnostic feature for most of the sections and the species. According to the result of the Post hoc test, multiple comparisons, the P/E value is sinificantly different among the taxa and can be used to differentiate the taxa by usuing other variables. The *L. tuberosus* has unique P/E value and can be differentiated from the other taxa. The P/E value of *L. inconspicuus* var. *inconspicuus* and *L. haussknechtii* are same and can't be used to differentiate these two taxa. The P/E value of the varietes of section *Aphaca* are same and it can be concluded that this value is not differentiable character for the varieties of section *Aphaca* (Table 8, Table 9, Table 14, and Table 15).

For the first time the anatomical characteristics of *Lathyrus* were examined. The anatomical sections were taken from the root, stem and leaf of the plants for taxonomic deduction. According to the anatomical studies, the number of pith rays in roots, shape and size of vascular tissue in stem, presence or absence of pith in stem, number of palisade parenchyma rows and size of air space between spongy parenchyma in leaves are considered as importan anatomical characters.

The leaf structure, distribution of trichomes, number of palisade parenchyma, distribution of spongy parenchyma cell, size of air space between the spongy parencyma were found to be different between the var. *L. brachypterus* and var. *L. haussknechtii* classified under the same species L. brachypterus. For these reasons, it is suggested that *L. haussknechtii* should be classified as different species not variety of *L. brachypterus*.

Endemism, phytogeography, habitat, phenology, distribution and conservation status of the taxa were determined according to the field studies and the literature surveys. The rate of endemism of *Latyrus* is 24 % in the study area. According to Davis's grid square system, the A4 Grid square has highest number of species. The rate of endemism is also highest in the A4 grid square. Three taxa (12%) are facing a very high risk of extinction in the wild. One taxon is (4%) likely to be threatened in the near future (Table 44, Table 45, Figure 85). The principle threats are mainly urbanization, constructions (especially new roads), overgrazing, and land clearing. Among these, construcion have heighest rate of threat for the species (Figure 86, Table 44, and Table 45).

The multivariety analysis was performed for infrageneric delimitation of the species. According to the results, the sectional grouping of the genus *Lathyrus* supports the previous studies. Sectional key and species key were made and updated. Expanded descriptions, GPS data, some photographs and some notes on the taxonomy of the species were given.

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