



Full Length Article

Seed Characteristics and Testa Textures some Taxa of Genus *Lathyrus* L. (Fabaceae) from Turkey

FATMA GÜNEŞ¹ AND ÇIRPICI ALİ[†]

Kafkas University, Faculty of Arts and Sciences, Department of Biology, Kars, Turkey

†Marmara University, Faculty of Arts and Sciences, Department of Biology, Göztepe, İstanbul, Turkey

¹Corresponding author's e-mail: drgunes@gmail.com

ABSTRACT

Seed morphology and testa texture of 18 wild taxa of *Lathyrus* L., distributed in Turkey, such as *L. niger* (L.) Bernh. subsp. *niger*, *L. palustris* L. subsp. *palustris*, *L. digitatus* (Bieb.) Fiori, *L. pratensis* L., *L. laxiflorus* (Desf.) O. Kuntze subsp. *laxiflorus*, *L. tuberosus* L., *L. undulatus* Boiss. (endemic), *L. sylvestris* L., *L. sphaericus* Retz., *L. setifolius* L., *L. annuus* L., *L. gorgoni* Parl. var. *pilosus* C.C. Townsend, *L. cicera* L., *L. hirsutus* L., *L. clymenum* L., *L. ochrus* (L.) DC., *L. nissolia* L., *L. aphaca* L. var. *affinis* (Guss.) Arcang were examined. The morphological characters of the seeds; general shape, size, colour, surface shape, length and width of the hilum were observed under stereomicroscope. The testa patterns, papillae shape, papillae density, ribbed and waxy layer were examined using scanning electron microscope (SEM). The general shapes of the seeds have been determined as elliptical, elliptical-circular and elliptical-angular. The surface shape is smooth, tuberculate and reticulate. Furthermore, some photos, taken under a stereomicroscope and SEM have been added. We suggest that the seed morphology and testa texture could be used as definers in the identification of *Lathyrus* taxa. © 2011 Friends Science Publishers

Key Words: *Lathyrus*; Seed morphology; Testa texture; Turkey

INTRODUCTION

The genus *Lathyrus* L. (Fabaceae) is comprised of approximately 200 species, most of which are annual and perennial plants, predominantly centered in the Mediterranean region (Seen, 1938; Tutin, 1968; Davis, 1970 & 1988; Heywood, 1978; Kupicha, 1983). *Lathyrus* is represented by 78 taxa, 61 species, 24 of which are endemic to Turkey. In the Flora of Turkey, this taxonomically diverse genus has been subdivided into 10 sections including *Orobos*, *Platystylis*, *Pratensis*, *Orobastrum*, *Orobon*, *Lathyrus*, *Cicercula*, *Aphaca*, *Nissolia* and *Clymenum* (Davis, 1970 & 1988; Gunes & Özhatay, 2000).

Many of the seed identifications have recently been based upon morphological characteristics including seed size, general appearance, outer shape and hilum length etc. (Gunn, 1970, 1971 & 1982; Perrino *et al.*, 1984). Advancement of SEM techniques in the studies of seed structure has brought new benefits for the detailed investigations of seed coat pattern. Several papers dealing with SEM studies of various plants have been published. Brisson and Peterson (1976) reported that characteristics of seed coat in the identification of species could be used as crucial key parameters in conjunction with the following two considerations, differences in the populations belonging to various geographical regions and random genetic

diversities among populations. Studies based on various genera in the family of *Fabaceae* indicated that seed morphologies and testa structure were valuable taxonomic characteristics in the distinguishing of some taxa (Lersten & Gunn, 1981; Kislev & Hoff, 1985; Chernoff *et al.*, 1992; Abou-El-Enain *et al.*, 2007; Vural *et al.*, 2008; Al-Ghamdi & Al-Zahrani, 2010).

Lersten and Gunn (1981) investigated not only the seed coat but also the hilum and lens morphologies of 100 species belonging to the 4 genera in the tribes of *Vicieae*. Butler (1988) defined the diversity of seed coat anatomy among the specimens representing identical species from diverse populations in 36 species of *Vicieae*. He particularly specified that samples of seed coat among populations appeared to be more diverse. In addition to those findings, it was also emphasized that hilum width and depth played crucial roles in the differentiation of species.

Kislev and Hoff (1985) examined the fossil samples belonging to 11th century. They reported that *L. cicera* could be distinguished from *L. sativus* on the basis of the differences in their testa structures. Chernoff *et al.* (1992) examined a total of 99 taxa (50 taxa of *Vicia*, 39 of *Lathyrus*, 6 of *Lens* & 4 taxa of *Pisum*) belonging to four genera in the tribus of *Viciae* grown in the Near East. They examined 99 specimens for distinguishable morphological properties including seed size, general shape, hilum shape, hilum location and length.

Furthermore, they also examined testa structures using SEM. In those earlier works (Gunn, 1970 & 1971; Lersten & Gunn, 1981; Gunn 1982; Perrino *et al.*, 1984; Kislev & Hoff, 1985; Butler, 1988; Chernoff *et al.*, 1992; Vural *et al.*, 2008) it was emphasized that seed morphologies were not sufficient properties for classification, but that seed coat sculpture could be used as a descriptive characteristic in taxonomy. All earlier studies indicated that the best diversity regarding to seed morphology properties and seed coat structure in the tribus of *Vicieae* was observed in the genus *Lathyrus*. Seeds obtained from samples of *L. niger*, *L. digitatus*, *L. pratensis*, *L. laxiflorus* subsp. *laxiflorus*, *L. tuberosus*, *L. sylvestris*, *L. setifolius*, *L. gorgoni*, *L. cicera*, *L. clymenum*, *L. ochrus* and *L. nissolia* taxa collected from distribution grown in the Near East have been analyzed by Chernoff *et al.* (1992) and Abou-El-Enain *et al.* (2007) have analyzed the seed morphology and testa properties of a total of 34 *Lathyrus* taxa obtained from seed banks of 18 countries. However, they did not state if the seed surface is smooth or reticulate; only the papillae properties was given. The papillae properties are similar to that of the smooth seed surface.

To the best of our knowledge, there is no previous data available on the seeds of *Lathyrus* species grown naturally in Turkey. Therefore, the initial goal of this study is to determine the seed morphological properties and testa structures of seeds belonging to 18 *Lathyrus* taxa. The secondary aim is to use these properties in the identification of species.

MATERIALS AND METHODS

Mature seeds of 18 taxa of the genus *Lathyrus* were collected from their natural habitats in Turkey between 1995 and 2009. Collected specimens were kept in the herbarium, Faculty of Arts and Sciences, Marmara University (MUFE) and Department of Biology, Faculty of Arts and Sciences, Kafkas University, Turkey. A total of 100 samples from each taxon were used for morphological properties; seed size, general shape, seed surface, color, hilum length and width. The general view photographs were taken with olympus SZXH stereo-microscope at a magnification 0,8x. For scanning electron microscopy, mature seeds (2-3) from each of the taxa were selected, the seeds were mounted onto stubs with double-sided adhesive tape and were then coated with gold. The seed coat pattern was examined on the lateral surfaces of the seeds. Photographs of testa were taken from JEOL JSM 5200 at a magnification of 1500×. Regions distant from the hilum were selected for SEM observations. The terminology of seed characters in this work was based on the descriptions used by Chernoff *et al.* (1992).

RESULTS

In this study seed morphology and testa properties of

18 taxa belonging to 9 sections are analyzed (Table I). The Morphological characters of examined taxa are given in Table II. The photographs of the seeds obtained from SEM were analyzed and testa characteristics shown in Table III. The largest seeds have been measured in the *Lathyrus* and *Clymenum* sections as 4-7 mm and the smallest seeds in *Nissolia* and *Orobastrum* sections 1,5-3.5 mm. The general shapes of the seeds were determined as elliptical, circular, elliptical-circular, pressed-laterally-angular, elliptical-angular, slightly pressed-elliptical and slightly elliptical-circular-rectangular. The seed color has black, brown, yellow, green tones and is speckled (*L. tuberosus* & *L. ochrus* taxa are not speckled). The surface shape is smooth, tuberculate and reticulate (Fig. 1 & 2). Seeds of *L. digitatus*, *L. sphaericus*, *L. ochrus* and *L. aphaca* covered with a dusty (waxy layer), while *L. digitatus*, *L. sphaericus* and *L. aphaca* the waxy layer is composed of rods and layers as parts, in *L. ochrus* it creates a thick layer on the papilla. Also wax accumulation on top of the papillae was observed in the analyzed SEM photographs of *L. tuberosus*, *L. undulatus*, *L. sylvestris*, *L. setifolius*, *L. gorgoni* and *L. cicera*. The longest hilum was measured in *L. sylvestris* as 4-6 mm, and the smallest in *L. Nissolia* 0.4-0.7 mm. The width hilum belongs to *L. annuus* 0.8 (0.9) 1.2 mm and the narrow hilum *L. nissolia* 0.2 (0.2) 0.3 mm. In tuberculate *L. nissolia* (Istanbul & Amasya) the papillae had accumulated in the tubercle and the surface was not papillate. In the other taxa, both the tubercles and the surface was papillated. The papillae were conical in *L. tuberosus*, *L. undulatus*, *L. sylvestris* *L. setifolius*, *L. gorgoni*, *L. cicera*, *L. clymenum* and *L. ochrus*. They were either flat or dished in *L. pratensis*, *L. laxiflorus*, *L. annuus*, *L. hirsutus*, *L. nissolia* (Fig. 1 & 2). In *L. digitatus*, *L. sphaericus* and *L. aphaca* the papillae were coated with a waxy layer and narrow, thin and short (Fig. 3 & 4). In *L. niger* and *L. palustris* the papillae were conical or obtuse (Fig. 3). The taxa examined in this study, include about ¼th of the *Lathyrus* in Turkey.

DISCUSSION

As the previous researches have pointed out (Gunn, 1970, 1971 & 1982; Perrino, 1984; Chernoff *et al.*, 1992) seed size, general shape, color, surface shape, hilum and testa properties (the shape, length & density of the papillae & waxy) are characteristics used in the distinguishing of taxa. The taxa that we studies besides *L. palustris* and *L. undulatus* were studied by Chernoff *et al.* (1992). It is seen that the results obtained in this study are in compliance with the results of Chernoff *et al.* (1992) except for *L. nissolia*. They have determined the seeds of *L. nissolia* as tuberculate. In this study it has been observed that the *L. nissolia* seeds collected from different populations are tuberculate and smooth (Fig. 2 & 5). In tuberculate seeds the papillae are accumulated in the tubercles and the surface has not papillae (population of Istanbul & Amasya).

Table I: The studied taxa, their distribution and locality

Taxa	Section	Distribution in the world	Locality
<i>Lathyrus niger</i> subsp. <i>niger</i>	<i>Orobus</i>	Eupope, N.W. Africa, Caucasia	A1 (E) Tekirdağ: Kırıkköy-Saray road, Kastro road discrimination, Quercus forest, 250 m, 14.07.1997, <i>F. Güneş</i> , MUFE 5553. A2 (A) İstanbul: Sarıyer - Atatürk Arboretum, open forest, 115 m, <i>F. Güneş et al.</i> , 29.05.1996, MUFE 5050.
<i>L. palustris</i> subsp. <i>palustris</i>	<i>Orobus</i>	Eupope, C. & E. Asia	A2 (A) İstanbul: Riva river, behind of Federation, riverside, marshy places, sl., 12.08.1997, <i>F. Güneş</i> and <i>A. Çırpıcı</i> MUFE 5573.
<i>L. digitatus</i>	<i>Platystylis</i>	E. Medit.	A1 (E) Kırklareli: Poyralı-İslambeyli road, 2. km, Quercus forest, 300 m, 13.07.1997, <i>F. Güneş</i> , MUFE 5550. A4 Kırkkale: Balışeyh, Koçubaba, quercus forest, 1218 m, 17.07.2009, <i>F. Güneş</i> , 2488. B1 Balıkesir: Savaştepe, Soğucak village, quercus forest, 540 m, 15.06.2009, <i>F. Güneş</i> and <i>Feyzullah Güneş</i> , 2370.
<i>L. pratensis</i>	<i>Pratensis</i>	Europe, N.W. Africa, Caucasia Asia	A1 (E) Kırklareli: Dereköy, opposite of military, road discrimination, roadside, 550 m, 27.07.1998, <i>F. Güneş</i> , MUFE 5777. A9 Kars: Melikköy, fields, 02.07.2004, 1872 m, <i>F. Güneş</i> , 27.
<i>L. laxiflorus</i> subsp. <i>laxiflorus</i>	<i>Pratensis</i>	Europe, Crimea, Caucasia, W. Asia	A1 (E) Kırklareli: Poyralı-Vize road, 16 km to Vize, forest, 300 m, 13.07.1997, <i>F. Güneş</i> , MUFE 5551. A9 Artvin: Şavşat – Yavuzköy, forest side, 820 m, 12.08.2004, <i>F. Güneş</i> , 43. B2 Kütahya: Simav-Sındırgı road, 18 km., open quercus forest, 488 m, 14.07.2009, <i>F. Güneş</i> , 2363.
<i>L. tuberosus</i>	<i>Lathyrus</i>	Europe, Caucasia, Siberia, C. Asia	A1 (E) Tekirdağ: Çorlu, Yenimahalle to Karahalil road, 2 km, streamside, 260 m, 18.07.1997 <i>F. Güneş</i> , MUFE 5565. A9 Kars: Melikköy, fields, 02.07.2004, 1872 m, <i>F. Güneş</i> , 26. C3 Isparta: Eğirdir-Aksu road, 7. km., fields, 955 m, 12.06.2009, <i>F. Güneş</i> , 2337.
<i>L. undulatus</i>	<i>Lathyrus</i>	Endemic N.W. Turkey	A2 (E) İstanbul: Kilyos-Demirciköy road, 2. km, mixed forest, 50 m, 30.06.1996, <i>F. Güneş</i> , MUFE 5081. A2 (A) İstanbul: Başbüyük, open forest, 300 m, 13.07.2003, <i>F. Güneş</i> , MUFE 8732.
<i>L. sylvestris</i>	<i>Lathyrus</i>	Europe, N.W. Africa, Caucasia	A2 (E) İstanbul: Çatalca, train station, streamside, 150 m, 26.08.1997, <i>F. Güneş</i> , MUFE 5574. A2 (A) İstanbul: Şile, road side, 150 m, 04. 08.1996, <i>F. Güneş</i> , MUFE 5086.
<i>L. sphaericus</i>	<i>Orobastrum</i>	Europe, Mediterranean	A1 (E) Edirne: Keşan-Şükürköy after 3 km, gardenside, 80 m, 30.05.1998, <i>F. Güneş</i> , MUFE 5733. B8 Erzincan: Tercan – Erzincan road, 15. km., quercus forest, 1310 m, 10.07.2009, <i>F. Güneş</i> , 2453. 7B Erzincan: Arapgir-Kemaliye road, Dutluca village, quercus forest, 1176 m, 12.07.2009, <i>F. Güneş</i> 2461.
<i>L. setifolius</i>	<i>Orobastrum</i>	Medit., Near East	A1 (E) Tekirdağ: Şarköy, Uçmakdere, rocky slopes, sl-5 m, 13.06.1998, <i>F. Güneş</i> and <i>A. Çırpıcı</i> , MUFE 5763. C3 Isparta: Aksu road side, 1209 m, 12.06.2009, <i>F. Güneş</i> , 2346. C5 Mersin: near girl castle, 50 m, 27.04.2005, <i>F. Güneş</i> , 60. A8 Bitlis: Bitlis-Baykan road 50. km, rocky slopes, 704 m, 09.05.2009, <i>F. Güneş</i> , 2111.
<i>L. annuus</i>	<i>Cicerula</i>	Medit., Near & Mid-East	A1 (E) Kırklareli: Pınarhisar-Ahmetbey road, Tozaklı village, streamside, 160 m, 18.07.1997, <i>F. Güneş</i> , MUFE 5568. A7 Trabzon: KATÜ campus area, 100 m, 29.05.2009, <i>F. Güneş</i> and <i>M. Özcan</i> , 2208. C5 Mersin: Silifke, field side, 40 m, 20.05.2009, <i>F. Güneş</i> , 2036. C9 Siirt: Baykan-Siirt road 14. km., streamside, 605 m, 09.06.2009, <i>F. Güneş</i> , 2114.
<i>L. gorgoni</i> var. <i>pilosus</i>	<i>Cicerula</i>	Mediterranean	A2 (E) İstanbul: Çatalca, field, 190 m, 15.06.1996, <i>F. Güneş</i> , MUFE 5057. A1 (A) Tekirdağ: Silivri-İstanbul road 5. km., fields, 100 m, 19.05.1998, <i>F. Güneş</i> , MUFE 5688.
<i>L. cicera</i>	<i>Cicerula</i>	Medit., Near & Mid-East	A1 (E) Edirne: Keşan, Karatepe, 250 m, 30.05.1998, <i>F. Güneş</i> , MUFE 5707. A2 (E) İstanbul: Çatalca, field, 190 m, 15.06.1996, <i>F. Güneş</i> , MUFE 5055. B1 Balıkesir: Savaştepe-Soğucak village, 450 m, 07.06.1997, <i>F. Güneş</i> , MUFE 5439. C8 Batman: Batman-Hasankeyf road 5. km, field side, 10.06.2009, <i>F. Güneş</i> , 2117.
<i>L. hirsitus</i>	<i>Cicerula</i>	Europe, Medit., Mid-East	A1 (E) Tekirdağ: Kılıçlı village, roadside, 260 m, 17.07.1997, <i>F. Güneş</i> , MUFE 5558. C6 K..Maraş: Akifiye, road side, 1357 m, 01.07.2009, <i>F. Güneş</i> , 2283.
<i>L. clymenum</i>	<i>Clymenum</i>	Mediterranean	A2 (E) İstanbul: Kilyos-Demirciköy road, 2. km, roadside, 50 m, 30.06.1996, <i>F. Güneş</i> , MUFE 5065. B1 İzmir: Narlıdere, military area, 30 m, 20.05.1999, <i>F. Güneş</i> , MUFE 6131.
<i>L. ochrus</i>	<i>Clymenum</i>	Mediterranean	A2 (E) İstanbul: Çatalca, field, 190 m, 15.06.1996, <i>F. Güneş</i> , MUFE 5058. C1 Muğla: Marmaris - Bozburun, fields, 59 m, 24.04.2009, <i>F. Güneş</i> , 2087.
<i>L. nissolia</i>	<i>Nissolia</i>	Europe, Medit.	A1 (E) Edirne: Havsa-Edirne road, 6. km, 50 m, 21.06.1997, <i>F. Güneş</i> , MUFE 5489. A2 (A) İstanbul: Kilyos, road side, 100 m, 25.06.2009, <i>F. Güneş</i> , MUFE 5064. A6 Amasya: Akdağ, Eğribük village, quercus forest, 1183 m, 16.07.2009, <i>F. Güneş</i> , 2481.
<i>L. aphaca</i> var. <i>affinis</i>	<i>Aphaca</i>	E. Mediterranean	A2 (E) İstanbul: Çatalca, fields, 190 m, 15.06.1996, <i>F. Güneş</i> , MUFE 5056.

In smooth seeds the papillae are wide, short and dense (population of Edirne) (Fig. 2 G-H, 3 H-J, 6 A-B).

Abou-El-Enain *et al.* (2007) have studied the species that we studied excluding *L. palustris* and *L. undulatus* and *L. setifolius*. There was no great diversity and difference

among the populations that they studied and the populations that we studied (seed shape, color, length & hilum properties). Butler (1988) noted that there are differences in seed coat, specimens among the various populations of the species. Even though the seeds of taxa found in *Orobus*,

Table II: Morphological characters of examined taxa (with stereomicroscope)

Taxa	Diameter (min.(mean) max.) (length-width) (mm)	Shape	Colour	Surface shape	Hilum length (min.(M) max.) (mm)	Hilum width (min.(M) max.) (mm)	Examined seed number
<i>L. niger</i> subsp. <i>niger</i>	2.5 (3.3) 5.0	elliptical	brown and tones, and speckled	smooth	2.0 (2.6) 3.2	0.4 (0.5) 0.6	100
<i>L. palustris</i> subsp. <i>palustris</i>	3.2 (3.6) 4.0	circular	brown, dark brown and speckled	smooth	2.0 (2.6) 3.0	0.5 (0.7) 1.0	100
<i>L. digitatus</i>	2.0 (3.3) 4.3	elliptical-circular	grey and brown, with waxy speckled	smooth	0.7 (1.2) 1.5	0.4 (0.5) 0.5	100
<i>L. pratensis</i>	3.5 (4.59) 5.5	elliptical-circular	brown and yellow tones and speckled	smooth	1.8 (1.97) 2.0	0.3 (0.4) 0.5	100
<i>L. laxiflorus</i> subsp. <i>laxiflorus</i>	2.0 (2.4) 3.0	slightly elliptical-circular	brown and tones and speckled	smooth	1.0 (1.6) 2.0	0.3 (0.4) 0.5	100
<i>L. tuberosus</i>	2.5 (3.8) 5.0	elliptical	brown and green tones	obsoletely tuberculate	1.8 (2.0) 2.1	0.5 (0.7) 0.8	100
<i>L. undulatus</i>	4.0 (4.3) 7.0	elliptical-circular	brown and tones and usually speckled	faintly reticulate-rugulose	2.0 (3.0) 3.8	0.5(0.5) 0.5	100
<i>L. sylvestris</i>	4.5 (5.0) 7.0	elliptical-circular	brown and tones and speckled	reticulate-rugose	4.0 (5.1) 6.0	0.8 (0.9) 1.0	100
<i>L. sphaericus</i>	2.5 (3.0) 3.5	slightly elliptical-circular-rectangular	dark brown and sometimes speckled, some with waxy layer	smooth	1.0 (1.0) 1.0	0.5 (0.6) 0.8	100
<i>L. setifolius</i>	4.0 (5.0) 6.0	circular to rectangular	brown tones and speckled	coarsely tuberculate, tubercles conical	1.5 (1.6) 2.0	0.6 (0.8) 1.0	100
<i>L. annuus</i>	4.0 (4.8) 5.7	elliptical-circular-rectangular	black, brown tones and speckled	coarsely - tuberculate	1.8 (2.0) 2.3	0.8 (0.9) 1.2	100
<i>L. gorgoni</i> var. <i>pilosus</i>	3.5 (4.5) 5.3	elliptical-angular	brown, green, yellow and speckled	smooth	1.0 (1.4) 1.5	0.5 (0.7) 1.0	100
<i>L. cicera</i>	3.5 (4.5) 5.0	pressed-angular	brown, green, yellow and speckled	smooth	1.0 (1.2) 1.5	0.5 (0.6) 0.6	100
<i>L. hirsutus</i>	3.0 (3.4) 4.0	circular	brown, sometimes speckled	tuberculate	1.5 (1.6) 2.0	0.5 (0.6) 0.7	100
<i>L. clymenum</i>	4. (5.5) 7.0	slightly pressed-elliptical to rectangular	brown and black tones, black speckled	smooth	3.0 (3.5) 4.0	0.5 (0.5) 0.5	100
<i>L. ochrus</i>	4.5 (5.4) 6.0	circular	light brown, with waxy layer	smooth	2.5 (3.0) 3.5	0.5 (0.6) 0.8	100
<i>L. nissolia</i> (from Edime)	1.7 (2.0) 2.7	elliptical-circular-slightly rectangular	brown tones and speckled	smooth	0.4 (0.6) 0.8	0.2 (0.3) 0.4	100
<i>L. nissolia</i> (from Kilyos and Amasya)	1.7 (2.0) 2.7	elliptical-circular-slightly rectangular	brown tones and speckled	tuberculate	0.4 (0.6) 0.7	0.2 (0.2) 0.3	100
<i>L. aphaca</i> var. <i>affinis</i>	2.5 (3.4) 5.0	elliptical-circular	brown, yellow, black and speckled	smooth	0.8 (1.0) 1.2	0.4 (0.4) 0.5	100

Pratensis and *Lathyrus* sections show similarities within the section the similarities of taxa seeds in other sections are less. Nearly all properties of *L. niger* and *L. palustris* seeds are very similar, their differences are the general shape and diameter of the seeds (Fig. 1, 3; Table II, III). *L. pratensis* and *L. laxiflorus* seeds are very similar both morphologically and in terms of their testa textures the differences are that the color and diameter of *L. laxiflorus* is shorter (Fig. 1, 3; Table II, III). Even though the seeds of *L. tuberosus*, *L. undulatus* and *L. sylvestris* are morphologically different (except shape & color), they show similarities in terms of testa textures (papillae large, conical, many ribbed & peaks topped with wax). Even though *L. sphaericus* and *L. setifolius* are in the *Orabastrum* section, their only similarity is that their papillae are multi-ribbed. *L. clymenum* and *L. ochrus* are in the *Clymenum* section but their similarities are diameter and surface shape.

L. annuus, *L. gorgoni*, *L. cicera* and *L. hirsutus* taxa belong to the *Cicercula* section; they were similar in size and color and different in shape, surface shape and hilum. *L. Gorgoni* and *L. cicera*, *L. annuus* and *L. hirsutus* taxa are more similar to each other in terms of morphological properties and testa characteristics (Fig. 2, 4; Table II, III).

In this study perhaps it can be stated that taxa belonging to *Orobis*, *Pratensis*, *Lathyrus* and *Cicercula* sections are more similar to each other in terms of morphological and testa properties than the taxa analyzed in other sections. For example even though the seeds of taxa that belong to the *Orobis* section are elliptical to circular, their surfaces are smooth, their papillae are short, dense and conical, the seeds of the species in the *Pratensis* section are elliptical to circular, smooth and their papillae are not conical (obtuse). The taxa analyzed from other sections, *L. sphaericus* and *L. setifolius*, *L. clymenum* and *L. ochrus*

Table III: Testa texture of examined taxa (SEM)

Taxa	Papillae	Papillae density	ribbed	Waxy
<i>Lathyrus niger</i> subsp. <i>niger</i>	large, conical or not, broad and low	density	many ribbed	-----
<i>L. palustris</i> subsp. <i>palustris</i>	large, conical or not, broad and low	density	many ribbed	-----
<i>L. digitatus</i>	large, round, low, obtuse	density to moderate	many ribbed	waxy layer and waxy rods
<i>L. pratensis</i>	large and low, obtuse	density to moderate	many ribbed	-----
<i>L. laxiflorus</i> subsp. <i>laxiflorus</i>	large and low, obtuse	density to moderate	many ribbed	-----
<i>L. tuberosus</i>	large, conical and low	density	many ribbed	some with wax incrustations
<i>L. undulatus</i>	large, conical and long or short	density to moderate	many ribbed	peaks topped with wax.
<i>L. sylvestris</i>	large, conical or broad and low	density to moderate	many ribbed	peaks topped with wax.
<i>L. sphaericus</i>	narrow and low irregular reticulate	density	many ribbed	delicate waxy rods
<i>L. setifolius</i>	tubercles conical, tubercles and background papillae, papillae scattered or forming ridges	density to moderate	many ribbed	peaks topped with waxy
<i>L. annuus</i>	tubercles dense, acute, tubercles with papillae	forming ridges, moderate	irregular many ribbed	-----
<i>L. gorgoni</i> var. <i>pilosus</i>	typical papillose pattern, large, conical or broad and low	density to moderate	multi-ribbed	peaks topped with wax.
<i>L. cicera</i>	typical papillose pattern, conical peaks topped curved	density to moderate	multi-ribbed	peaks topped with wax.
<i>L. hirsutus</i>	tubercles and background papillae, papillae varying in size, scattered or forming in peaks	density in peaks	irregular many ribbed	-----
<i>L. clymenum</i>	typical papillose pattern, conical	moderate	multi-ribbed	sometimes peaks topped with waxy
<i>L. ochrus</i>	large or huge, conical	density to moderate	many ribbed	peaks topped with waxy
<i>L. nissolia</i>	papillae large forming in peaks background with small papillae, in smooth seeds papillae large and low	moderate	many ribbed	-----
<i>L. aphaca</i> var. <i>affinis</i>	papillae narrow and low irregular reticulate	density	many ribbed	waxy rods and dusty

Fig. 1: General view of seeds in light microscope. A; *L. niger* subsp. *niger*, B; *L. palustris* subsp. *palustris*, C; *L. digitatus*, D; *L. pratensis*, E; *L. laxiflorus* subsp. *laxiflorus*, F; *L. tuberosus*, G; *L. undulatus*, H; *L. sylvestris*, I; *L. sphaericus*, K; *L. setifolius*. Bar: 1 mm

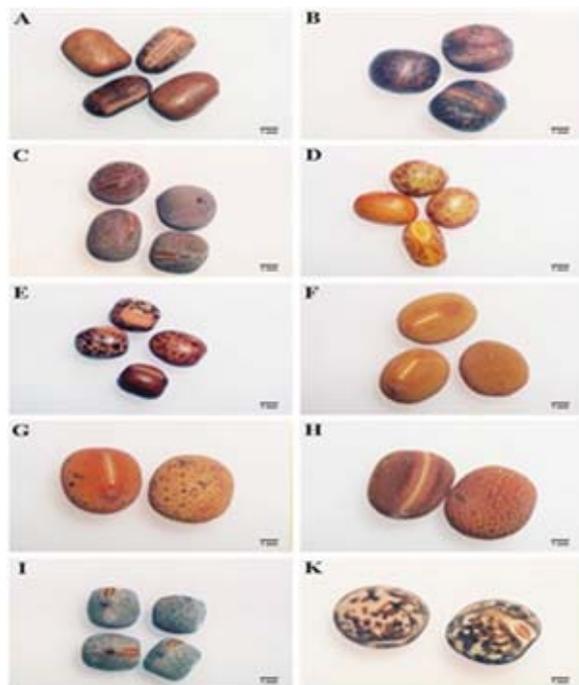


Fig. 2: General view of seeds in light microscope. A *L. annuus*, B *L. gorgoni* var. *pilosus*, C *L. cicera*, D *L. hirsutus*, E *L. clymenum*, F *L. ochrus*, G *L. nissolia*, (tuberculate and smooth seed), H *L. aphaca* var. *affinis*. Bar: 1 mm

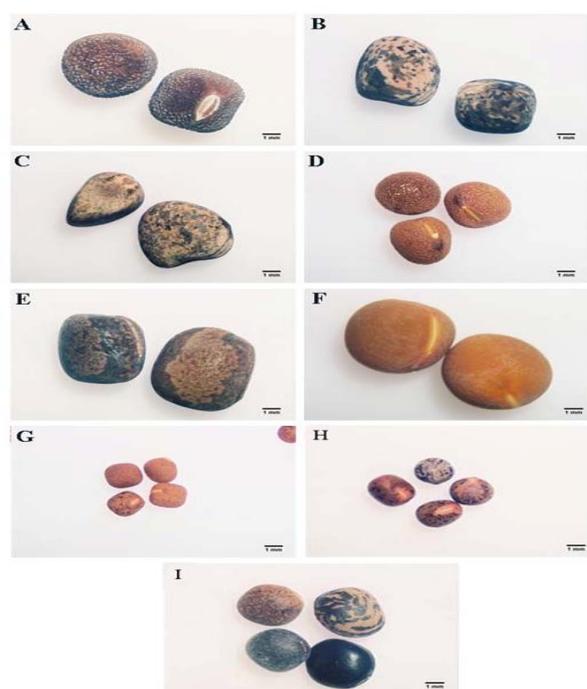


Fig. 3: General shape and surface some of examined taxa (SEM) A; *L. undulatus*, B; *L. palustris*, C; *L. setifolius*, D; *L. pratensis*, E; *L. setifolius*, F; *L. sphaericus*, G; *L. annuus*, H; *L. nissolia*, I; *L. hirsutus*, J; *L. Nissolia*

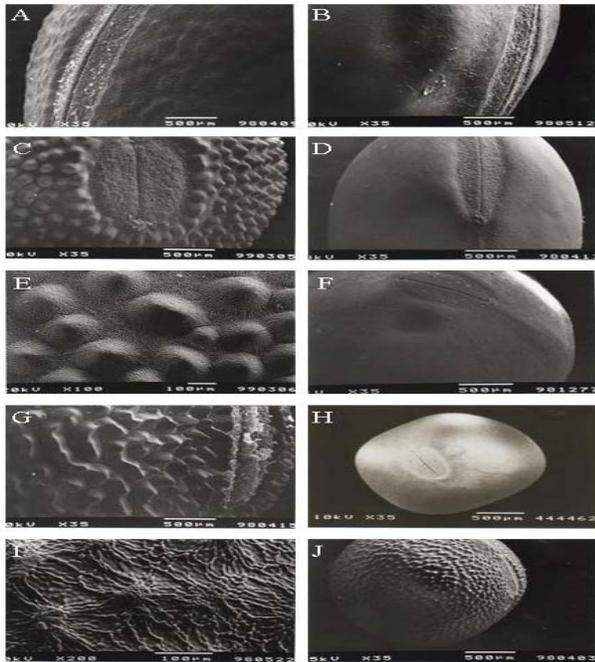


Fig. 4: Seed sculpture of examined taxa (SEM). A; *L. niger* subsp. *niger*, B; *L. palustris* subsp. *palustris*, C; *L. digitatus*, D; *L. pratensis*, E; *L. laxiflorus* subsp. *laxiflorus*, F; *L. tuberosus*, G; *L. undulatus*, H; *L. sylvestris*. Bar: 10 µm (x 1500)

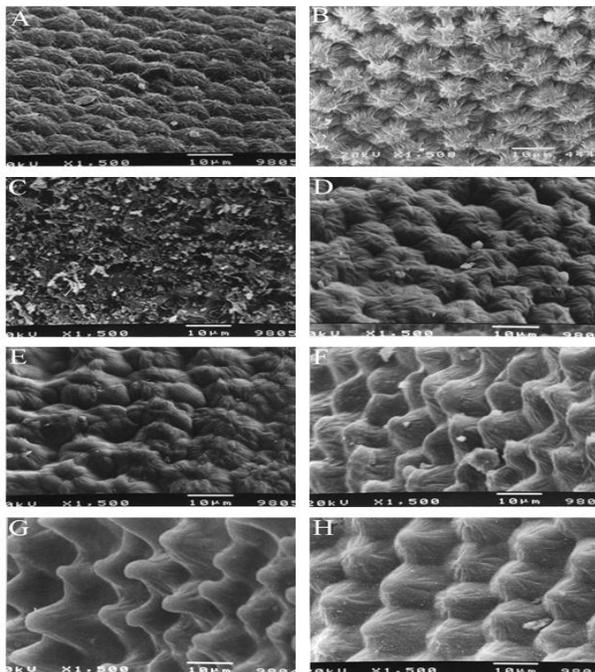


Fig. 5: Seed sculpture of examined taxa(SEM). A; *L. sphaericus*, B; *L. setifolius*, C; *L. annuus*, D; *L. Gorgoni* var. *pilosus*, E; *L. cicera*, F; *L. hirsutus*, G; *L. clymenum*, H; *L. ochrus* Bar: 10 µm (x 1500)

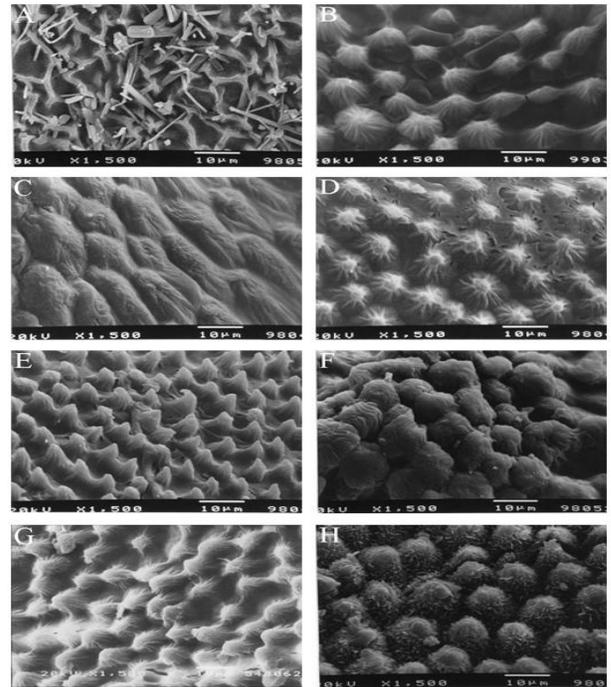
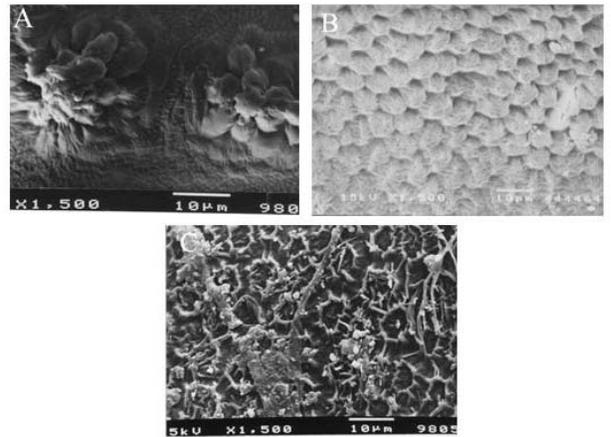


Fig. 6: Seed sculpture of examined taxa (SEM). A *L. nissolia* (tuberculate, from Kilyos), B; *L. nissolia*, (smooth, from Edirne), C: *L. aphaca* var. *Affinis*



have different characteristics among each other. No classification has been done due to this wide variety in the morphological characters of the seeds and the testa texture. With the help of studies made in the section level, characters that may directly be used in taxonomy may be determined. In this study characters having the taxonomic values to be used in section level could not be determined since 18 taxa belonging to nine sections were studied.

Previous researchers (Kislev & Hoff, 1985; Chernoff *et al.*, 1992) have stressed that only seed characters cannot be used for distinguishing the taxa however, when used together with general morphological characteristics it might be helpful in the distinguishing of some species. Our results are in accordance with the results of these researchers. This study also supports the result explained by the other researchers that the *Lathyrus* species has a wide variety of seed characteristics.

Acknowledgement: The authors would like to thank to Scientific Research Project, Commission of Marmara University (Project No: 1996 FEN-16) for financial support.

REFERENCES

- Abou-El-Enain, M.M., M.H.A. Lofti and A.A. Shehata, 2007. Seed surface characters and their systematic significance in the genus *Lathyrus* (Leguminosae, Papilionaceae, Viciae). *Feddes Rep.*, 118: 269–285
- Al-Ghamdi, F.A. and R.M. Al-Zahrani, 2010. Seed morphology of some species of *Tephrosia* Pers. (Fabaceae) from Saudi Arabia. *Feddes Rep.*, 121: 59–65
- Brisson, J.D. and R.L. Peterson, 1976. A critical review of the use of scanning electron microscopy in the study of the seed coat. *Proceedings of the Workshop on Plant Science Application of the SEM*, part VII, pp: 477–496. IIT Research Institute, Chicago
- Butler, E.A., 1988. The SEM and seed identification, with particular reference to the *Viciae*. In: Olsen, S.L. (ed.), *Scanning Electron Microscopy in Archeology*. BAR Int. Ser., 452: 215–224
- Chernoff, M., U. Plitmann and M.E. Kislev, 1992. Seed Characters and Testa Texture in Species of *Viciae*: Their Taxonomic Significance, *Israel J. Bot.*, 41: 167–186
- Davis, P.H. 1970. *Lathyrus* L. In Davis, P.H. (ed.), “*Flora of Turkey and the East Aegean Islands*”, Vol. 3, pp: 328–369. Edinburg
- Davis, P.H., 1988. “*Flora of Turkey and the East Aegean Islands*”, Vol: 10. University Press, Edinburg
- Gunes, F. and N. Özhatay, 2000. *Lathyrus*. In: Güner, A., N. Özhatay, T. Ekim and K.H.C. Baser (eds.), *Flora of Turkey and East Aegean Islands*, Vol. 11, pp: 92–94. Edinburg University Press
- Gunn, C.R., 1970. A key and diagrams for the seeds of one hundred species of *Vicia* (Leguminosae). *15 th International Seed Testing Congress*, pp: 1–18. New Zealand
- Gunn, C.R., 1971. *Seeds of Native and Naturalised Vetches of North America*. USDA Agricultural Handbook no. 92. USDA, Beltsville, Maryland
- Gunn, C.R., 1982. Seed topography in the *Fabaceae*. *Seed Sci. Technol.*, 9: 737–757
- Heywood, V.H., 1978. *Flowering Plants of the World*. Oxford University Press, Oxford
- Kislev, M.E. and M. Hopf, 1985. Food remains from Tel Qasile with special reference to *Lathyrus sativus/cicera*. In: Mazar, A. (ed.), *Excavations at Tel Qasile*, pp: 140–147. Qedem 20 (Appendix), Jerusalem
- Kupicha, F.K., 1983. The infrageneric structure of *Lathyrus*. Notes from the Royal Botanic. *Garden Edinburg*, 41: 209–244
- Lestern, N.R. and C.R. Gunn, 1981. *Testa Characters in the Tribe Viciae, with Notes about Tribes Abreae, Cicereae and Trifolieae (Fabaceae)*. USDA Tech. Bull. No. 1667, USDA with Iowa State University
- Perrino, P., M. Yarwood, P. Hanelt and G.B. Polignano, 1984. Variation of seed characters in selected *Vicia* species. *Kulturpflanze*, 32: 103–122
- Seen, H.A., 1938. Experimental data for the revision of the genus *Lathyrus*. *American J. Bot.*, 25: 67–78
- Tutin, T.G., V.H. Heywood, N.A. Burges and D.H. Valentine, 1968. *Flora Europaea*, Vol 2. Cambridge University Press, Cambridge
- Vural, C., M. Ekici, H. Akan and Z. Aytaç, 2008. Seed morphology and its systematic implications for genus *Astragalus* L. sections *Onobrychoidei* DC., *Uliginosi* Gary and *Ornithopodium* Bunge (Fabaceae). *Plant Syst. Evol.*, 274: 255–263

(Received 15 April 2011; Accepted 13 September 2011)