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Full Length Research Paper

Seed morphology and their systematic importance of *Lathyrus* taxa belonging to *Platystylis* (=*Lathyrostylis*) section (Fabaceae) from Turkey

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In this study, the seed morphologies and testa structures of 16 taxa belonging to the *Platystylis* section of the *Lathyrus* (Fabaceae) genus were analyzed. These taxa were the following; *L. pallescens* (Bieb.) Koch*, L. brachypterus* Cel. *L. haussknechtii* Širj. *L. karsianus* P.H. Davis, *L. satdaghensis* P.H. Davis, *L. nivalis* Hand.-Mazz, *L. atropatanus* (Grossh.) Širj., *L. armenus* (Boiss. & Huet) Širj., *L. cyaneus* (Steven) Koch var. *cyaneus*, *L. digitatus* (Bieb.) Fiori, *L. tukhtensis* Czecz., *L. variabilis* (Boiss. & Kotschy) Maly, *L. spathulatus* Cel., *L. elongatus* (Bornm.) Širj., *L. cilicicus* Hayek & Siehe, *L. boissieri* Širj. The analyzed morphological properties were seed size and shape, color, surface shape, hilum length and width. The general shapes of the seeds were determined as prolate, subprolate and spheroidal. The surface shape was smooth and slightly tuberculate. The largest seeds were observed in *L. satdaghensis* 3.39 (5.96) 7.90 × 3.08 (3.88) 5.00 mm, and the smallest seeds in *L. elongatus* 2.24 (3.45) 5.05 × 2.11 (2.74) 3.73 mm. Also the testa structures of the seeds were analyzed by using a scanning electron microscope (SEM). The stereo microscope and SEM pictures of the taxa were shown in the text.

Key words: *Lathyrus*, *Platystylis*, seed morphology, Turkey.

INTRODUCTION

The *Lathyrus* genus belongs to the Vicieae (Adans.) DC. tribe of the Fabaceae family. This genus is represented by 13 sections and 150 species in the world; 66 species belong to 10 sections in Turkey (Davis, 1970; Heywood, 1978; Kupicha, 1983, 1988; Gunes and Ozhatay, 2000). The endurance of the *Lathyrus* genus against drought (e.g., *L. sativus*, *L. ochrus*) is well known, and the economic value of this is high. *L. sylvestris* is utilized to prevent erosion in the disrupted and burned-down fields of America (Whyte et al., 1953; Yamamoto and Fujıwara, 1984). The roots of *L. tuberosus* are consumed as food in the East Anatolian region of Turkey. *L. ochrus* and *L. sativus* are used for agricultural processes (Gunes, 2006). Approximately 33 species are used for ornamental purposes (Campbell, 1997). The *Platystylis* (*Lathyrostylis*) (Griseb.) Bässler section contains 21 perennial species throughout the middle and southern Europe, southwest Asia and northwest Africa (Tosheva and Tonkov, 2007). Turkey is the most important centre of distribution of this section. The species in this group have very well-framed characteristics. The leaves are pinnate, subdigitate, and digitate, the leaflets are linear lanceolate with a regular and parallel venation, and there are a several flowered inflorescences with a spatulate and linear style. The colour of the flowers is white with tones of purple. Most of the specimens are distinct in their characteristics. This section in Turkey contains 18 taxa in total which 11 taxa are endemic for Turkey (*L. brachypterus*, *L. haussknechtii*, *L. karsianus*, *L. satdaghensis*, *L. nivalis*, *L. armenus*, *L. cyaneus* var. *pinnatus*, *L. tukhtensis*, *L. elongatus*, *L. cilicicus*, *L. bitlisicus*). The endemism rate of this section is 61% and its genetic centre on earth is found in Turkey (Davis, 1970, 1988).

Many of the seed identifications have recently been based upon morphological characteristics including seed size, shape, color, surface shape, hilum length (Gunn, 1970, 1971, 1982; Bassler, 1980; Perrino et al., 1984;

Chernoff et al., 1992; Abou-El-Enain et al., 2007; Al-Gramdi and Al-Zahrani, 2010; Morozowska et al., 2010). 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 and Gunn, 1981; Kislev and Hoff, 1985; Chernoff et al., 1992; Abou-El-Enain et al., 2007; Al-Gramdi and Al-Zahrani, 2010, Morozowska et al., 2010).

Lersten and Gunn (1981) have investigated not only the seed coat but also the hilum and lens morphologies of 100 species belonging to the 4 genera in the tribe 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* and 4 taxa of *Pisum*) belonging to the 4 genera in the tribe 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 and Gunn, 1981; Gunn, 1982; Perrino et al., 1984; Kislev and Hoff, 1985; Butler, 1988; Chernoff et al., 1992; Abou-El-Enain et al., 2007; Vural et al., 2008, Morozowska et al., 2010). 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 indicate that the best diversity regarding to seed morphology properties and testa structures in the tribe of *Vicieae* was observed in the genus *Lathyrus*.

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. *L. nissolia* seeds have been obtained from Turkey. It has not been stated if the seed surface is smooth or reticulate, only the papillae properties have been given. The papillae properties are similar to that of the smooth seed surface. The first seed morphological study for Turkish species has carried out by Gunes and Cirpici (2011). By using light and electron microscope they have analyzed the seeds of 18 *Lathyrus* seeds from 9 sections that grown in Turkey and also determined their testa and morphological properties. They have stressed out that the seed properties of taxa found in perennial sections (*Orobus*, *Pratensis*, *Lathyrus*) show more resemblance in comparison to the taxa in annual sections (*Cicercula*, *Orabastrum*, *Clymenum*). They have stated that the seed studies carried out at section level might put forth the characteristics that may be used in the systematic. They have stated that *L. nissolia* seeds obtained from different localities display tuberculate and smooth properties. In their studies, Gunes and Cirpici (2011) have determined the seed properties of *L. digitatus* that belongs to the *Platystylis* section. There is no other seed morphology study regarding taxa in Turkey.

Therefore, the initial goal of this study is to determine the morphological properties and testa structures of seeds belonging to sixteen *Platystylis* taxa. The secondary aim is to use these properties in the identification of species and systematic esage. Along with *L. pallescens, L. atropatanus*, *L. cyaneus* var. *cyaneus*, *L. digitatus*, *L. variabilis*, *L. spatulatus*, *L. boissieri,* the seed properties of *L. brachypterus*, *L. haussknecthii*, *L. karsianus*, *L. satdaghensis*, *L. armenus*, *L. nivalis*, *L. elongatus*, *L. Cilicicus*, which are endemic to Turkey have been determined in this study for the first time.

MATERIALS AND METHODS

Mature seeds of 16 taxa of the section *Platystylis* were collected from their natural habitats of Turkey between 2007 and 2009. *L. cyaneus* var. *pinnatus* and *L. bitlisicus* were not analyzed since it was not possible to collect them from the field. Collected specimens were kept in the Herbarium Departmant of Biology, Faculty of Arts and Sciences, Kafkas University. Morphological properties such as seed size, general shape, seed surface, color, hilum length and width were investigated. The localities of seeds have been given (Table 1). 100 seeds for 5 taxa, 200 seeds for 6 taxa and 300 seeds for 5 taxa were analyzed (Table 2). 100 mature seeds were collected from every locality. Comparisons among localities were carried out for taxa with seeds collected from more than one locality and average values have been given. The general view photographs were taken with Olympus SZXH stereo-microscope at 5× magnification (Figure 1). Morphological features of the seeds on these photos were carried out by using Imagel program. Length/width ratio for both seed and hilum was calculated. For scanning electron microscopy, two to three mature seeds 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. The microphotographs were obtained using LEO 440 SEM (in Erciyes University) at a magnification of ×20 to 30, ×1500 (Figures 2 to 6). Therefore regions which were distant from the hilum were selected for SEM observations. The morphological properties of all taxa seeds were shown in Table 2 and testa

Table 1. Examined specimens, distribution in the world, locality and herbarium numbers.

Taxa	Distribution in the world	Locality and herbarium numbers
L. pallescens	N. Balkans, Hungary, Romania, C. & S. Russia, Crimea, Transcaucasia, Widespread on the Kars highlands in Turkey	**A9 Kars:** Kars-Susuz road, 8.km, uncultivated fields, 1843 m, 11.08.2004, *F.Güneş* 42. **B9 Ağrı:** Ağrı, Tazeköy village, the slopes across the bridge step, 1654 m, 07.07.2009, *F.Güneş* 2441.
L. brachypterus	C. Anatolia	**B5 Kayseri:** Mount Erciyes, 32 km to Develi, roadsides 1704 m, 26.07.2008, *F.Güneş* 1994. **Yozgat:** Çamlık National Park, 1515 m, *F.Güneş* 2491.**C4 Karaman:** Ayrancı, Çat village surrounding, field-sides, 1681 m, 09.07.2008, *F.Güneş* 1960.
L. haussknechtii	E. Anatolia	**B7 Tunceli:** Pülümür, 1640 m, 10.07.2009, *F.Güneş* 2457. **B9 Van:** Muradiye-Gündüzlü villade road, 13. km, right slopes, 2769 m, 13.07.2008, *F.Güneş* 1978. **Ağrı:** Hamur-Tutak road 2. km, 1642 m, 05.07.2008, *F.Güneş* 1450.
L. karsianus	N. E. Anatolia	**A8 Erzurum:** Pasinler-Demirdöven dam, 4 km. after village Tımar, natural *Pinus sylvestris* and *Populus trimula* down the forested and open areas, 1945 m, 22.07.2008, *F.Güneş* 1988. **A9 Kars:** Sarıkamış–Isnos meadows, sloppy fields, 2200 m, 07.08.2007, *F.Güneş* 1387.
L. satdaghensis	S. E. Anatolia	**C10 Hakkari:** Yüksekova-Dağlıca road, 14-25 km., road sides and meadows, 1872 m, 13.07.2008, *F.Güneş* 1977.
L. nivalis	Anti-Toros and E. Anatolia	**B7 Tunceli:** Ovacık, above Kırkmerdivenler, right slopes, 2285 m, 14.08.2009, *F.Güneş* 2580.
L. atropatanus	E. Anatolia and Nahcivan	**B9 Van:** Van–Hakkari road, Güzeldere passageway, behind the military care building, 2370 m, 13.07.2008, *F.Güneş* 1976.
L. armenus	C. and E. Anatolia	**B6 Sivas:** Cumhuriyet University Campus gate, to the right-fields and road side, 1247 m, 18.07.2009, *F. Güneş* 2492. **B7 Erzincan:** Erzincan-Kelkit road, Ahmediye passageway, 1900 m, 17.08.2008, *F.Güneş* 2000. **B9 Ağrı:** Tutak-Patnos road, 22 km to Patnos, inner parts of the fields and the sides, 1670 m, 22.07.2009, *F.Güneş* 2499.
L. cyaneus var. *cyaneus*	Caucasia	**A9 Ardahan:** Ardahan-Şavşat road, Yalnızçam passageway, slopes, 2177 m, 09.10,2009, *F.Güneş* 2631. **Kars:** Küçükçatma village, slopes, 2064 m, 20.08.2009, *F.Güneş* 2613.
L. digitatus	W. Italy, Greece, Crimea, Cyprus, Turkey	**A1(E) Kırklareli:** Poyralı-Demirköy road 2. km, *Quercus* forest, 387 m, 13.07.2009, *F.Güneş* 2497. **B1 Balıkesir:** Savaştepe, Soğucak village, forest side, 475 m. 15.06.2009, *F.Güneş* 2370. **B5 Yozgat :** Çamlık National Park, 1515 m, 18.07.2009, *F.Güneş* 2490. **C4 Antalya:** Dumlugöze, 1277 m, 10.06.2009, *F.Güneş* 2311.
L. tukhtensis	N. Anatolia	**A6 Amasya:** Borabay, down the forest, around lake, 1067 m, 16.07.2009, *F.Güneş* 2478. **A7 Gümüşhane:** Vavuk Mount, Güvercinlik village, forest side, 1865 m, 26.07.2007, *F.Güneş* 1308.
L. variabilis	Lebanon, Anti-Toros, S. Anatolia (Amanus)	**C6 Kahramanmaraş:** Mount Ahir, to the side of the delivery, slopes, 1367 m, 03.06.2008, *F.Güneş* 1820. Başkonuşlar National Park, 1295 m, 08.06.2009, *F.Güneş* 2273.
L. spatulatus	W. Syria, S. Anatolia (Amanus)	**C6 Hatay:** Dörtyol, Çökek plateau, 650 m, 07.07.2008, *F.Güneş* 1954. **Osmaniye:** Olukbaşı plateau, forest and road side, *Pinus brutia,* 1104 m, 07.07.2008, *F.Güneş* 1957.
L. elongatus	S. Anatolia	**C5 Adana:** Adana-Pozantı road, 45 km, highway side, 602 m 04.06.2008, *F.Güneş* 1825. **Mersin:** Pozantı–Mersin road (old) Gülek village, the back of Taşaltı, open forest, 1227 m, 04.06.2008, *F.Güneş* 1826.

Table 1. Contd.

L. cilicicus	S. Anatolia	**C4 Karaman:** Ermenek-Mut road, 10 km. to Ermenek, pine forest sides and openland, 1396 m, 08.07.2008, *F.Güneş* 1959.
L. boissieri	W. Iran, N. Iraq, E and SE Anatolia	**C7 Urfa:** Karacadağ, 1100 m, 06.07.2008, *F.Güneş* 1953. **B6 Elazığ:** Harput–Eğin road, Inceler village parting way, road and garden side, 980 m, 25.07.2008, *F.Güneş* 1993. **B9 Ağrı:** Tazeköy gate, wheat fields, 1654 m, 07.07.2009, *F.Güneş* 2438.

structures obtained from SEM were shown in Table 3. The terminology of seed characters in this work was based on the descriptions used by Chernoff et al. (1992) and Punt et al., (1994).

RESULTS

The morphological properties and seed coat pattern of taxa were given in Tables 2 and 3. The largest seeds were observed in the taxa analyzed in *L. satdaghensis* 3.39 (5.96) 7.90 × 3.08 (3.88) 5.00 mm and the smallest seeds in *L. elongatus* 2.24 (3.45) 5.05 × 2.11 (2.74) 3.73 mm. The general shapes of the seeds were determined as prolate, subprolate, and spheroidal. Seed colours had brown tones and are speckled but seeds of *L. armenus* were black, seeds of *L. boissieri* were dark brown and they were not speckled. The seeds of *L. pallescens*, *L. nivalis* and *L. tukhtensis* species were green in color (Figure 1).

The surface shape was smooth (*L. brachypterus*, *L. haussknechtii*, *L. satdaghensis*, *L. nivalis*, *L. atropatanus*, *L. armenus*, *L. cyaneus* var. *cyaneus*, *L. digitatus* and *L. boissieri*) and slightly tuberculate (*L. pallescens*, *L. karsianus*, *L. tukhtensis*, *L. variabilis*, *L. spatulatus* and *L. cilicicus*). The longest hilum was measured in *L. cyaneus* var. *cyaneus*, as 1.51 (1.96) 2.96 mm, and the smallest in *L. digitatus* 0.68 (0.98) 1.27 mm. The width hilum belonged to *L. nivalis* 0.34 (0.61) 0.86 mm and the narrow hilum *L. atropatanus* 0.30 (0.34) 0.42 mm.

The papillae that forms the testa structure was large and conical for the tubercules with surface shape of tuberculate and was generally small, low and obtuse among tubercles (*L. pallescens*, *L. karsianus*, *L. tukhtensis*, *L. variabilis*, *L. spatulatus* and *L. cilicicus*). For seeds with smooth surface shapes the papillae had almost the same size and was short and sinuate (*L. brachypterus*, *L. haussknechtii*, *L. satdaghensis*, *L. nivalis*, *L. atropatanus*, *L. armenus*, *L. cyaneus* var. *cyaneus*, *L. digitatus* and *L. boissieri*) Waxy layer was accumulated on top of the papillae for *L. karsianus*, *L. tukhtensis L. cilicicus* and *L. satdaghensis* taxa (Figures 2 to 4). Sometimes the waxy layer in *L. tukhtensis* and *L. spatulatus* species was composed of threads (Figure 6). In *L. variabilis* waxy layer was composed of rods (Figure 2). In *L. digitatus* and *L. spatulatus* the papillae were coated with a dust like waxy layer (Figures 3 and 4). Whereas seeds from different localities generally did not differentiate much in terms of morphological properties and testa structures, *L. cyaneus* var. *cyaneus* stands out with the differences it displays. Seed surface and waxy layer variety observed in some species were given in Figure 6. Seed photographs taken with a stereo-microscope and an electron microscope were included in the study (Figures 1 to 6). Seeds of the analysed taxa were divided into groups according to their seed shape, surface and papillae shape.

According to seed shape

1. Prolate: *L. karsianus*, *L. satdaghensis*, *L. nivalis*, *L. atropatanus*, *L. cyaneus* var. *cyaneus*, *L. variabilis*, *L. boissieri*;
2. Subprolate: *L. pallescens*, *L. brachypterus*, *L. haussknecthii*, *L. armenus*, *L. digitatus*, *L. tukhtensis*, *L. spatulatus*, *L. elongatus*;
3. Spheroidal: *L. cilicicus.*

According to surface shape

1. Tuberculate: *L. pallescens*, *L. karsianus*, *L. tukhtensis*, *L. spatulatus*, *L.* variabilis, *L. cilicicus;*
2. Smooth: *L. brachypterus*, *L. haussknecthii*, *L. satdaghensis*, *L. nivalis*, *L. atropatanus*, *L. armenus*, *L. cyaneus* var. *cyaneus*, *L. digitatus*, *L. elongatus*, *L. boissieri*.

According to papillae shape

1. Papillaee big in tubercules, small and low among tubercules: *L. pallescens*, *L. karsianus*, *L. tukhtensis*, *L. variabilis*, *L. spatulatus*, *L. cilicicus*;
2. Papillae generally same size ribbed-ruminate and sinuate: *L. satdaghensis*, *L. brachypterus*, *L. haussknecthii*, *L. nivalis*, *L. atropatanus*, *L. armenus*, *L. cyaneus* var. *cyaneus*, *L. digitatus*, *L. elongatus*, *L.*

DISCUSSION

The taxa in this section can be divided into two groups

Table 2. Morphological characters of examined taxa (with stereomicroscope).

Taxa	*Diamether (min.(mean)max.) (lengt - width) (mm)*	*Rate of lenght/width (P/E)*	*Colour*	*Shape*	*Surface shape*	*Hilum lenght (min.(mean)max.) (mm)*	*Hilum width (min.(ean)max.) (mm)*	Examined seed number
L. pallescens	3.08 (4.22) 5.41 × 2.74 (3.31) 3.96	1.28	Brown tones , green and black	Subprolate	Slightly tuberculate,	0.86 (1.20) 1.52	0.39 (0.54) 0.69	200
L. brachypterus	3.40 (4.30) 5.13 × 2.88 (3.40) 3.96	1.26	Brown tones and speckled	Subprolate	Smooth	0.35 (1.35) 1.72	0.28 (0.42) 0.56	300
L. haussknechtii	3.36 (4.45) 5.50 × 2.73 (3.39) 3.92	1.31	Brown tones and speckled	subprolate	Smooth	1.08 (1.40) 1.65	0.17 (0.32) 0.47	300
L. karsianus	3.46 (4.56) 5.75 × 2.90 (3.35) 4.46	1.36	Brown tones and speckled	Prolate	Slightly tuberculate	1.63 (1.98) 2.58	0.27 (0.40) 0.55	200
L. satdaghensis	3.39 (5.96) 7.90 × 3.08 (3.88) 5.00	1.54	Brown tones and speckled	Prolate	Smooth	1.29 (1.70) 2.24	0.20 (0.33) 0.47	100
L. nivalis	4.24 (5.94) 6.96 × 2.53 (3.92) 5.09	1.52	Brown tones, green and speckled	Prolate	Smooth	1.44 (1.96) 2.56	0.34 (0.61) 0.86	100
L. atropatanus	4.05 (5.16) 6.62 × 2.21 (3.62) 4.41	1.43	Brown tones and speckled	Prolate	Smooth	1.28 (1.59) 2.07	0.30 (0.34) 0.42	100
L. armenus	2.13 (3.85) 5.14 × 2.29 (3.11) 3.90	1.24	Black	Subprolate	Smooth	1.08 (1.48) 1.95	0.14 (0.36) 0.68	300
L. cyaneus var. *cyaneus*	2.31 (3.54) 5.19 × 2.09 (2.52) 3.06	1.41	Brown tones and speckled	Prolate	Smooth	1.51 (1.96) 2.96	0.32 (0.40) 0.64	200
L. digitatus	2.08 (3.41) 5.26 × 2.18 (2.90) 3.77	1.18	Brown tones and speckled	Subprolate	Smooth	0.68 (0.98) 1.27	0.20 (0.45) 0.45	300
L. tukhtensis	2.69 (3.70) 5.31 × 2.21 (3.10) 3.74	1.22	Brown tones, green and speckled	Subprolate	Slightly tuberculate	0.80 (1.12) 1.64	0.20 (0.30) 0.43	200
L. variabilis	2.65 (4.35) 6.34 × 2.57 (3.17) 3.95	1.37	Brown tones and speckled	Prolate	Slightly tuberculate	0.90 (1.31) 1.90	0.25 (0.35) 0.56	100
L. spatulatus	2.72 (3.92) 5.67 × 2.45 (3.05) 3.69	1.29	Brown tones and speckled	Subprolate	Very slightly tuberculate	0.85 (1.19) 1.55	0.22 (0.38) 0.48	200
L. elongatus	2.24 (3.45) 5.05 × 2.11 (2.74) 3.73	1.26	Brown tones and speckled	Subprolate	Smooth	0.94 (1.37) 2.04	0.24 (0.32) 0.44	200
L. cilicicus	2.53 (3.64) 4.96 × 2.56 (3.24) 4.19	1.13	Brown tones and speckled	Spheroidal	Slightly tuberculate	0.72 (1.13) 1.55	0.24 (0. 35) 0.51	100
L. boissieri	3.41 (5.60) 7.62 × 3.08 (4.17) 5.68	1.34	Dark brown	Prolate	Smooth	1.43 (2.11) 2.81	0.32 (0.47) 0.65	300

based on their style shape: Those with style shapes of linear and spatulate. According to the classification regarding seed shape, it is observed that taxa with spatulate style shape are found in three groups whereas those with linear style shape are found in two groups. When it is considered that the leaves are pinnat or digitat, another disorder is observed among the groups. Taxa *L. nivalis* and *L. atropatanus*, *L. brachypterus* and *L. haussknecthii*, *L. digitatus*, *L. tukhtensis* and *L. spatulatus* which are morphologically very similar (flower color, leave and style shape) are in different groups. The classification made according to the seed shape does not give specific clues supporting the morphological characteristic of the taxa and it is seen that it cannot be used as a direct characteristic to distinguish between the taxa of this section. Grouping in terms of surface shape supports classification based on morphology more than grouping in terms of seed shape. The style shapes of taxa in the 1st group are spatulate with the exception of *L. karsianus* whereas the style shapes of taxa in the 2nd group are linear with the exception of *L. elongatus*. *L. karsianus* and *L. elongatus* have stayed outside their own groups. If these two species are ignored, we may state that the style shape of taxa with tuberculate seeds is spatulate whereas the style shape of taxa with smooth seeds is linear.

When the testa structures of the analyzed taxa are compared in general, it is the same with the surface shape classification made above. However the papillae of *L. pallescens* in the 1st group are not conical like those in the other groups but are obtuse (Figure 2). The papillae of *L. satdaghensis* in the 2nd group differentiate with its group due to the fact that its middle section is more advanced. Abou-El-Enain et al. (2007) have

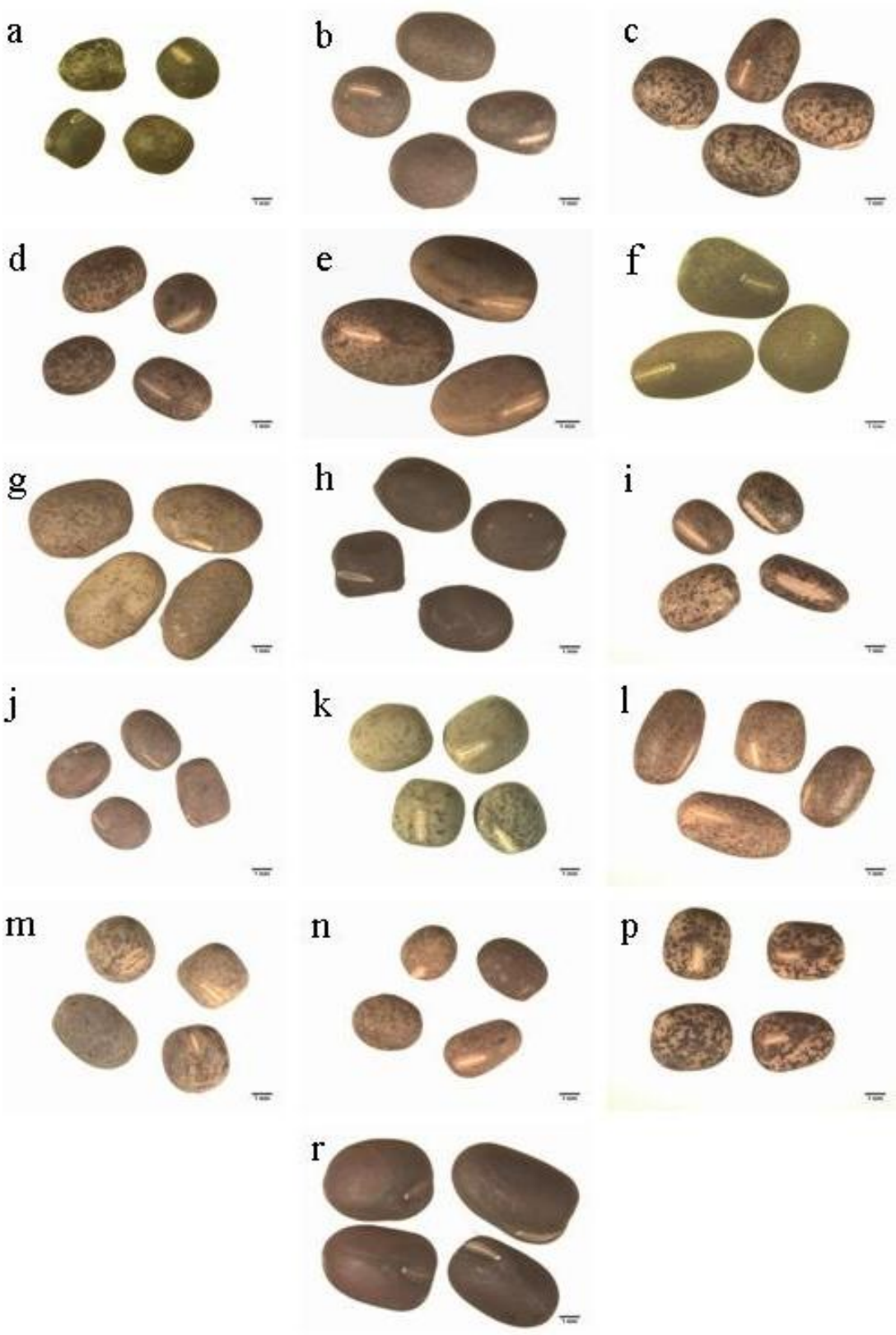

Figure 1. General view of seeds in light microscope. **a.** *L. pallescens*, **b.** *L. brachypterus*, **c.** *L. haussknechtii*, **d.** *L. karsianus*, **e.** *L. satdaghensis*, **f.** *L. nivalis*, **g.** *L. atropatanus*, **h.** *L. armenus*, **i.** *L. cyaneus* var. *cyaneus*, **j.** *L. digitatus*, **k.** *L. tukhtensis*, **l.** *L. variabilis*, **m.** *L. spathulatus*, **n.** *L. elongatus*, **p.** *L. cilicicus*, **r.** *L. boissieri.*

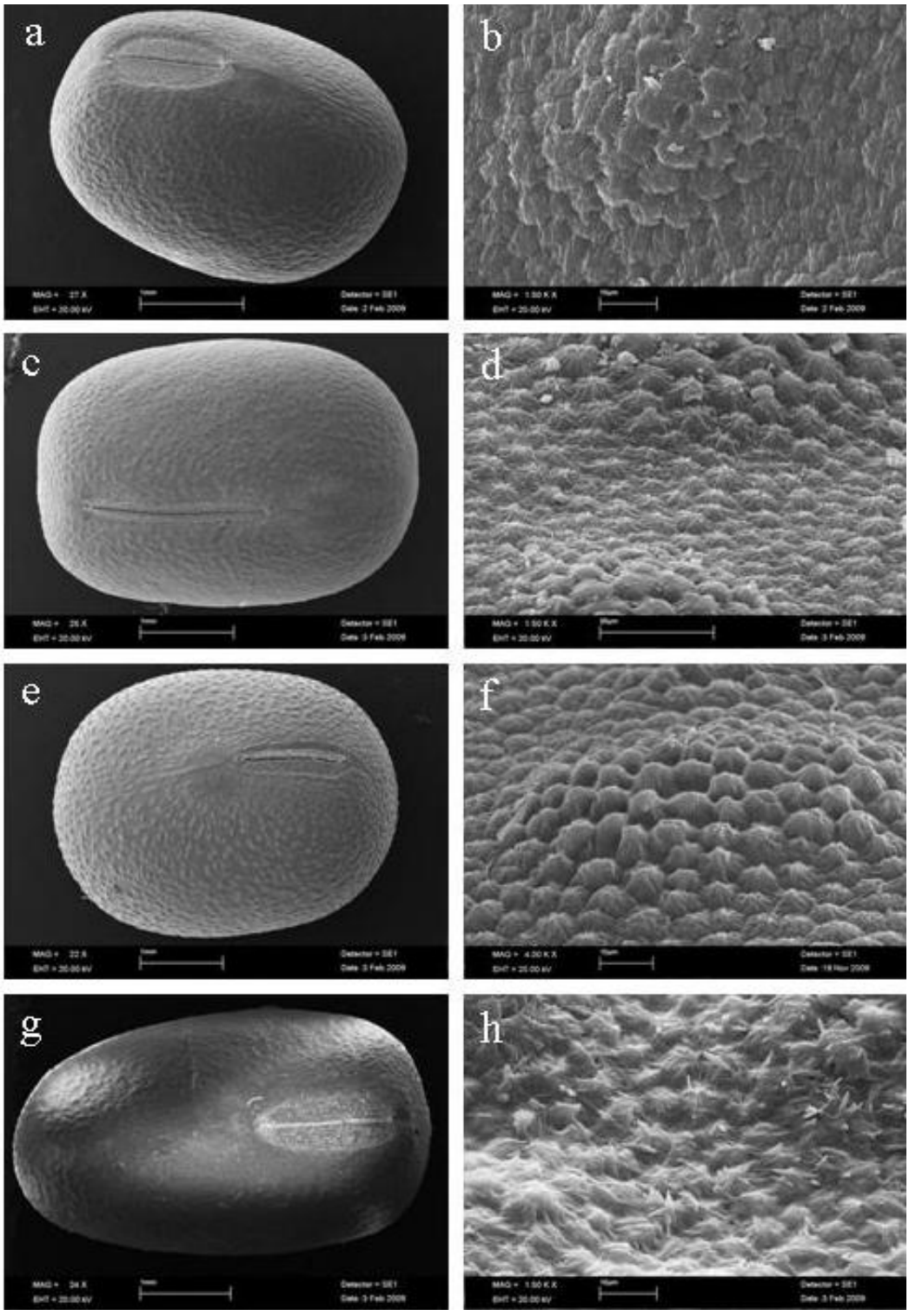

Figure 2. General shape and seed sculpture of examined taxa (SEM). **a-b** *L. pallescens*, **c-d.** *L. karsianus*, **e-f.** *L. tukhtensis*, **g-h.** *L. variabilis.*

analyzed the seed morphological properties of *L. cirrhosus* and *L. digitatus* in the *Platystylis* section. Whereas the seed size and surface shape are in accordance with our results, the hilum properties are different. They have determined the average length and width of hilum as 0.4 × 0.2 mm, while our results are 0.98

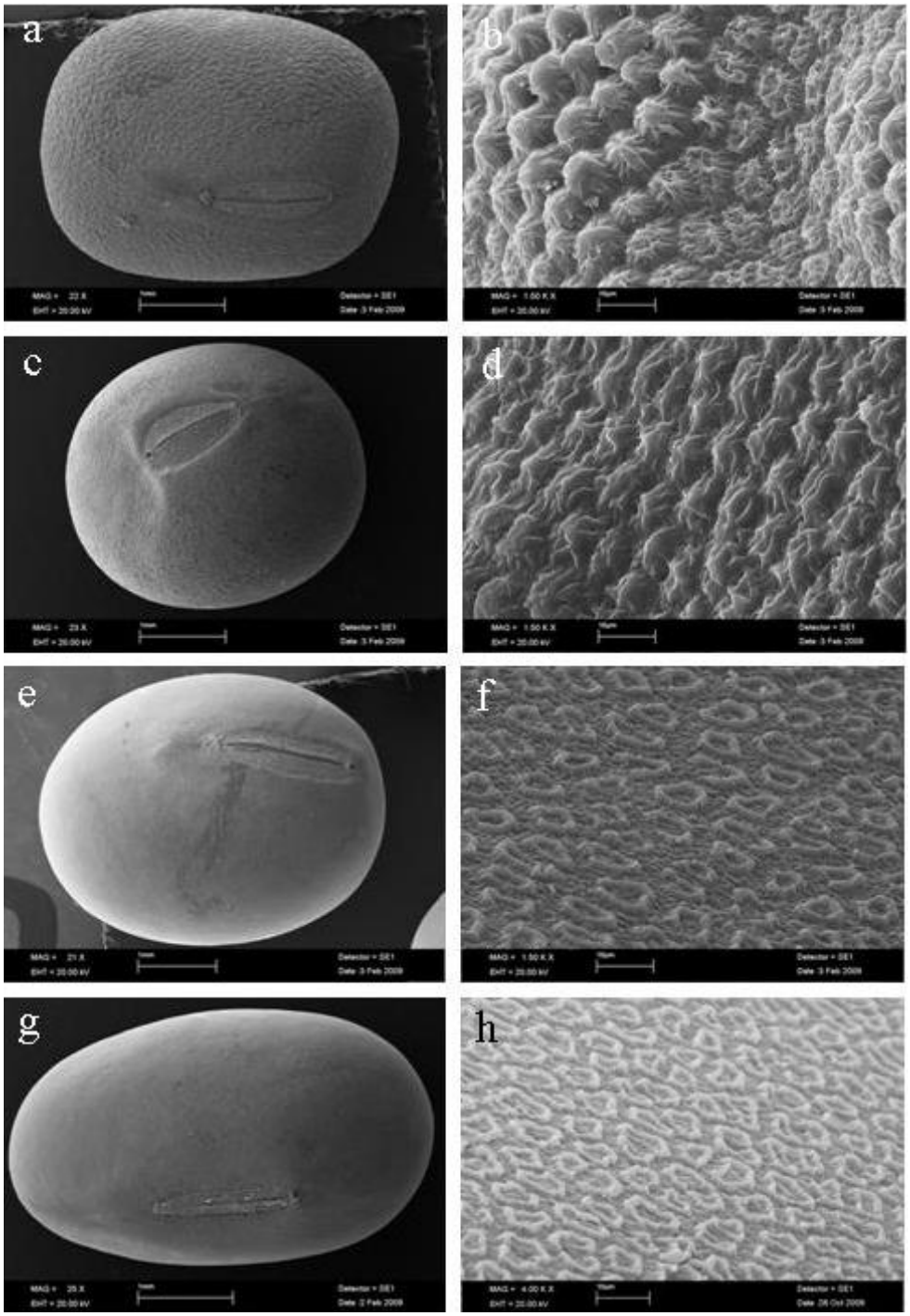

Figure 3. General shape and seed sculpture of examined taxa (SEM). **a-b.** *L. cilicicus,* **c-d.** *L. spathulatus* **e-f.** *L. brachypterus*, **g-h.** *L. haussknechtii.*

× 0.45 mm. Gunes and Cirpici (2011) have also put forth the seed morphological properties of *L. digitatus* which is widespread in Turkey. The determined property such as seed size, shape, hilum length is in accordance with our results. Since its surface is covered with a waxy layer, they were not able to properly explain the papillae shape. Since this study was a detailed one carried out across Turkey, they had the chance to analyze many samples from different localities. During this study the properties of seeds collected from different localities were compared, it was determined that waxy layer displayed some difference and the papillae structure was put forth in

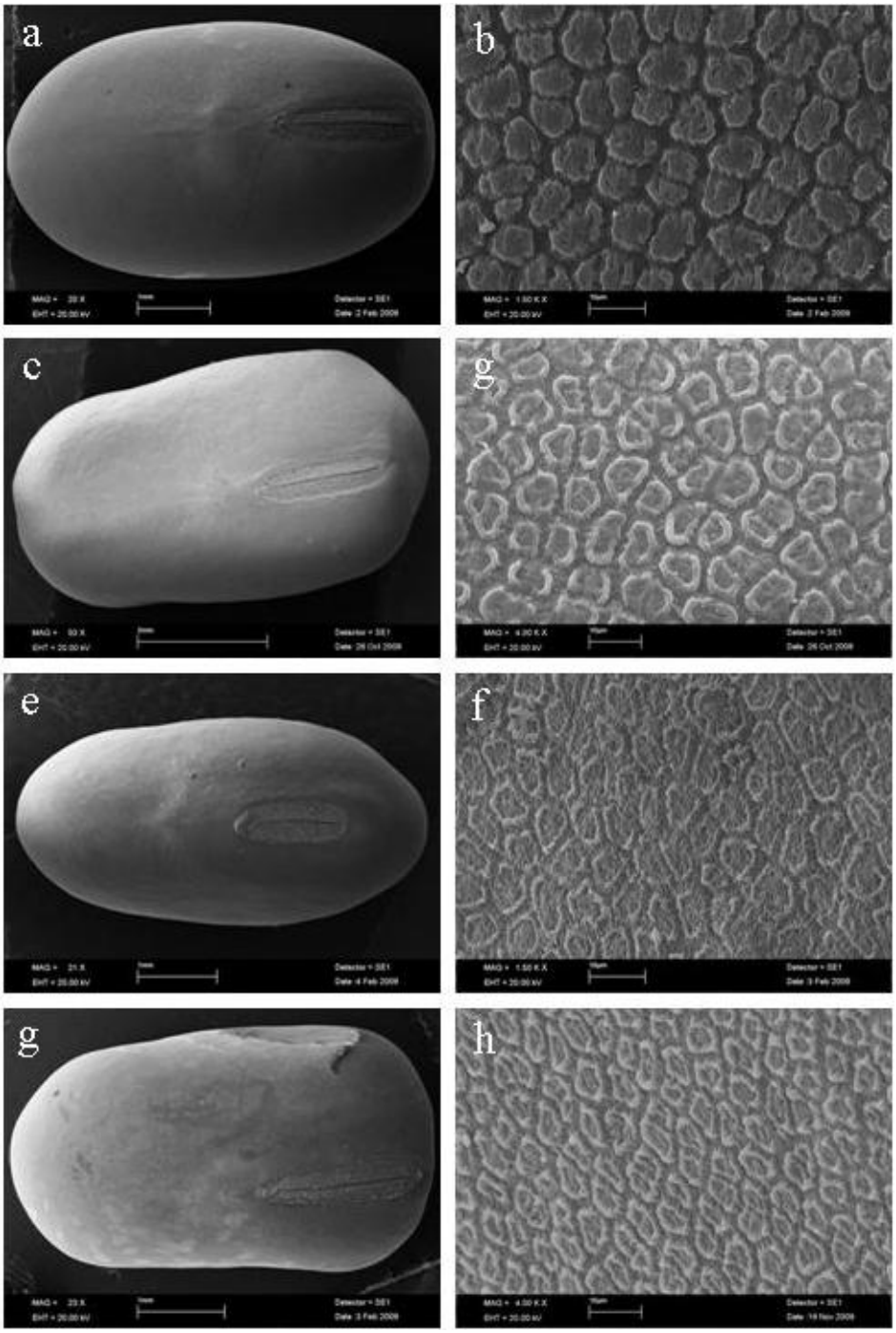

Figure 4. General shape and seed sculpture of examined taxa (SEM). **a-b** *L. satdaghensis,* **c-d.** *L. nivalis*, **e-f.** *L. artopatanus*, **g-h.** *L. armenus.*

detail. Researchers who carried out studies on *Lathyrus* species (Gunn, 1970, 1971; Brisson and Peterson, 1976; Lersten and Gunn, 1981; Gunn, 1982; Perrino et al., 1984; Kislev and Hoff, 1985; Butler, 1988; Chernoff et al., 1992; Abou-El-Ending et al., 2007) have stressed out that seed properties may not be used directly for species differentiation however they are used in the classification of taxa which are harder to differentiate morphologically. Kislev and Hoff (1985) were able to distinguish *L. cicera* and *L. sativus* which are very similar morphologically by using seed properties. Gunes and Cirpici (2011) have stated that the seed properties of taxa belonging to perennial sections show more similarities. This study carried out on taxa belonging to the *Platystylis* section,

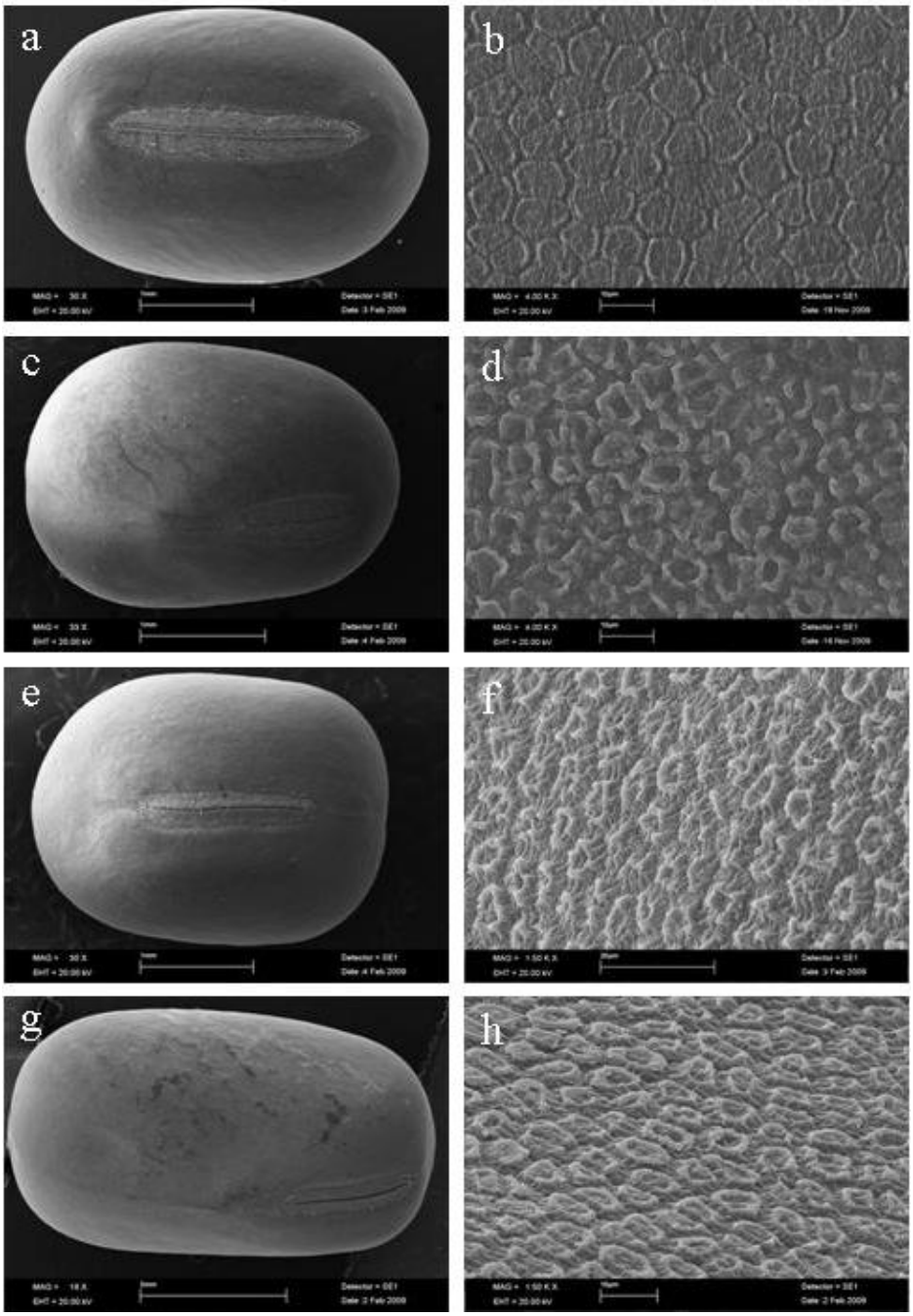

Figure 5. General shape and seed sculpture of examined taxa (SEM). **a-b** *L. cyaneus* var. *cyaneus,* **c-d.** *L. digitatus,* **e-f.** *L. elongatus,* **g-h.** *L. boissieri.*

which grows in Turkey also supports the findings of Gunes and Cirpici (2011).

Conclusıon

Even though the surface shape of the 16 analyzed taxa do not 100% support the style shape used for inner-section classification it supports by 90. If *L. karsianus* and *L. elongatus* species are ignored, we may state that the style shape of taxa with tuberculate seeds is spatulate whereas the style shape of taxa with smooth seeds is linear. It has been determined that seed properties may be used for the differentiation of taxa such as *L. digitatus*, *L. variabilis* and *L. spatulatus*, *L. nivalis* and *L. atropatanus*, *L. cyaneus* var. *cyaneus* and *L. karsianus*,

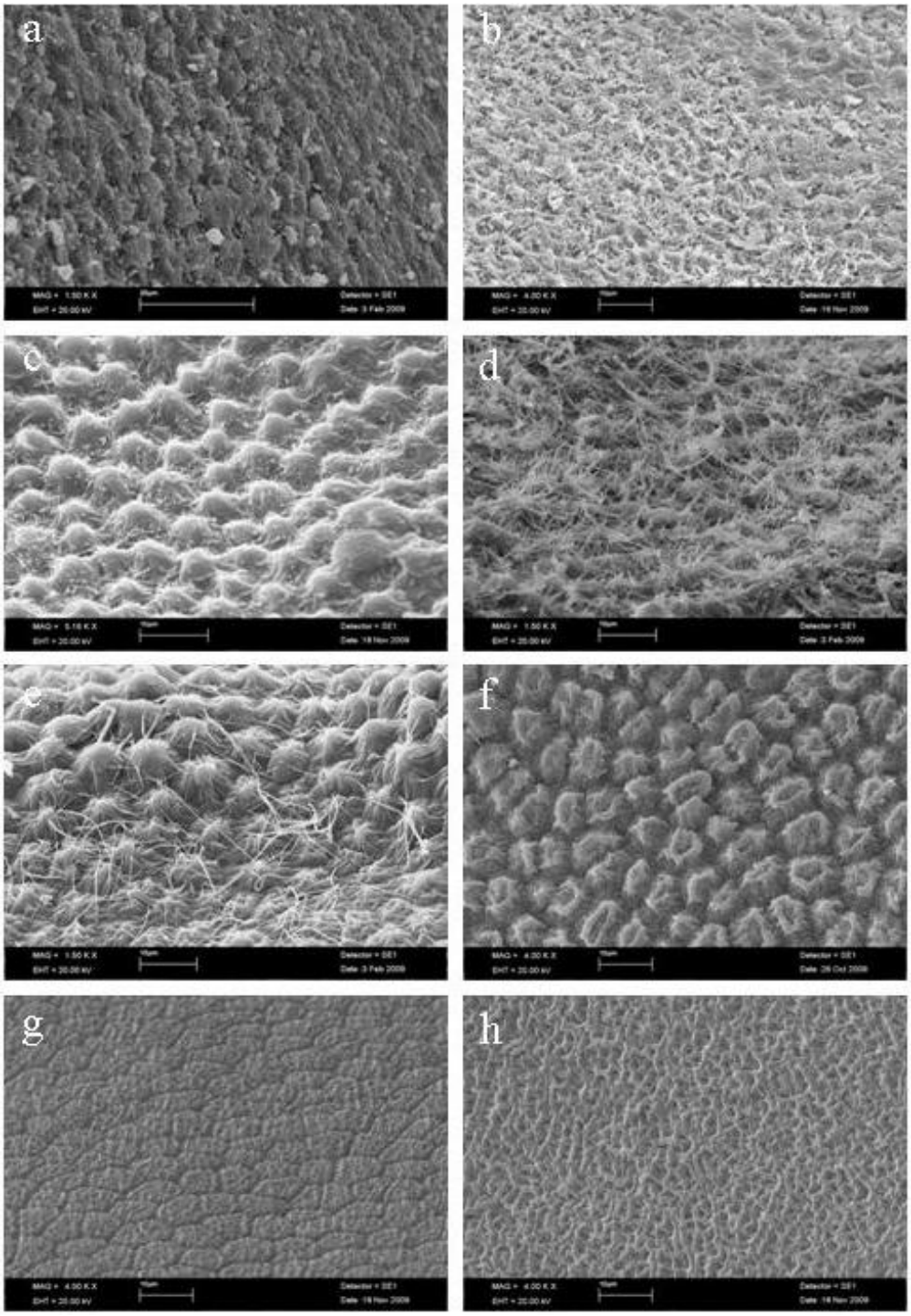

Figure 6. Seed sculpture of examined taxa (SEM). **a-b**. *L. digitatus*, **c-d.** *L. spathulatus*, **e.** *L. tukhtensis*, **f.** *L. boissieri*, **g-h.** *L. cyaneus* var. *cyaneus.*

L. armenus and *L. boissieri* which are morphologically very similar. As conclusion, this study is part of the revision study for the taxa in the *Platystylis* section that grows in Turkey. As a result of analyses, it has been determined that the pollen properties of the taxa support the style shape used in systematic, that chromosome properties may be used in the differentiation of taxa that are difficult to distinguish morphologically (such as *L. spatulatus*, *L. variabilis* and *L. tukhtensis*) and that even though seed properties do not fully support morphological

Table 3. Testa structures of examined taxa (SEM).

Taxa	Papillae	Papillae density	ribbed	waxy
L. pallescens	Tubercles and background papillae, large and big in tubercules, obtuse, varying in size	Density	Irregulary many ribbed	-----
L. brachypterus	Large, broad and low, ruminate, margins sinuate	Density	Irregulary many ribbed	-----
L. haussknechtii	Large, broad and low, ruminate, margins sinuate	Moderate to density	Irregulary many ribbed	-----
L. karsianus	Tubercles and background papillae, large and big in tubercles, conical, varying in size	Density	İrregulary many ribbed	Peaks topped with wax.
L. satdaghensis	Large, broad and low, ruminate, margins sinuate	Density	Irregulary many ribbed	Peaks topped with waxy
L. nivalis	Large, broad and low, ruminate, margins sinuate	Density	Irregulary many ribbed	------
L. atropatanus	Large, broad and low, ruminate, margins sinuate	Density to moderate	Irregulary multi-ribbed	------
L. armenus	Large, broad and low, ruminate, margins sinuate	Density to moderate	Irregulary many ribbed	------
L. cyaneus var. *cyaneus*	Large, broad and low, ruminate, margins sinuate	Density	Irregulary multi-ribbed	------
L. digitatus	large, broad and low, ruminate, margins sinuate	Density	Irregulary many ribbed	Dust like waxy layer or waxy layer on delicate waxy rods
L. tukhtensis	Tubercles and background with papillae, large and big in tubercles, conical, varying in size	Density	Irregulary many ribbed	Some times peaks topped with waxy and waxy layer on delicate waxy threads
L. variabilis	Tubercles and background with papillae, large and big in tubercles, conical, varying in size	density	Irregulary many ribbed	Peaks topped with waxy and waxy layer on delicate waxy rods
L. spatulatus	Silghtly conical, silghtly large and big in tubercles	Density to moderate	Irregulary many ribbed	Dust like waxy layer or waxy layer on delicate waxy threads

Table 3. Contd.

L. elongatus	Large, broad and low, ruminate, margins sinuate	Density	Irregulary multi-ribbed	------
L. cilicicus	Tubercles and background with papillae, large and big in tubercles, conical, varying in size	Density	Irregulary many ribbed	Peaks topped with waxy
L. boissieri	Large, broad and low, ruminate, margins sinuate	Density to moderate	Irregulary many ribbed	------

features, they are widely used in systematic.

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