



**Full Length Article**

## Pollen Morphology of the Genus *Lathyrus* (Fabaceae) Section *Pratensis* in Turkey

FATMA GUNES AND BURHAN AYTUG<sup>1</sup>

Kafkas University, Faculty of Arts and Science, Department of Biology, Kars 36100, Turkey

<sup>1</sup>Corresponding author's e-mail: drgunes@gmail.com

### ABSTRACT

Pollen morphology of five taxa of *Lathyrus* belonging to the section *Pratensis* (*L. pratensis*, *L. layardii*, *L. laxiflorus*, subsp. *laxiflorus*, *L. laxiflorus* subsp. *angustifolius* & *L. czechottianus*) were collected from various fields in the regions of Marmara, Mediterranean, Inner Anatolia, Eastern Anatolia, Western and Eastern Black Sea. Three of these taxa, *L. layardii*, *L. laxiflorus* subsp. *angustifolius* and *L. czechottianus* are endemic to Flora of Turkey. Pollen grains prepared by the method of Wodehouse were subjected to the four diagnostic characteristics: pollen type, shape, apertures and ornamentation. Following the observations, the measured pollens were photographed by a scanning electron microscopes (SEM). The pollen grains were 3-zonocolporate of subprolate and prolate types (P/E=1.2378-1.4491) medium to large in size. Ectoapertures-colpi; long, narrow, with acute ends. Endoapertures-pori; circular to lalongate. The ornamentation was perforate-foveolate (*L. pratensis*, *L. layardii* & *L. laxiflorus* subsp. *angustifolius*) or low-relief reticulate (*L. laxiflorus* subsp. *laxiflorus* & *L. czechottianus*) sculpture. Some photographs belonging to species were also added. During the study, the pollen's characteristics were defined according to Wodehouse method and SEM ornamentation and the taxa were separately identified. The pollen morphology of *L. layardii*, *L. laxiflorus* subsp. *angustifolius* and *L. czechottianus* were also defined for the first time. © 2010 Friends Science Publishers

**Key Words:** *Lathyrus*; Morphology; Pollen; *Pratensis*; Turkey

### INTRODUCTION

The genus *Lathyrus* L. (Fabaceae) comprises around 200 species of annual and perennial plants, which are mainly distributed from northern hemisphere to highlands of tropical Africa, centered in the Mediterranean countries (Davis, 1970; Heywood, 1978; Kupicha, 1983; Davis, 1988). *Lathyrus* consists of ten sections (*Orobis*, *Plathystylis*, *Pratensis*, *Orobastrum*, *Orobon*, *Lathyrus*, *Cicerula*, *Aphaca*, *Nissolia*, *Clymenum*) and includes 64 species in the flora of Turkey. A total of 78 taxa are represented by the level of species, subspecies of which 24 taxa are endemic to Turkey (Davis, 1970 & 1988; Gunes & Ozhatay, 2000). *Pratensis* section of *Lathyrus* are represented by five wild taxa in the flora of Turkey.

Several morphological markers have been used to examine the diversity of *Lathyrus*. The pollen morphology is not affected by environmental conditions; hence it has been used as a reliable diagnostic key in the taxonomical researches (Aytug, 1959). These features are aperture shape, aperture number, aperture location in pollen and ornamentation of exine. Pollen morphologies of *L. sylvestris*, *L. pratensis*, *L. Maritimus*, *L. nissolia* and *L. montanus* (Moore *et al.*, 1991), *L. grandiflorus*, *L. latifolius*, *L. sylvestris*, *L. tuberosus*, *L. alpestris*, *L. aureus*, *L.*

*linifolius*, *L. niger*, *L. palustris*, *L. transilvanicus*, *L. venetus* and *L. vernus* (Tosheva *et al.*, 2004), were previously examined. *Lathyrus emodii*, *L. cicera*, *L. humulis* and *L. pratensis* is also examined by Perveen and Qaiser (1998). Pollen morphological studies dealing with some *Lathyrus* species grown in Turkey were carried out by Aytug (1967) and Aytug *et al.* (1971) and Gunes and Cırpıcı (1998), who described the pollen morphologies of *L. digitatus* and *L. undulatus*, *L. sylvestris* and *L. ochrus*. To the best of our knowledge, pollen morphology of five taxa including *L. pratensis*, *L. layardii*, *L. laxiflorus* subsp. *laxiflorus*, *L. laxiflorus* subsp. *angustifolius* and *L. czechottianus* have not been examined previously in the investigated fields of Turkey. This study provides the first report on the pollen morphologies of these taxa.

### MATERIALS AND METHODS

Collection of the five wild taxa in *Pratensis* section of *Lathyrus* were made in natural habitats between 1998 and 2008. Specimens are kept in the herbarium of the Biology Department, Faculty of Arts and Sciences, Marmara University (MUFE) and Kafkas University (KARS) for future reference.

Pollen grains for LM observations were made using

the method described by Wodehouse (1959). Ten pollen morphological characters were measured by light microscope (LM) at magnification of  $\times 400$ -P (polar diameter), E (equatorial diameter), at  $\times 1000$  for clg (colpus length), clt (colpus width; the measurement of colpus width was made to the regions close to porus), plg (porus length), plt (porus width), exine thickness and intin thickness. Almost 60 measurements of each character were performed and the main value and ranges measured (Table I). The microphotographs were obtained with LEO 440 SEM at magnification of  $\times 2000$ – $\times 5000$  (Fig. 1). The pollen morphological descriptions follow the terminology of Iversen and Troels-Smith (1950), Reitsma (1970), Moore *et al.* (1991) and Punt *et al.* (1994).

## RESULTS

Below are given descriptions of the pollen of *L. pratensis*, *L. layardi*, *L. laxiflorus* subsp. *laxiflorus*, *L. laxiflorus* subsp. *angustifolius* and *L. czechotianus*. Details of ornamentation and measurements for all taxa of section *Pratensis* are given in Table I. The pollen morphologies of five taxa had following characteristics: 3-zonocolporate type of pollen, subprolate and prolate shapes of pollen, tectate type of exine structure and perforate-foveolate and low-relief reticulate type of sculpture (ornamentation). M (arithmetic means),  $\sigma$  (standard deviation) and var. (variations) were shown in the horizontal columns (see Table I). Standard deviations are not given for characteristics having no requirement for multiple measurements.

*L. pratensis* (Table I; Fig. 1) A1(E) Tekirdağ: Muratlı, Kepenekli village, lower part of dam, stream side, 60 m, 19.06.1998, F. Gunes MUFE 5765. A9 Kars: Melik village, in field, 1800 m, 02.07.2004, F. Güneş KARS 27.

Pollen class: 3-zonocolporate.

Pollen group: Subprolate P= 36.8300  $\mu\text{m}$ , E= 29.7540  $\mu\text{m}$ , P/E= 1.2378.

**Apertures: Ectoapertures–colpi.** Long, narrow with acute ends, thick costae along the margins of the colpi, colpus membrane covered by small granules; clg: 25.288  $\mu\text{m}$ , clt: 1.4616  $\mu\text{m}$ . Endoapertures–pori: circular to very slightly lalongate, plg 8.3810  $\mu\text{m}$ , plt 9.0109  $\mu\text{m}$  and plg/plt= 0.9300.

Outlines: Equatorial view–elliptic to rectangular-obtuse-convex; polar view slightly triangular.

Ornamentation: Perforate-foveolate in mesocolpium, perforations slightly distinct. Colpus area and apocolpium psilate.

Intin: c. 1  $\mu\text{m}$  thick in apocolpium.

Exine: c. 1 thick in apocolpium, sexine as thick as the nexine.

*L. layardii* (endemic) (Table I; Fig. 1) A8 Ağrı: Eleşkirt–Horasan road, 5 km to Tahir, stream edges, 2000 m, 15.07.2007, F. Gunes KARS 1028.

Pollen class: 3-zonocolporate.

Pollen group: Subprolate–Prolate, P=38.7202  $\mu\text{m}$ , E= 29.0191  $\mu\text{m}$ , P/E= 1.3343 Apertures: Ectoapertures–colpi: long, nearly reaching the poles, narrow with acute ends, thick costae along the margins of the colpi, colpus membrane covered by small granules; clg: 35.5649  $\mu\text{m}$ , clt: 2.8999  $\mu\text{m}$ , borders of colpi in the pollens were not clear. Endoapertures–pori: lalongate, plg 10.6499  $\mu\text{m}$ , plt 13.3131  $\mu\text{m}$  and plg/plt= 0.7999.

Outlines: Equatorial view–elliptic to slightly rectangular-obtuse-convex; polar view circular.

Ornamentation: Perforate-foveolate in mesocolpium, perforations distinct and irregular. Colpus area and apocolpium are almost psilate.

Intin: c. 1  $\mu\text{m}$  thick in apocolpium.

Exine: c. 1  $\mu\text{m}$  thick in apocolpium, sexine as thick as the nexine.

*L. laxiflorus* subsp. *laxiflorus* (Table I; Fig. 1) A1(E) Tekirdağ: Saray-Kıyıköy road, 6 km to Kıyıköy, forest distinctness, 120 m, 19.06.1998, F. Gunes MUFE 5034. A1(E) Balıkesir: From Balıkesir to Savaştepe 28. km, Soğucak village, forest edges, 550 m, 25.04.1998, F. Güneş MUFE 5665. A9 Artvin: Şavşat, under forest, 910 m, 12.08.2004, F. Güneş KARS 43.

Pollen class: 3-zonocolporate.

Pollen grup: Subprolate, P=39.1790  $\mu\text{m}$ , E=29.5800  $\mu\text{m}$ , P/E=1.3245.

Apertures: Ectoapertures–colpi: short, not reaching the poles, narrow with acute ends, thick costae along the margins of the colpi, colpus membrane covered by small granules; clg: 24.0816  $\mu\text{m}$ , clt: 2.3200  $\mu\text{m}$ , Endoapertures–pori: lalongate, plg 6.7280  $\mu\text{m}$ , plt 9.2119  $\mu\text{m}$  and plg/plt= 0.7303.

Outlines: Equatorial view–elliptic to slightly rectangular-obtuse-convex; polar view circular.

Ornamentation: Perforate-foveolate and low-relief reticulate with finely perforate lumina in mesocolpium, reticules slightly distinct, big and rough. Colpus area, porus and apocolpium are psilate.

Intin: c. 1  $\mu\text{m}$  thick in apocolpium.

Exine: c. 1  $\mu\text{m}$  thick in apocolpium, sexine as thick as the nexine.

*L. laxiflorus* subsp. *angustifolius* (endemic) (Table I; Fig. 1) C6 Hatay: Dörtöyl: Çökek plateau, under forest and forest edges, N 36 49.47.20–E 36 17.0677, 627 m, 28.05.2006, F. Gunes KARS 141. C6 Gaziantep: Fevzipaşa-Hasanbeyli road (old road), 15 km, under forest, N 037 37.380 - E 036 54.800, 920 m, 27.04.2008, F. Güneş KARS 1564.

Pollen class: 3-zonocolporate.

Pollen group: Prolate, P=42.9520  $\mu\text{m}$ , E=29.6400  $\mu\text{m}$ , P/E=1.4491.

Apertures: Ectoapertures–colpi: long, narrow with acute ends, thick costae along the margins of the colpi, colpus membrane covered by small granules; clg: 32.9999  $\mu\text{m}$ , clt: 2.3499  $\mu\text{m}$ , Endoapertures–pori: lalongate, plg 10.5250  $\mu\text{m}$ , plt 13.1895  $\mu\text{m}$  and plg/plt= 0.7979.

Outlines: Equatorial view—elliptic to slightly rectangular-obtuse-convex; polar view circular.

Ornamentation: Perforate-foveolate in mesocolpium, less distinct, thin, irregular. Colpus area, porus and apocolpium are psilate.

Intin: c. 1  $\mu\text{m}$  thick in apocolpium.

Exine: c. 1  $\mu\text{m}$  thick in apocolpium, sexine as thick as the nexine.

*L. czeczottianus* (endemic) (Table I; Fig. 1) A3 Sakarya: Gerede, Aktaş, 18.06.1998, F. Güneş MUFE 5227. A5 Amasya: Amasya-Elma mount, 18,06,2004, F. Güneş KARS 22. A7 Gümüşhane: Vavuk mountain gateway, around forest, 1900 m, 26.07.2007, F. Güneş KARS 1310.

Pollen class: 3-zonocolporate.

Pollen group: Prolate, P= 43.0856  $\mu\text{m}$ , E= 31.2000  $\mu\text{m}$ , P/E= 1.3809.

Apertures: Ectoapertures—colpi: long, narrow with acute ends, thick costae along the margins of the colpi, colpus membrane covered by small granules; clg: 28.3266  $\mu\text{m}$ , clt: 2.6600  $\mu\text{m}$ . borders of colpus were not clear. Endoapertures—pori: slightly lalongate, plg 8.0640  $\mu\text{m}$ , plt 8.5825  $\mu\text{m}$  and plg/plt= 0.9395.

Outlines: Equatorial view—elliptic to slightly rectangular-obtuse-convex; polar view slightly triangular.

Ornamentation: Perforate-foveolate or low-relief reticulate, distinct to less distinct, big and irregular. Colpus area, porus and apocolpium are psilate.

Intin: c. 1  $\mu\text{m}$  thick in apocolpium.

Exine: c. 1  $\mu\text{m}$  thick in apocolpium, sexine as thick as the nexine.

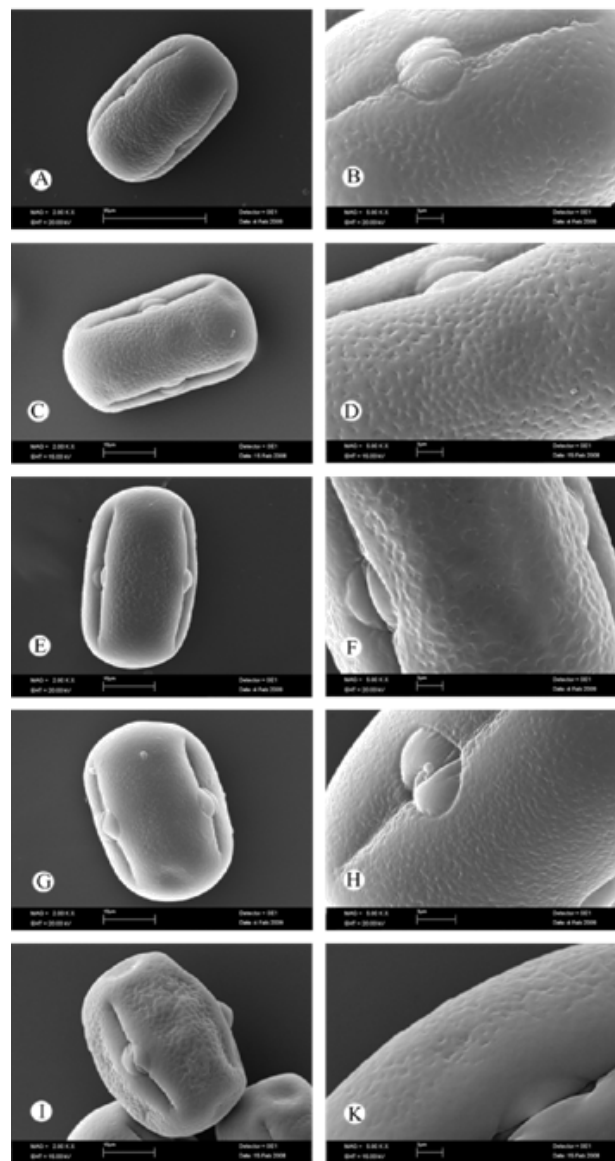
## DISCUSSION

Dimensions of pollens in taxa showed also differences. Pollen shape (P/E) was 1.2378= subprolate in *L. pratensis*, 1.3343=subprolate-prolate in *L. layardii*, 1.3245=subprolate in *L. laxiflorus* subsp. *laxiflorus*, 1.4491=prolate in *L. laxiflorus* subsp. *angustifolius*, 1.3809=prolate in *L. czeczottianus*. The shapes of apertures revealed differences in five taxa. The ratio of plg/plt in taxa were determined: 0.9300 in *L. pratensis*, 0.7999 in *L. layardii*, 0.7303 in *L. laxiflorus* subsp. *laxiflorus*, 0.7979 in *L. laxiflorus* subsp. *angustifolius* and 0.9395 in *L. czeczottianus*.

All taxa had narrow colpus. *L. pratensis* and *L. czeczottianus* had similarities with respect to the pore length and diameter length. However pore wideness in *L. layardii*, *L. laxiflorus* subsp. *laxiflorus* and *L. laxiflorus* subsp. *angustifolius* was longer than their pore length. The results found in the present work were similar to the findings of Moore *et al.* (1991), who also noted that surroundings of endexine pores around the colpus and porus, exposing two to three times enlargement, formed a large costae formation (c. 2-3  $\mu\text{m}$ - pori region).

All five taxa possessed tectate-infrastructure (structure) and perforate-foveolate and low-relief reticulate type of sculpture (ornamentation), on the other hand,

**Fig. 1** A: *L. pratensis* equatorial view, B -detail showing ornamentation. C-*L. layardii* equatorial view, D-detail showing ornamentation. E-*L. laxiflorus* subsp. *laxiflorus* equatorial view, F- detail showing ornamentation. G-*L. laxiflorus* subsp. *angustifolius* equatorial view, H-detail showing ornamentation, I-*L. czeczottianus* equatorial view, K-detail showing ornamentation (SEM)



largeness and arrangements of perforate-foveolate were different. Our findings were consistent with the reports of Iversen and Troels-Smith (1950), Aytug *et al.* (1971), Moore *et al.* (1991), Gunes and Cırpıcı (1998), Tosheva *et al.* (2004). *L. pratensis* had a slightly distinct, rough and evenly shaped perforations. *L. layardii* included a distinct, small and evenly shaped perforations. *L. laxiflorus* subsp. *laxiflorus* possessed low-relief, large and evenly shaped reticules. *L. laxiflorus* subsp. *angustifolius* and *L.*

**Table I: Pollen characteristics of the examined taxa. M; arithmetic means,  $\sigma$ ; standard deviation, var.; variations, polar diameter (P), equatorial diameter (E), pollen shape (P/E), exine thickness (Ex), the ratio of exine to the intin (Ex/Int), colpus length (clg), colpus width (clt), porus length regarding the poles (plg), porus width, regarding the equatorial diameter (plt), porus shape (plg/plt), structure (exine) and sculpture (ornamentation), Marks are in  $\mu\text{m}$**

TAXA		P	E	P/E	Ex	Ex/int	clg	clt	plg	plt	plg/plt	structure	sculpture
<i>L. pratensis</i>	M	36.8300	29.7540	1.2378	1	2/1	25.288	1.4616	8.3810	9.0109	0.9300	Tectate	Perforate-
	$\sigma$	$\pm 1.4165$	$\pm 1.2385$	Subpolarate			$\pm 1.3161$	$\pm 0.547$	$\pm 0.5495$	$\pm 0.7098$		infrastructurae	foveolate,
	var.	11-14	9-11				19-24	1-2	6-8	6-9			perforations
<i>L. layardii</i>	M	38.7202	29.0191	1.3343	1	1/1	35.5649	2.8999	10.6499	13.3131	0.7999	Tectate	Perforate-foveolate
	$\sigma$	$\pm 2.1515$	$\pm 1.8200$	Subporolate-			$\pm 1.5921$	$\pm 0.8038$	$\pm 1.0476$	$\pm 1.1416$		infrastructurae	perforations
	var.	13-16	10-12	Prolate			23-28	1-3	7-9	7-11			distinct, small and
<i>L. laxiflorus</i> subsp. <i>laxiflorus</i>	M	39.1790	29.5800	1.3245	1	2/1	24.0816	2.3200	6.7280	9.2119	0.7303	Tectate	Perforate-
	$\sigma$	$\pm 0.3539$	$\pm 0.9619$	Subpolarate			$\pm 1.3439$	$\pm 0.3668$	$\pm 0.5405$	$\pm 0.6436$		infrastructurae	foveolate low-relief
	var.	13-15	9-11				18-23	1-3	5-7	7-9			reticulate, big and
<i>L. laxiflorus</i> subsp. <i>angustifolius</i>	M	42.9520	29.6400	1.4491	1	1/1	32.9999	2.3499	10.5250	13.1895	0.7979	Tectate	Foveolate-
	$\sigma$	$\pm 1.2989$	$\pm 1.4707$	Prolate			$\pm 2.0159$	$\pm 0.9938$	$\pm 1.0244$	$\pm 1.6366$		infrastructurae	foveolate, less
	var.	16-17	11-13				20-26	1-2	6-9	7-11			distinct, thin and
<i>L. czechottianus</i>	M	43.0856	31.2000	1.3809	1	2/1	28.3266	2.6600	8.0640	8.5825	0.9395	Tectate	Perforate-
	$\sigma$	$\pm 1.6189$	$\pm 1.7835$	Prolate			$\pm 1.0651$	$\pm 0.6615$	$\pm 0.8192$	$\pm 1.0365$		infrastructurae	foveolate slightly
	var.	16-18	9-13				19-22	1-3	5-7	5-7			reticulate, less
													distinct, thin and
													irregular

*czechottianus* had a bit distinct, thin, regular and irregular perforate-foveolate. Perforations of *L. pratensis*, *L. layardii* and *L. laxiflorus* subsp. *angustifolius* were close to the aperutries and appeared to be small and less distinct. Low-relief reticulate of *L. laxiflorus* subsp. *laxiflorus* and *L. czechottianus* placed on the poles and were a little or none in connection with apereturities. Operculum above pore and colpus seemed to be a type of reticulate. Exine thickness is nearly 1  $\mu\text{m}$  in pollen grains of all taxa. Some differences between the species were established regarding the thickness and structure of the sexine and nexine, but in general the sexine as thick as the nexine. T value (one edge of polar triangle) was not measured in fresh pollens of taxa borders of colpus in the pollens of *L. layardii* ve *L. czechottianus* were not clear.

Investigation of the pollen morphology of the taxa from the section *Pratensis* (genus *Lathyrus*) showed that comparatively homogenous and confirmed in broad lines the data previously reported (Iversen & Troels-Smith, 1950; Aytug, 1959, 1967; Aytug *et al.*, 1971; Moore *et al.*, 1991; Gunes & Cirpici, 1998; Tosheva *et al.*, 2004; Tosheva & Tonkhov, 2005; Banks & Levis, 2009) in the following respects.

1. The pollen grains are 3-zonocolporate of subprolate–prolate type (P/E = 1.2378 - 1.4491  $\mu\text{m}$ ), medium to large in size. The smallest pollen grains belong to *L. pratensis* (P/E = 36.8300 x 29.7540  $\mu\text{m}$ ), while the biggest to *L. czechottianus* (P/E = 43.0856 x 31.2000  $\mu\text{m}$ ). Equatorial view is elliptic to slightly rectangular-obtuse-convex; The polar view are circular to slightly triangular.

2. The aperture system is consist of ectoapertures–colpi and endoapertures–pori. The colpi are straight, narrow, with

acute ends and thick costae along the colpus regions. There are small granules in colpus membrane. The pori are large and lalongate.

3. Exine thickness is 1  $\mu\text{m}$ , nexine as thick as sexine, tectate-infrastructurae.

4. The ornamentation is perforate-foveolate (*L. pratensis*, *L. layardii* & *L. laxiflorus* subsp. *angustifolius*) and low-relief reticulate (*L. laxiflorus* subsp. *laxiflorus* *L. czechottianus*). Although perforate-foveolate and low-relief reticulate were seen in five taxa, perforations and reticules size and their arrangement were not very distinct. Perforations and reticules are clear in mesocolpium, while the apocolpium, colpus area and porus are psilate or small.

Pollens in all taxa had a type of 3-zonocolporate characteristic, but shapes of pollen (P/E), the shapes and largeness of apertures, largeness of polar circular-triangle, clear and/or less clear borders of apertures, one edge of polar triangle (t), ornamentation and thickness of exine and intin played important diagnostic keys in the differentiation of taxa (Aytug, 1959). On conclusion all taxa in the *Pratensis* section can be differentiated on the basis palynological findings stated as above.

**Acknowledgement.** This work is a part of the project supported by the Research Fund at Kafkas University (2005 FEF-14). I thank Zeynep Ulukanlı for improving English.

## REFERENCES

- Aytug, B., 1959. Role of Palynology in Taxonomy and Classification (in Turkish) Istanbul. *J. Forestry Faculty Serial B.*, IX: 118–125  
 Aytug, B., 1967. *Pallinologic Researches in Polen Morphology and Important Gymnosperms of Turkey (In Turkish)*. İ.Ü. yay no: 1261, O.F. yay no: 114

- Aytug, B., S. Aykut, N. Merev and G. Edis, 1971. *Pollen Atlas of Plants from Environs of Istanbul (In Turkish)*. Yayın No. 1654/174, Kurtulmuş Matbaası, Istanbul
- Banks, H. and G. Levis, 2009. *Polen Morphology of the Dimorphandra Group (Leguminosae, Caesalpinioideae)*, Vol. 48, pp: 19–26. Grana
- Davis, P.H., 1970. *Lathyrus L.* In: Davis, P.H. (ed.), *Flora of Turkey and East Aegean Islands*, Vol. 3, pp: 328–369. Edinburgh University Press, Edinburg
- Davis, P.H., RR. Mill and T. Kit, 1988. *Flora of Turkey and East Aegean Islands*. 10: Edinburgh University Press, Edinburg
- Gunes, F. and N. Ozhatay, 2000. *Lathyrus L.* In: Guner, A., N. Ozhatay, T. Ekim and K.H.C. Baser (eds.), *Flora of Turkey and the East Aegean Islands*, Vol. 11, pp: 92–94 (supplement 2). Edinburgh University Press, Edinburg
- Gunes, F. and A. Cırpıcı, 1998. *Pollen Morphology of Some Lathyrus Types (L. undulatus Boiss., L. sylvestris L., L. ochrus (L.)DC.) Growing Environs of Istanbul (In Turkish)*, pp: 431–440. Symposium Quercus vulcanica and Flora of Turkey, 21-23 September Çantay Kitapevi, Laleli-Istanbul, Turkey
- Heywood, V.H., 1978. *Flowering Plants of the World*. Oxford Univ. Press, Oxford
- Iversen, J. and O.G.J. Troels-Smith, 1950. *Pollen Morphological Definitions and Types*, Denmark Geological Researchs, Kopenhagen, Denmark
- Kupicha, F.K., 1983. The infrageneric structure of *Lathyrus*. *Notes from the Royal Botanic Garden Edinburg*, 41: 209–244
- Moore, P.H., JA. Webb and M. Collinson, 1991. *Pollen Analysis* 2<sup>nd</sup> edition. Blackwell Sci. Publication. London
- Perveen, A. and M. Qaiser, 1998. Pollen Flora of Pakistan-VIII Leguminosae (subfamily: Papilionoideae). *Turkish J. Bot.*, 22: 73–91
- Punt, W., S. Blackmore and A. Nilsson Le Thomas, 1994. *Glossary of Pollen and Spores Terminology*. Lab. Paleobot. Palynol. Utrecht
- Reitsma, T., 1970. Suggestions towards unification of descriptive terminology of Angiospermae pollen grains. *Rev. Palaeobot. Palynol.*, 10: 39–60
- Tosheva, A., S. Tonkov and N. Dimitrov, 2004. Pollen morphology of Bulgarian species from the section *Lathyrus* (Lathyrus, Fabaceae). *Phytologia Balcanica*, 9: 529–536
- Tosheva, A. and S. Tonkov, 2005. Pollen morphology of Bulgarian species from the section *Orobus* (L.) Gren. Et Godr. (genus Lathyrus, Fabaceae). *Acta.Bot. Croat*, 64: 275–287
- Wodehouse, R.P., 1959. *Pollen Graine*. Mc Graw-Hill, New York

(Received 29 July 2009; Accepted 29 September 2009)