

Palynological Studies of the Genus *Convolvulus* L. (Convolvulaceae) from Turkey

MEHMET TEKIN^{1,3} AND GULDEN YILMAZ²

Botanical Sciences
94 (3): 543-549, 2016

DOI: 10.17129/botsci.554

Abstract

Pollen morphology of six taxa of the genus *Convolvulus* (*Convolvulus assyricus*, *C. betonicifolius* subsp. *betonicifolius*, *C. cataonicus*, *C. galaticus*, *C. lineatus*, and *C. pseudoscammonia*) were investigated. Three of these taxa, *C. assyricus*, *C. cataonicus* and *C. pseudoscammonia*, are endemic to Turkey. Pollen grains were evaluated mainly for four diagnostic characteristics: pollen type, pollen shape, apertures and ornamentation. Following the measurements and observations, pollen grains were photographed under an optical and a scanning electron microscope. The pollen grains of the examined taxa are all 3-zonocolpate. The pollen shape is oblate, suboblate, oblate spheroidal or prolate spheroidal. The nexine is thinner than the sexine or equal, and the tectum is microechinate and rarely or densely perforated in all species except *C. pseudoscammonia*. Colpus borders and tapering ends are distinct and the colpus area is gemmate and granulate in all examined species.

Key words: *Convolvulus*, Convolvulaceae, pollen morphology, Turkey

Estudios palinológicos del género *Convolvulus* L. (Convolvulaceae) de Turquía

Resumen

Se estudió la morfología del polen de seis especies del género *Convolvulus* (*Convolvulus assyricus*, *C. betonicifolius* subsp. *betonicifolius*, *C. cataonicus*, *C. galaticus*, *C. lineatus* y *C. pseudoscammonia*). Tres de estos taxones, *C. assyricus*, *C. cataonicus* y *C. pseudoscammonia*, son endémicos de Turquía. Se evaluaron principalmente cuatro características diagnósticas del polen: tipo de polen, forma del polen, aperturas y ornamentaciones. Después de hacer estas mediciones y observaciones, se tomaron fotos bajo el microscopio óptico y los granos se escanearon con microscopio electrónico de barrido. Los granos de polen de los grupos examinados son todos trizonocolpados. Por su forma, el polen es oblató, suboblató, esferoide oblató o esferoide prolato. La nexina es igual o más delgada que la sexina y el tectum es microequinado y rara o densamente perforado en todas las especies excepto en *C. pseudoscammonia*. Los bordes del colpo y las terminaciones atenuadas son distintivos, y el área del colpo es gemada y granulada en todas las especies examinadas.

Palabras clave: *Convolvulus*, Convolvulaceae, morfología del polen, Turquía.

¹ Cumhuriyet University, Faculty of Pharmacy, Department of Pharmaceutical Botany, Turkey

² Trakya University, Faculty of Science, Department of Biology, Balkan Campus, Turkey

³ Author for correspondence: mtekin2280@gmail.com

The family Convolvulaceae Juss. is represented by 56 genera and approximately 1,600 species worldwide (Simpson, 2006). *Convolvulus* L. is the second largest genus in the family, with about 250 species (Cronquist, 1981). Pollen morphology of some taxa of the family was examined first by Hallier (1893), who divided the family into two main groups, *Psiloconiea* and *Echinoconiea*, on the basis of pollen morphology. The group *Psiloconiea* consisted of psilate or granulate pollen grains while group *Echinoconiea* consisted of pollen grains with echinate exine ornamentation. The family was also divided into two groups by Gamble (1923) on the basis of spinulose or non-spinulose apertural types. According to the classification of Gamble (1923), *Convolvulus* was situated in the non-spinulose group. Based on these classifications, Erdtman (1952) divided the pollen grains of Convolvulaceae, into “Ipomea type” and “other types”, and incorporated the genus *Convolvulus* into the latter group. The genera of Convolvulaceae were separated by O’Donell (1959) according to Hallier’s aperture distinction, but at the same time he stated that pollen grains of the genus *Convolvulus* have the 3-colporate pollen type. Lewis and Oliver (1965) reported results that supported the findings of Hallier (1893), but not those of O’Donell (1959). Sengupta (1972) reported an exhaustive palynological investigation on the Convolvulaceae based on the number and dispersion of apertures. He divided the family into four main pollen types and grouped *Convolvulus* in the tricolpate type, as distinct from the results of O’Donell (1959).

Convolvulus species are mainly distributed in the temperate and tropical regions of the world. The number of *Convolvulus* taxa recognized for Turkey has varied among different treatments. The “Flora of Turkey” recognized 32 species (36 taxa) and 3 imperfectly known species (Parris, 1978; Davis *et al.*, 1988). According to Aykurt (2010), there are 35 *Convolvulus* species (three of them hybrids) distributed in Turkey. Güner *et al.* (2012) reported 35 species of the genus and 39 taxa. The taxonomy and pollen morphology of the genus *Convolvulus* in Turkey was studied by Aykurt (2010) and Aykurt & Sümbül (2011). The aim of this study is to document for the first time the pollen features of six *Convolvulus* taxa growing in Turkey: *Convolvulus assyricus* Griseb., *C. betonicifolius* Mill. subsp. *betonicifolius*, *C. cataonicus* Boiss. & Hausskn., *C. galaticus* Rost. ex Choisy, *C. lineatus* L., and *C. pseudoscammonia* K. Koch.

Material and methods

Pollen samples were obtained from specimens housed in the Faculty of Science Herbarium (CUFH), Cumhuriyet University, Sivas province, Turkey (Table 1). Pollen grains obtained from mature anthers were prepared following Wodehouse (1965). Observations and measurements were made from prepared materials of 30 pollen grains per species on an Olympus optical microscope CX21 (Tokyo, Japan) with an immersion objective lens (100×) and an ocular scale (10×). For the measurements, 1 ocular division was equivalent to 1.015 μm . In addition, the ornamentation and the structure of the pollen grains were determined. The pollen images were taken with an Olympus DP 70 digital camera (Tokyo, Japan) fitted on an Olympus BX51 optical microscope (Tokyo, Japan). Statistical analyses were performed with the SPSS package program (ver. 15) on the results of the palynological measurements given in Table 2. For study with scanning electron microscopy (SEM), the pollen grains taken from the anther were transferred to stubs that were previously prepared with double-sided adhesive tape. The stubs were then

Table 1. Collection data of investigated *Convolvulus* taxa.

Taxon	Country, City	Herbarium	Collector name	Collector number
<i>Convolvulus assyricus</i> Griseb.	Turkey, Sivas	CUFH	M. Tekin	1435
<i>C. betonicifolius</i> Mill. subsp. <i>betonicifolius</i>	Turkey, Sivas	CUFH	Ş. Civelek	4634
<i>C. cataonicus</i> Boiss. & Hausskn.	Turkey, Sivas	CUFH	B. Yıldız	3626
<i>C. galaticus</i> Rost. ex Choisy	Turkey, Sivas	CUFH	Ş. Civelek	3045
<i>C. lineatus</i> L.	Turkey, Sivas	CUFH	Ş. Civelek	1639
<i>C. pseudoscammonia</i> K. Koch.	Turkey, Malatya	CUFH	B. Yıldız	7451

coated with gold for 5 minutes. The surface ornamentation detail and the aperture characteristics of the pollen grains were investigated under an LEO 440 scanning electron microscope, and microphotographs were taken at different magnifications for each species. The terminology used in this study follows Punt *et al.*, (1994).

Results

In this study, pollen grains of the *Convolvulus* species examined are 3-zonocolpate. The shape of the pollen grains are oblate, suboblate, oblate spheroidal or prolate spheroidal. For all examined species, nexine is thinner than the sexine or equal (Table 2). The SEM study showed that the tectum is microechinate and rarely or densely perforate in all examined species, with the exception of *C. pseudoscammonia*, which has only a microechinate tectum surface. Perforations are approximately circular (Figure 1). Palynological measurements and observations of each species are given in Table 2.

Descriptions of pollen grains

1. *Convolvulus assyricus*

Pollen type: 3-zonocolpate, Pollen shape: oblate or suboblate, Apertures: colpi borders and tapering ends distinct and colpus area gemmate and granulate. Exine structure: tectate, microechinate, tectum rarely perforate, perforations approximately circular, irregularly distributed, sexine thicker than nexine or equal (Figure 1; Figure 2; Table 2).

Table 2. The palynological measurement results of *Convolvulus* taxa examined in this study and their comparisons with the study of Aykurt & Sümbül (2011) [minimum (min), maximum (max), arithmetic mean (mean), standard deviation (std.), polar diameter (P), equatorial diameter (E), P/E ratio (P/E), exine thickness (Ex), nexine thickness (N), sexine thickness (S) N/S ratio (N/S), Measurements are given in µm]

		Present study (Tekin & Yılmaz)						Aykurt & Sümbül (2011)				
		C. <i>assyricus</i>	C. <i>betonicifolius</i> subsp. <i>betonicifolius</i>	C. <i>cataonicus</i>	C. <i>galaticus</i>	C. <i>lineatus</i>	C. <i>pseudoscammonia</i>	C. <i>pseudocompactus</i>	C. <i>oleifolius</i> var. <i>deserti</i>	C. <i>compactus</i>	C. <i>peshmenii</i>	C. <i>holosericeus</i> subsp. <i>macrocaycinus</i>
P	min	35.52	48.72	44.66	55.82	54.81	52.78	41.00	54.32	57.40	41.00	59.45
	mean	48.56	52.57	49.93	58.61	62.37	55.06	46.42	57.91	61.27	51.13	62.76
	max	52.78	56.84	55.82	62.93	69.02	59.88	52.27	61.50	66.62	59.96	66.62
	std.	4.25	2.24	2.88	1.94	3.81	1.67	—	—	—	—	—
E	min	53.79	58.87	49.73	58.87	57.85	58.87	32.80	56.37	58.42	32.80	61.50
	mean	57.59	62.55	53.03	62.42	62.26	62.31	37.69	58.91	62.66	38.05	64.25
	max	60.90	64.96	55.82	66.99	65.97	64.96	42.02	62.52	66.62	43.05	67.65
	std.	1.88	1.88	2.05	2.14	2.19	1.45	—	—	—	—	—
P/E	0.66-0.87	0.82-0.88	0.89-1.00	0.93-0.94	0.94-1.05	0.89-0.93	1.39	0.98	0.98	1.46	0.99	
Exine	min	3.04	3.04	3.04	3.04	3.55	3.55	2.05	1.02	1.02	2.05	1.02
	mean	3.24	3.72	3.09	3.72	3.93	3.75	—	—	—	—	—
	max	4.06	4.06	4.06	4.06	4.06	4.06	3.07	2.05	1.02	4.1	2.05
	std.	0.38	0.34	0.22	0.38	0.22	0.25	—	—	—	—	—
Nexine	min	1.01	1.01	1.01	1.01	1.52	1.52	—	—	—	—	—
	mean	1.21	1.69	1.03	1.69	1.90	1.72	—	—	—	—	—
	max	2.03	2.03	1.52	2.03	2.03	2.03	—	—	—	—	—
	std.	0.38	0.34	0.11	0.38	0.22	0.25	—	—	—	—	—
Sexine	min	2.03	2.03	2.03	2.03	2.03	2.03	—	—	—	—	—
	mean	2.03	2.03	2.05	2.03	2.03	2.03	—	—	—	—	—
	max	2.03	2.03	2.53	2.03	2.03	2.03	—	—	—	—	—
	std.	0.00	0.00	0.00	0.00	0.00	0.00	—	—	—	—	—
N/S	0.49-1.00	0.49-1.00	0.49-0.61	0.49-1.00	0.74-1.00	0.74-1.00	—	—	—	—	—	

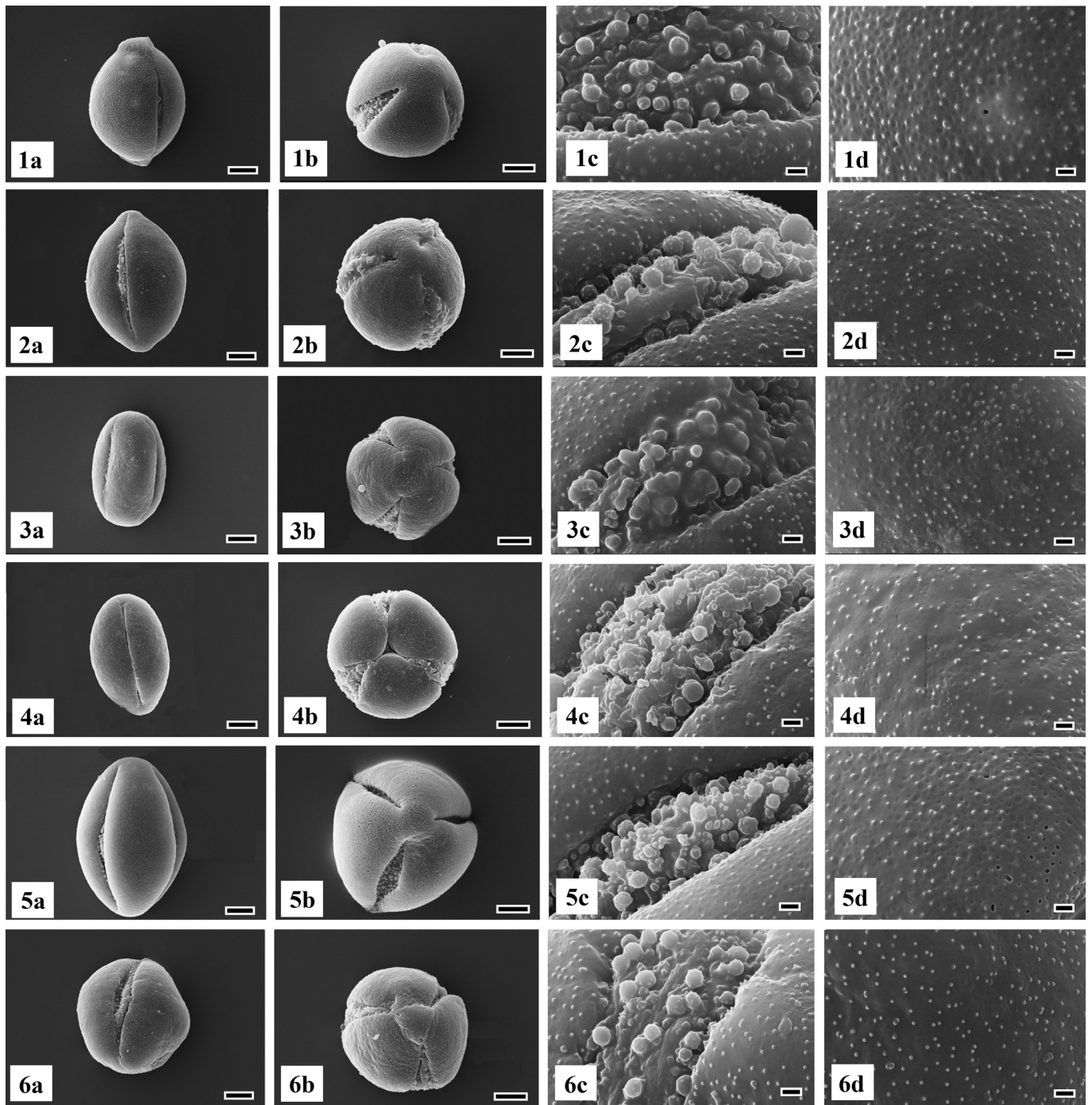


Figure 1. Palynological micrographs taken with an SEM microscope. 1) *Convolvulus assyricus*; 2) *C. betonicifolius* subsp. *betonicifolius*; 3) *C. cataonicus*; 4) *C. galaticus*; 5) *C. lineatus*; 6) *C. pseudoscammonia*; **a.** equatorial view; **b.** polar view; **c.** detail of aperture; **d.** exine ornamentation (Scale bars 10 μm in a,b; 1 μm in c,d)

2. *Convolvulus betonicifolius* subsp. *betonicifolius*

Pollen type: 3-zonocolpate, Pollen shape: suboblate, Apertures: colpi borders and tapering ends distinct and colpus area gemmate and granulate. Exine structure: tectate, microechinate, tectum densely perforate, perforations approximately circular, irregularly distributed, sexine thicker than nexine or equal (Figure 1; Figure 2; Table 2).

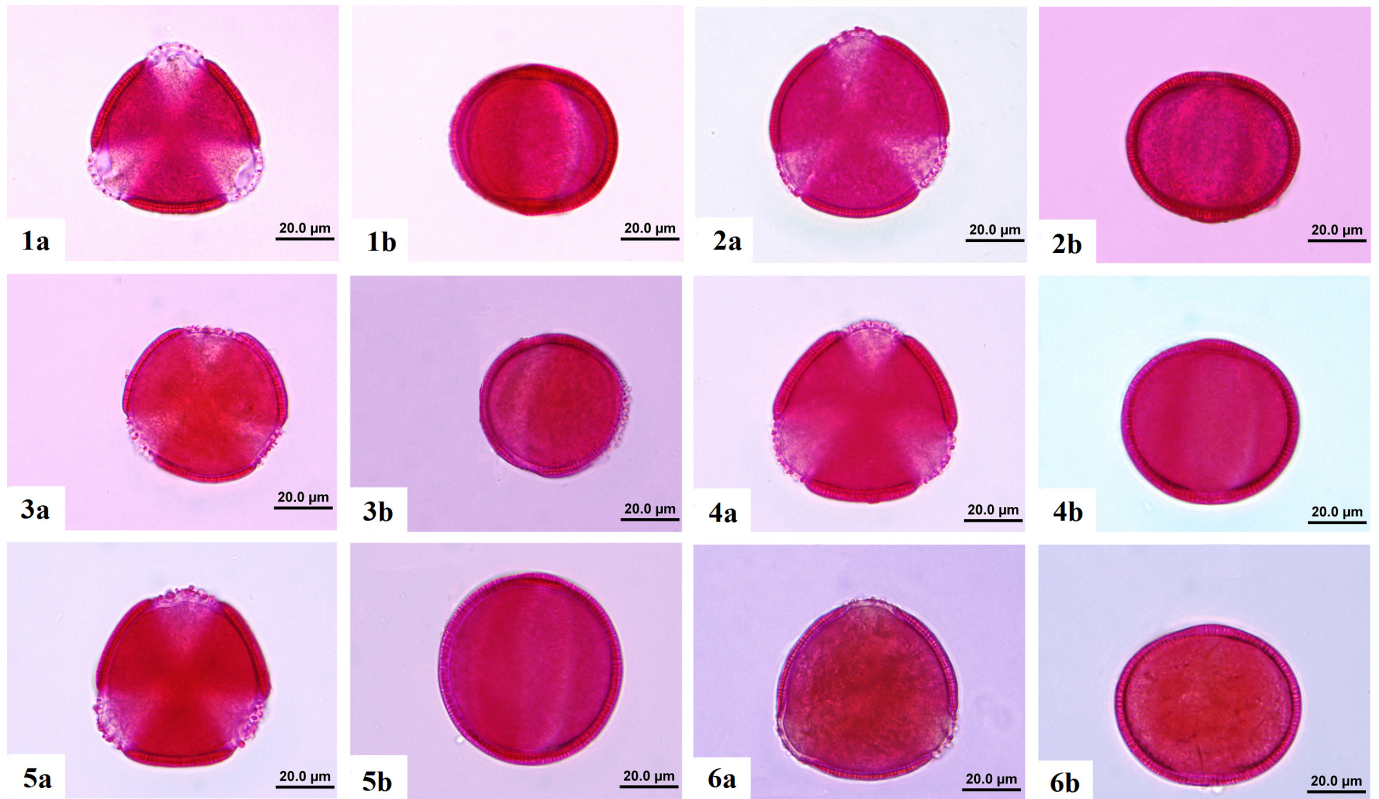


Figure 2. Palynological micrographs taken with an optical microscope. **1)** *Convolvulus assyricus*; **2)** *C. betonicifolius* subsp. *betonicifolius*; **3)** *C. cataonicus*; **4)** *C. galaticus*; **5)** *C. lineatus*; **6)** *C. pseudoscammonia*; **a.** optical section in polar view; **b.** optical section in equatorial view

3. *Convolvulus cataonicus*

Pollen type: 3-zonocolpate, Pollen shape: oblate-spheroidal, Apertures: colpi borders and tapering ends distinct and colpus area gemmate and granulate. Exine structure: tectate, microechinate, tectum rarely perforate, perforations approximately circular, irregularly distributed, sexine thicker than nexine (Figure 1; Figure 2; Table 2).

4. *Convolvulus galaticus*

Pollen type: 3-zonocolpate, Pollen shape: suboblate or oblate-spheroidal, Apertures: colpi borders and tapering ends distinct and colpus area gemmate and granulate. Exine structure: tectate, microechinate, tectum rarely perforate, perforations approximately circular, irregularly distributed, sexine thicker than nexine (Figure 1; Figure 2; Table 2).

5. *Convolvulus lineatus*

Pollen type: 3-zonocolpate, Pollen shape: oblate-spheroidal or prolate spheroidal, Apertures: colpi borders and tapering ends distinct and colpus area gemmate and granulate. Exine structure: tectate, microechinate, tectum densely perforate, perforations approximately circular, irregularly distributed, sexine thicker than nexine or equal (Figure 1; Figure 2; Table 2).

6. *Convolvulus pseudoscammonia*

Pollen type: 3-zonocolpate, Pollen shape: oblate-spheroidal, Apertures: colpi borders and tapering ends distinct and colpus area gemmate and granulate. Exine structure: tectate, microechinate, sexine thicker than nexine or equal (Figure 1; Figure 2; Table 2).

Discussion

Convolvulaceae is an eurypalynous family (Lewis and Olivier, 1965). However the pollen grains of the genus *Convolvulus* are not very different, and there is little variation between spe-

cies. Therefore, *Convolvulus* is a stenopalynous genus (Perveen *et al.*, 1989). The present study supports this view and showed that all six *Convolvulus* species have radial symmetrical and isopolar pollen grains.

The shape of pollen grain is oblate or suboblate in *Convolvulus assyricus*, suboblate in *C. betonicifolius* subsp. *betonicifolius*, oblate spheroidal in *C. cataonicus* and *C. pseudoscammonia*, suboblate or oblate spheroidal in *C. galaticus* and oblate spheroidal or prolate spheroidal in *C. lineatus*. Aykurt and Sümbül (2011) studied pollen morphology of five other *Convolvulus* taxa (*C. pseudocompactus* Aykurt & Sümbül, *C. oleifolius* Desr. var. *deserti* Pamp., *C. compactus* Boiss., *C. peshmenii* Aykurt & Sümbül, and *C. holosericeus* M. Bieb. subsp. *macrocalycinus* Hausskn. & Bornm. ex Bornm.) distributed in Turkey. Comparison of the results between their study and this study are given in Table 2. According to Aykurt and Sümbül (2011) all *Convolvulus* species are tricolpate, with the exception of *C. oleifolius* var. *deserti*, which sometimes has tetracolpate pollen grains and pollen shape varies from spheroidal to spheroidal subprolate and prolate. However, according to Aykurt and Sümbül (2011) the ornamentation type of all five taxa is microechinate-perforate. The aperture type of all species examined in this study are 3-zonocolpate and ornamentation types are microechinate, with rarely or densely perforate sculpturing. However, pollen grains of *C. pseudoscammonia* do not have perforations on the exine surface, and that is an important distinction between the examined species.

According to Parris (1978), of these six *Convolvulus* species, *C. pseudoscammonia* is the most distinct morphologically. Results of this study support that, as in morphology, there are important differences in pollen ornamentation between *C. pseudoscammonia* and the other five examined species. Perveen *et al.* (1989) grouped the pollen grains of 22 West Asian and Arabian Peninsula *Convolvulus* species into four different pollen types which they recognized on the basis of exine ornamentation: Type I- Coarsely reticulate type; Type II- Medium reticulate type; Type III- Finely reticulate/punctuate-scabrate type; Type IV- Sparsely punctuate-scabrate type. They grouped 13 out of a total of 22 species in Type III, which is the major group. In the present survey, if we grouped the examined *Convolvulus* taxa according to Perveen *et al.* (1989), we can incorporate *C. assyricus*, *C. betonicifolius* subsp. *betonicifolius*, *C. cataonicus*, *C. galaticus* and *C. lineatus* into Type IV which have sparsely punctate pollen grains. In our study we use the terminology of Punt *et al.* (1994), so that instead of punctuate-scabrate, we used perforate-microechinate. Pollen grains of *C. pseudoscammonia* have not perforation on the exine surface. Thus, in contrast to all other examined species, *C. pseudoscammonia* could not be included in the classification of Perveen *et al.* (1989).

Among the studied species, *C. assyricus* is an endemic for the flora of Turkey and is morphologically very similar to *C. compactus* (Parris, 1978). When we consider the results of present study and that of Aykurt and Sümbül (2011), we concluded that the variations of the pollen grains between *C. assyricus* and *C. compactus* are very obvious and that they can be used to distinguish between these two species. In our study, the P/E ratio of *C. assyricus* pollen grains varied between 0.66-0.87 and accordingly pollen shape is oblate or suboblate. According to Aykurt and Sümbül (2011), the P/E ratio of *C. compactus* pollen grains is 0.98 and pollen shape is spheroidal. Another important palynological difference between the two species is exine thickness. While exine is very thick in *C. assyricus*, varying from 3.04-4.06 μm , exine of *C. compactus* pollen grains is very thin, 1.02 μm (Table 2). With these two distinctive palynological features, the morphologically similar species *C. assyricus* and *C. compactus* are easily separable from each other. In the future, with the determination of the pollen morphology of other *Convolvulus* taxa from Turkey, this study will contribute to the comparison of the pollen morphology of all members of the genus *Convolvulus*. In this study, pollen morphology of six *Convolvulus* species, three of them endemic to Turkey, were studied in detail for the first time. The results were compared with those from previous studies of different species of the same genus. In addition, significant differences are reported between some *Convolvulus* species that are morphologically very similar, and thus they can be separated easily from each other based on their pollen.

Received:
March 13th, 2015

Accepted:
December 1st, 2015

Acknowledgments

We would like to thank the curator of herbarium CUFH, Dr. Erol Dönmez, and the collectors of some of the *Convolvulus* specimens examined, Prof. Bayram Yıldız and Prof. Şemsettin Civelek, for their valuable contributions.

Literature cited

- Aykurt C. 2010. Türkiye’de Yayılış Gösteren *Convolvulus* L. (Convolvulaceae) Türleri Üzerine Taksonomik Bir Araştırma – PhD thesis, University of Akdeniz, Antalya.
- Aykurt C. and Sümbül H. 2011. New natural hybrids of *Convolvulus* (Convolvulaceae) from Turkey. *Nordic Journal of Botany* **29**: 408-416.
- Cronquist A. 1981. *An Integrated System of Classification of Flowering Plants*. Columbia University Press, New York.
- Davis P.H., Mill R.R. and Tan K. 1988. *Convolvulus* L. In: Davis P.H. Ed. *Flora of Turkey and the East Aegean Islands, Vol. 10, Suppl. I*, Edinburgh University Press, Edinburgh.
- Erdtman I.G. 1952. *Pollen Morphology and Plant Taxonomy – Angiosperms*. Almqvist and Wiksell, Waltham, Mass: Chrinica Botanica Co., Stockholm.
- Gamble J.S. 1923. *Flora of the Presidency of Madras*, Adlard & West Newman, London.
- Güner A., Aslan S., Ekim T., Vural M. and Babaç M.T. (eds) 2012. Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul.
- Hallier H. 1893. Versuch einer natürlichen Gliederung der Convolvulaceen auf morphologischer und anatomischer Grundlage. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzeographie* **16**:453-591.
- Lewis W.H. and Oliver R.L. 1965. Realignment of *Calystegia* and *Convolvulus* (Convolvulaceae). *Annals of the Missouri Botanical Garden* **52**:217-222.
- O’Donell C.A. 1959. Convolvulaceae Argentinas. *Lilloa* **29**:299-311.
- Parris B.S. 1978. *Convolvulus* L. In: Davis P.H. Ed. *Flora of Turkey and the East Aegean Islands, Vol. 6*, pp. 198-221, Edinburgh University Press, Edinburgh.
- Perveen A., Al-Alawi A.H. and Husain S.Z. 1989. A contribution to the palynological survey of the genus *Convolvulus* from Southwest Asia and Arabian Peninsula. *Pakistan Journal of Botany* **21**:197-209.
- Punt W., Blackmore S., Nilsson S. and Le Thomas A. 1994. *Glossary of Pollen and Spore Terminology*. LPP Contributions Series No. 1, LPP Foundation, Utrecht.
- Sengupta S. 1972. On the pollen morphology of Convolvulaceae with special reference to taxonomy. *Review of Palaeobotany and Palynology* **13**:157-212.
- Simpson M.G. 2006. *Plant systematics*. Elsevier Academic Press, San Diego.
- Wodehouse R.P. 1965. *Pollen Grains, their Structure, Identification and Significance in Science and Medicine*. Hafner Publishing Company, New York.