

## Seed morphology of *Ebenus* L. species endemic to Turkey

Fatma BAYRAKDAR, Zeki AYTAÇ, Zekiye SULUDERE, Selami CANDAN

Gazi University, Faculty of Arts and Science, Department of Biology, 06500 Ankara - TURKEY

Received: 2009

Accepted: 2009

**Abstract:** In the present study, seed surface morphology of species of the genus *Ebenus* L. in Turkey, all of which are endemic, was studied. *E. plumosa* var. *speciosa* has the biggest and *E. laguroides* var. *laguroides* has the smallest seeds. The seed shapes are spheroid in *E. reesei*, orbiculate in *E. pisidica*, and oblong-spheroid in others. Ornamentation is striate in *E. macrophylla*, rugose in *E. haussknechtii*, and reticulate or multi-reticulate in others. Microphylle is subterminal in all Turkish *Ebenus* species.

**Key words:** *Ebenus*, Fabaceae, seed morphology, Turkey

### Türkiye'ye endemik olan *Ebenus* L. türlerinin tohum morfolojileri

**Özet:** Bu çalışmada Türkiye *Ebenus* L. cinsi türlerinin tohum yüzey morfolojileri çalışılmıştır. Türlerin hepsi Türkiye için endemiktir. En büyük tohuma *E. plumosa* var. *speciosa*, en küçük tohuma ise *E. laguroides* var. *laguroides* sahiptir. Tohum şekli *E. reesei*'de sferoid, *E. pisidica*'da orbikulat ve diğerlerinde oblong-sferoiddir. Tohum ornamentasyonu *E. macrophylla*'da striat, *E. haussknechtii*'de rugoz, diğerlerinde retikulat yada multiretikulatır. Çalışılan bütün türlerde mikropil subterminaldedir.

**Anahtar sözcükler:** *Ebenus*, Fabaceae, tohum morfolojisi, Turkey

### Introduction

Fabaceae is the 2<sup>nd</sup> most economically important family after Gramineae and 3<sup>rd</sup> largest family after Compositae and Gramineae in the Turkish flora (Davis, 1988; Huber-Morath, 1970). *Ebenus* L., a member of Fabaceae family, is represented by 19 species worldwide; 6 of them are distributed in different parts of Irano-Turanian and Mediterranean regions (*E. critica* L. and *E. sibthorpii* DC in Crete and Rhodes Islands; *E. pinnata* Ait. in Morocco, Algeria, Tunisia; *E. armitagei* Schwein in Libya and Algeria; *E. stella* Boiss. in Iran, Pakistan, and

Afghanistan; *E. lagopus* (Jaub.& Spach) Boiss in south Iran, and the rest (13 species) grow in Turkey and all of them are endemic. The genus *Ebenus* is represented by 16 taxa in total, including 13 species and 3 varieties belonging to the sect. *Euebenus* Boiss. (Aytaç et al., 2000) in Turkey (Huber-Morath, 1965). Among these, 8 taxa are Irano-Turanian elements and 8 are East Mediterranean elements (Aytaç, 2000). *Ebenus longipes* Boiss. & Bal. and *E. argentea* Siehe ex Bornm. have been subjected to morphological, palynological, and cytotaxonomical studies by Aytaç et al. (2000); caryology of 4 endemic *Ebenus* species

\* E-mail: facikgoz@gazi.edu.tr

were studied by Aksoy et al. (2001); pollen morphology of *Ebenus* species were studied by Pınar et al. (2000), and seed oils were studied by Azcan et al. (2001). No studies are found on the seed morphology of *Ebenus* species.

Species are generally identified by stereomicroscopy, but in many cases, when taxonomists disagree on the identity of taxa, micromorphological characters of leaves, pollens, fruit, and seeds examined with scanning electron microscopy (SEM) show diagnostic differences (Brisson & Peterson, 1976, Shehata 2006). Seeds exhibit a complex and high morphological diversity, providing valuable taxonomic information. Their shapes, colours, and sizes can be of high systematic significance. Various seed coat features are believed

to aid in dispersal of the seeds of several species by water or with animals (Chuang & Ornduff, 1992).

The present study was undertaken to illustrate the external morphology of mature seeds using scanning electron microscopy and obtain information on the seed coat structure of *Ebenus* species endemic to Turkey.

### Materials and methods

Seeds of *Ebenus* species were collected from different localities during field studies between 1996 and 2001 (Figures 1 and 2). All species are deposited in GAZI Herbarium. Morphometrical data of cleaned and mature seeds were obtained using a stereomicroscope with a micrometer. Seed length and

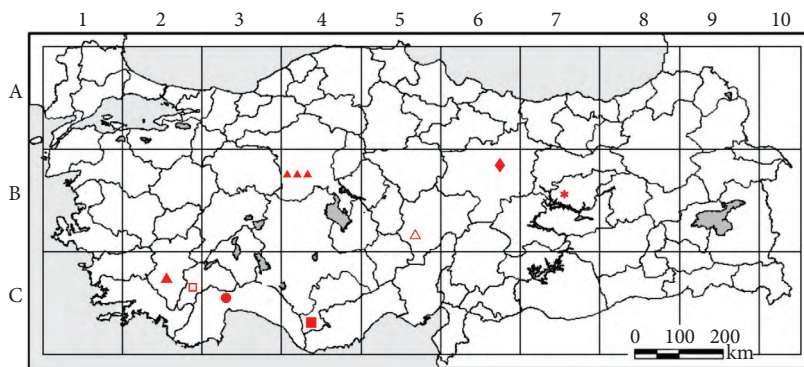


Figure 1. Distribution of *Ebenus* taxa in Turkey. ● *E. plumosa* var. *plumosa*, ■ *E. plumosa* var. *speciosa*, ◆ *E. macrophylla*, ▲ *E. barbiger*, \* *E. haussknechtii*, □ *E. pisidica*, △ *E. longipes*, ▲▲▲ *E. hirsuta*.

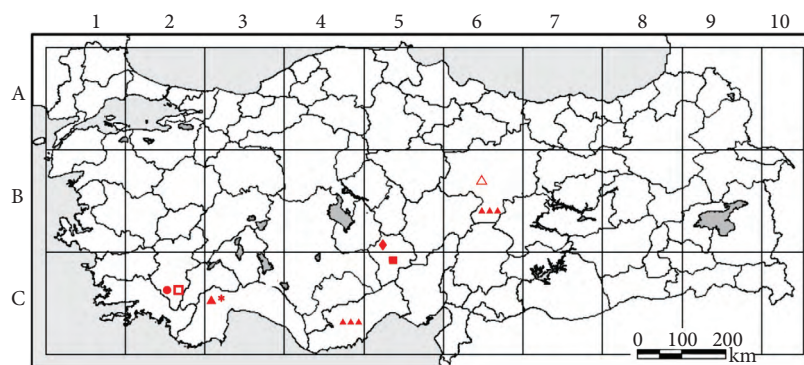


Figure 2. Distribution of *Ebenus* taxa in Turkey. ● *E. reesei* var. *reesei*, □ *E. reesei* var. *minor*, ■ *E. depressa*, \* *E. bourgaei*, ◆ *E. cappadocica*, ▲ *E. boissieri*, △ *E. laguroides* var. *laguroides*, ▲▲▲ *E. laguroides* var. *cilicica*.

width are measured at the widest point. For each species at least 50 seeds were measured from different individuals of the same population. Punt et al. (1994) was used for the terminology of the seed characteristics.

Mature seeds were mounted using double sided tape on the SEM stubs and coated with gold in a Polaron SC502 Sputter coater. They were examined with a JEOL JSM 840A Scanning Electron Microscopy at 10-20 kV.

## Results and discussion

Shape, colour, size, ornamentation of the seed coat, and position of the hilum can be used taxonomically. In the present study, seed morphologies of a total of 13 species and 3 varieties belonging to genus *Ebenus*, which are endemic to Turkey, were studied. Seed colours of all examined taxa change from brown to yellow. Position of the hilum and the micropyle is subterminal in all examined taxa. It is shown that *Ebenus* taxa have reticulate, multi-reticulate, striate, and rugose seed surface ornamentations (Figures 3 and 4).

Average seed size of *E. plumosa* var. *plumosa* is  $2.47 \times 3.02$  mm (Figures 3 and 4) and var. *speciosa* is  $2.44 \times 3.57$  mm (Figures 3 and 4). Seed shapes of both taxa are oblong-spheroid and their surface ornamentation is reticulate. While *E. plumosa* var. *plumosa* is distributed in west Anatolia (Uşak), var. *speciosa* is distributed only around Ermenek (Karaman province). However, in recent years, var. *plumosa* was collected from Elmalı (Antalya), so it means that this taxon has a wider distribution. Both taxa grow up on large calcareous rocks, but geographical distances lead to morphological differences between these taxa (Aytaç, 2000). Although both taxa have reticulate seed surface ornamentation, there are differences in lumina sizes (Table 1). In addition, these taxa have differences related to their pollen morphology (Pınar et al., 2000) and chromosome structures (Aksoy, 2001).

*E. macrophylla* is close to *E. plumosa* var. *plumosa* with cylindrical to oblong flowering, average seed size is  $2.43 \times 3.12$  mm and ornamentation is striate, not reticulate (Figures 3 and 4). It is a unique species with striate ornamentation among Turkish *Ebenus* genus.

*E. barbiger* can be distinguished from other species with its long-bearded keel, but the seed characters are close to *E. reesei*. The seed has multi-reticulate seed coat; average seed size is  $2.12 \times 2.64$  mm (Figures 3 and 4). *E. reesei* is represented by 2 varieties. *E. reesei* var. *reesei* has multi-reticulate seed coat ornamentation (Figures 3 and 4) and its average size is  $1.88 \times 2.64$  mm; var. *minor* has reticulate seed coat ornamentation and its size is smaller ( $1.51 \times 2.37$  mm in average) (Figures 3 and 4). Although var. *minor* seems to be an ecotype, differences between seed morphology supports the separation of these taxa. Seed shapes of these taxa are spheroid. Seed surface ornamentation of *E. haussknechtii* is rugose and its average size is  $1.85 \times 2.44$  mm (Figures 3 and 4).

*E. depressa* (Figures 3 and 4), *E. bourgaei* (Figures 3 and 4) and *E. cappodocica* (Figures 3 and 4) have reticulate seed coats. Seed sizes of these taxa are  $1.77 \times 2.59$  mm,  $1.72 \times 2.57$  mm,  $1.59 \times 2.51$  mm, respectively. Similarities between seed morphology can be observed in other morphological features. Leaflet pair numbers in these taxa are at least (3-5 pairs) and they are found in a leaf length exceeding peduncle group (Aytaç, 2000). *E. boissieri* has rugose seed surface ornamentation and its average size is  $1.76 \times 3.28$  mm (Figures 3 and 4).

*E. longipes* (Figures 3 and 4) has reticulate ornamentation; an average seed size of this taxon is  $1.99 \times 3.27$  mm. Average seed size of *E. hirsuta* is  $2.10 \times 3.29$  mm and has rugose ornamentation (Figures 3 and 4). Seed measures, shapes, and ornamentations are much close to *E. boissieri*. These 2 taxa are very close to each other according to their morphological characters.

Also *E. plumosa* var. *plumosa*, *E. boissieri*, and *E. hirsuta* are similar to each other with their yellow flowers, but the peduncle is as long as or shorter than the leaves in *E. hirsuta*; however, longer than the leaves in other species. Seed surface ornamentation of *E. laguroides* var. *laguroides* is rugose (Figures 3 and 4); however, it is multi-reticulate in *E. laguroides* var. *cilicica* (Figures 3 and 4). Seed surface ornamentations of varieties support the morphological classification. *E. pisidica* (Figures 3 and 4) has orbicular seed shape. It is the only taxon that grows on serpentine rocks (Aytaç, 2000). It can be distinguished easily with its seed shape.

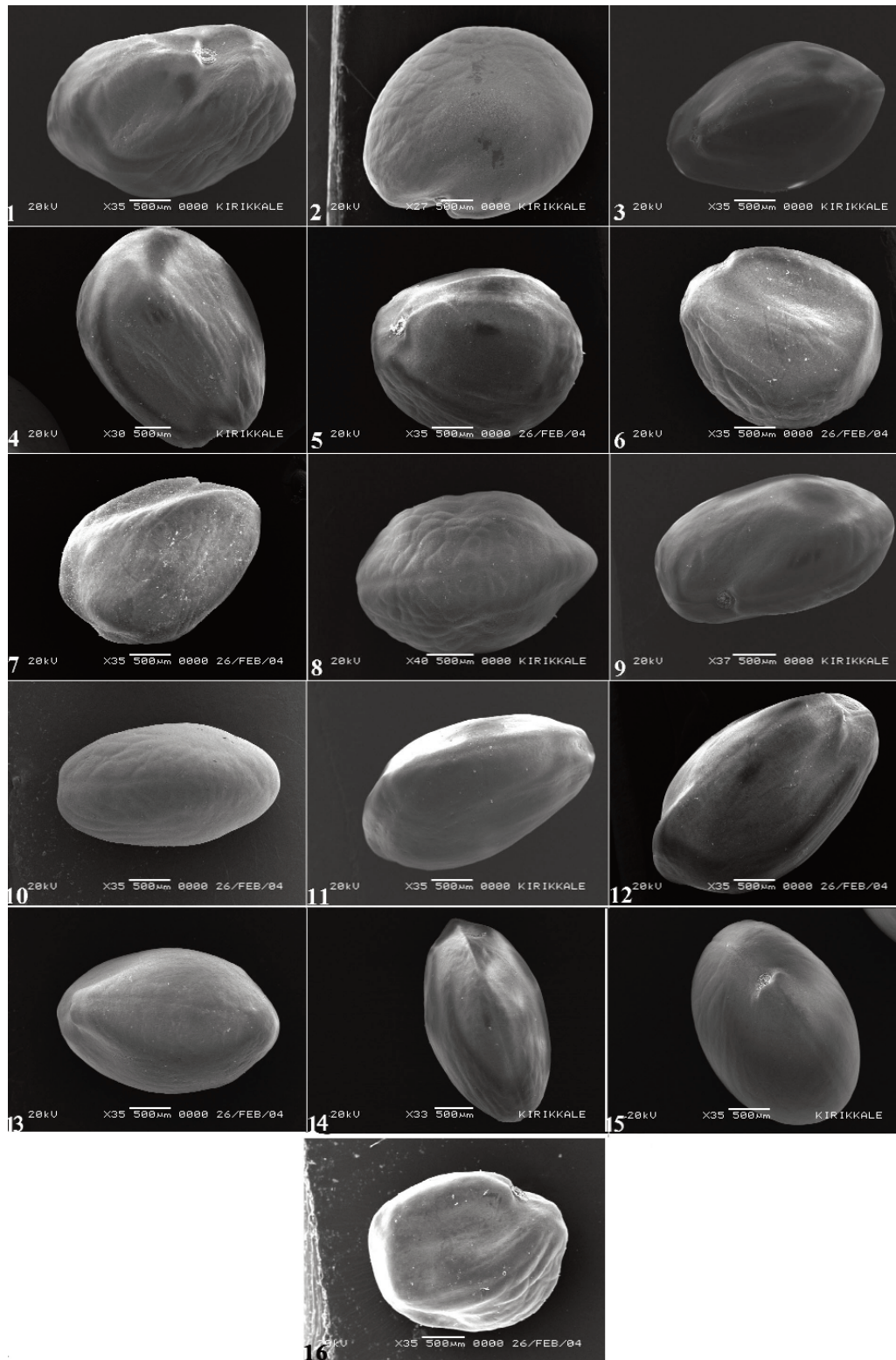


Figure 3. General SEM views of seeds of taxa belong to *Ebenus*. 1. *E. plumosa* var. *plumosa*, 2. *E. plumosa* var. *speciosa*, 3. *E. macrophylla*, 4. *E. barbiger*, 5. *E. reesei* var. *reesei*, 6. *E. reesei* var. *minor*, 7. *E. haussknechtii*, 8. *E. depressa*, 9. *E. bourgaei*, 10. *E. cappadocica*, 11. *E. boissieri*, 12. *E. longipes*, 13. *E. hirsuta*, 14. *E. laguroides* var. *laguroides*, 15. *E. laguroides* var. *cilicica*, 16. *E. pisidica*.

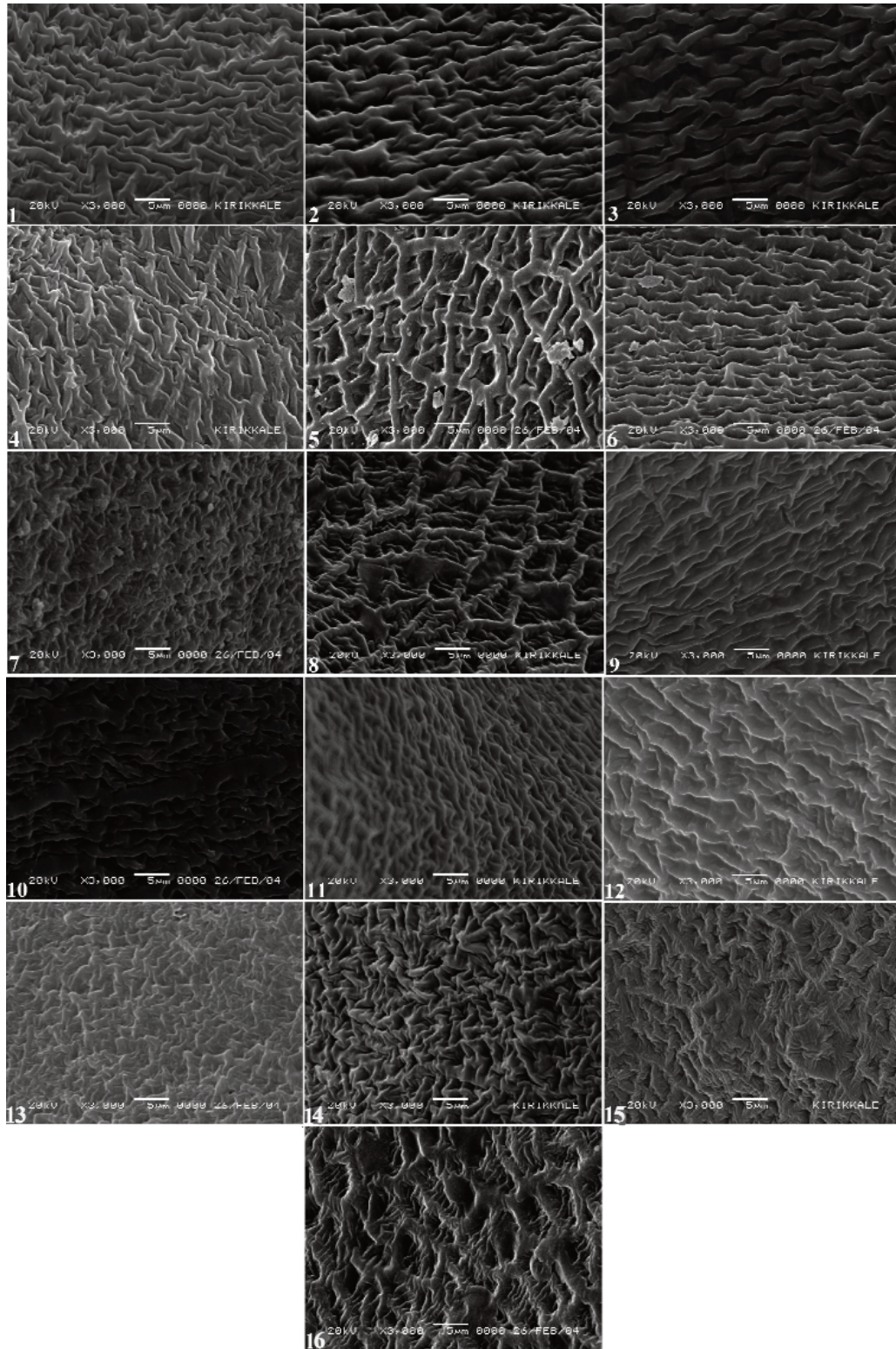


Figure 4. SEM view of seed surfaces of *Ebenus* taxa. 1. *E. plumosa* var. *plumosa*, 2. *E. plumosa* var. *speciosa*, 3. *E. macrophylla*, 4. *E. barbiger*, 5. *E. reesei* var. *reesei*, 6. *E. reesei* var. *minor*, 7. *E. haussknechtii*, 8. *E. depressa*, 9. *E. bourgaei*, 10. *E. cappadocica*, 11. *E. boissieri*, 12. *E. longipes*, 13. *E. hirsuta*, 14. *E. laguroides* var. *laguroides*, 15. *E. laguroides* var. *cilicica*, 16. *E. pisidica*.

Table 1. Seed sizes and seed morphologies of *Ebenus* L. species.

Taxa	Seed Shape	Surface Ornamentation	Seed Width (mm)	Seed Length (mm)	Lumina Size	
					Width(µm)	Length (µm)
<i>E. barbigera</i>	Oblong-Spheroid	Multi-Reticulate	2,12 ± 0,25	2,64 ± 0,24	2,68 ± 0,57	3,95 ± 0,51
<i>E. boissieri</i>	Oblong-Spheroid	Rugose	1,76 ± 0,17	3,28 ± 0,20		
<i>E. bourgaei</i>	Oblong-Spheroid	Reticulate	1,72 ± 0,19	2,57 ± 0,20	2,26 ± 0,34	4,17 ± 0,55
<i>E. cappadocica</i>	Oblong-Spheroid	Reticulate	1,59 ± 0,17	2,51 ± 0,13	1,25 ± 0,28	3,45 ± 0,58
<i>E. depressa</i>	Oblong-Spheroid	Reticulate	1,77 ± 0,12	2,59 ± 0,25	5,14 ± 1,13	5,61 ± 1,61
<i>E. haussknechtii</i>	Oblong-Spheroid	Rugose	1,85 ± 0,34	2,44 ± 0,20		
<i>E. hirsuta</i>	Oblong-Spheroid	Rugose	2,10 ± 0,14	3,29 ± 0,26		
<i>E. laguroides</i> var. <i>cilicica</i>	Oblong-Spheroid	Multi- Reticulate	1,76 ± 0,21	2,40 ± 0,18	0,78 ± 0,13	2,12 ± 0,35
<i>E. laguroides</i> var. <i>laguroides</i>	Oblong-Spheroid	Rugose	1,58 ± 0,20	2,13 ± 0,25		
<i>E. longipes</i>	Oblong-Spheroid	Reticulate	1,99 ± 0,19	3,27 ± 0,20	1,25 ± 0,34	3,00 ± 0,23
<i>E. macrophylla</i>	Oblong-Spheroid	Striate	2,43 ± 0,23	3,12 ± 0,11		
<i>E. pisidica</i>	Orbicular	Reticulate	1,67 ± 0,25	2,18 ± 0,15	3,02 ± 0,23	7,67 ± 0,52
<i>E. plumosa</i> var. <i>plumosa</i>	Oblong-Spheroid	Reticulate	2,47 ± 0,23	3,02 ± 0,19	3,79 ± 0,97	6,79 ± 0,50
<i>E. plumosa</i> var. <i>speciosa</i>	Oblong-Spheroid	Reticulate	2,44 ± 0,26	3,57 ± 0,28	1,65 ± 0,66	3,42 ± 0,88
<i>E. reesei</i> var. <i>minor</i>	Spheroid	Reticulate	1,51 ± 0,28	2,37 ± 0,35	1,98 ± 0,19	2,34 ± 0,49
<i>E. reesei</i> var. <i>reesei</i>	Spheroid	Multi- Reticulate	1,88 ± 0,23	2,64 ± 0,18	0,74 ± 0,24	8,30 ± 1,04

In the Fabaceae family seed surface ornamentation resembles within the closely related genera. Engel (1990) reported that taxa belonging to *Astragalus* L. genus have reticulate, multi-reticulate, and foveolate and multi-foveolate seed surface ornamentation. Vural et al. (2008) studied the seed morphology of *Astragalus* sections *Onobrychoidei* DC., *Uliginosi* Gray and *Ornithopodium* Bunge and showed that seeds have regulate and regulate-reticulate ornamentation. Chernoff et al. (1992) stated that *Vicia*, *Pisum*, *Lens* and *Lathyrus* genera have papillose and tuberculate seed surface ornamentation. The pollen ornamentation of *Ebenus* is reticulate and in *Astragalus* usually microreticulate, rarely reticulate or rugulate (Pinar et al., 2000, 2009).

Investigation of seed morphology of the genus *Ebenus* shows us that, seed shapes and ornamentations are not adequate for separation; however, supports the differentiation of *E. plumosa*, *E. longipes*, and *E. pisidica* and it is understood that *Ebenus* genus is close to *Astragalus* genus regarding their seed and pollen structures.

### Acknowledgements

The present study was financed by the research foundation of Gazi University. We thank Kırıkkale University for the use of their SEM device.

### References

- Aksoy H, Ünal F & Aytaç Z (2001). Karyological study on four endemic *Ebenus* L. Taxa (Fabaceae) in Turkey. *Caryologica* 54: 307-311.
- Aytaç Z (2000). The genus *Ebenus* L. (Leguminose/Fabaceae) in Turkey. *Karaca Arboretum* 5: 145-171.
- Aytaç Z, Ünal F & Pinar MN (2000). Morphological, palynological and cytotaxonomical study of *Ebenus longipes* Boiss et Bal. and *E. argentea* Siehe ex. Bornm. (Fabaceae) from Turkey. *Isr J Plant Sci* 48: 321-326.

- Azcan N, Sariçoban S, Demirci M, Aytaç Z & Başer, KHC (2001). Seed oil of fifteen *Ebenus* taxa growing in Turkey. *Chem Nat Comp* 37: 253-255.
- Brisson JD & Peterson NL (1976). Acritical review of the use of scanning electron microscopy in the seed coat. Proceedings of the workshop on Plant Science Application of SEM. III. *Inst. Techn. Res. Inst. /SEM/1796*, 2.
- Chernoff M, Plitmann U & Kıslev, ME (1992). Seed characters and testa texture in species of Viciae: their taxonomic significance. *Isr J Bot* 41: 167-186.
- Chuang TI & Ornduff R (1992). Seed morphology and systematics of Menyanthaceae. *Am J Bot* 79: 1396-1406.
- Davis PH (ed.) (1988). *Flora of Turkey and the Aegean Islands* (Suppl.), Vol 10. Edinburgh: Edinburgh University Press.
- Engel T (1990). Dornenanatomie und Samenmikromorphologie der kleinasiatischen Vertreter der Gattung *Astracantha* Podl. Sowie der dornigen Arten der Gattung *Astragalus* L. (Fabaceae). In: Cramer J (ed.) *Dissertationes Botanicae*, Band 151, pp. 264-280, Berlin.
- Huber-Morath A (1965). Die Anatolischen Arten der Gattung *Ebenus* L. *Bauhinia*, Band 2, Heft 3, pp. 219-237. Verlag, Basel: Inkommission bei Wepf & Co.
- Huber-Morath A (1970). *Ebenus* L. in: *Flora of Turkey and the East Aegean Islands*, Vol. 3. Edinburgh: Edinburgh University Press.
- Pınar NM, Vural C & Aytaç Z (2000). Polen morphology of *Ebenus* L. (Fabaceae: subfamily Papilionoideae) in Turkey. *Pak J Bot* 32: 303-310.
- Pınar NM, Ekici M, Aytaç Z, Akan H, Çeter T & Alan Ş (2009). Pollen morphology of *Astragalus* L. sect. *Onobrychoidei* DC. (Fabaceae) in Turkey. *Turk J Bot* 33: 291-303.
- Punt W, Blackmore S, Nilsson S & Thomas A (1994) Glossary of pollen and spore terminology. LPP foundation, Utrecht.
- Shetata AA (2006). On the taxonomy of Plantaginaceae Juss. sensu lato: evidence from SEM of the seed coat. *Turk J Bot* 30: 71-84.
- Vural C, Ekici M, Akan H & Aytac Z (2008) Seed Morphology and its systematic implications of genus *Astragalus* L. sections *Onobrychoidei* DC., *Uliginosi* Gray and *Ornithopodium* Bunge (Fabaceae). *Plant Syst Evol* 274: 255-263.