

## SEED COAT MACROSCULPTURING IN SOME TURKISH *AETHIONEMA* R. BR. (BRASSICACEAE)

NUR MÜNEVVER PINAR<sup>1</sup>, NEZAKET ADIGÜZEL<sup>2</sup>, FATMAGÜL GEVEN<sup>1</sup>

<sup>1</sup>*Department of Biology, Science Faculty, Ankara University, Ankara-06100, Turkey,  
pinar@science.ankara.edu.tr*

<sup>2</sup>*Department of Biology, Faculty of Science & Arts, Gazi University, Ankara-06500, Turkey*

### Abstract

Seeds of 17 species of *Aethionema* R.Br. (Brassicaceae) from various regions in Turkey were examined with a scanning electron microscope and light microscope. Based on seed features such as shape, colour and surface ornamentation pattern, 4 morphological types were recognized. The different seed types are described, illustrated compared and their taxonomic importance is discussed.

### Introduction

*Aethionema* R.Br. (Brassicaceae) is a taxonomically complex genus and a few macromorphological characters are available for species delimitation. Life duration (annual or perennial) and fruit morphology are of importance at the species level in *Aethionema*. The genus has its center in Turkey and outside Anatolia the number declined very rapidly (Hedge, 1965). The Turkish flora comprises of about 41 *Aethionema* species, of which 20 species are endemic to Turkey (Davis, 1965; Davis *et al.*, 1988; Güner *et al.*, 2000).

Micromorphological characters may provide additional taxonomic information in the genus. The importance of ultrastructure of seed surface, as a reliable approach for solving taxonomic problems has been well recognised (Heywood, 1971; Buth & Roshan, 1983; Brochmann, 1992; Koul *et al.*, 2000). Until now, the morphology of the seed in relation to taxonomy has not been studied in *Aethionema*.

The aims of the present study are to illustrate the utility of derivated seed morphology features in the identification of most of the species considered, and to relate such characters to the systematics of the genus.

### Materials and Methods

Material used for this study was collected from wild populations and herbarium specimens. Collectors code and localities of collections are shown in the Table 1. Vaucher specimens are deposited at GAZI.

For scanning electron microscopy, dry seeds were mounted directly on stubs using double-sided adhesive tape and coated with gold in a sputter coater. Morphological observations were made under a Jeol 100 CX11 electron microscope. Length and width of 10 seeds for each plant (total 180 seeds) were measured under a stereomicroscope.

Terminology of Brochmann (1992) was followed.

**Table 1. Specimens investigated and localities are as follows.**

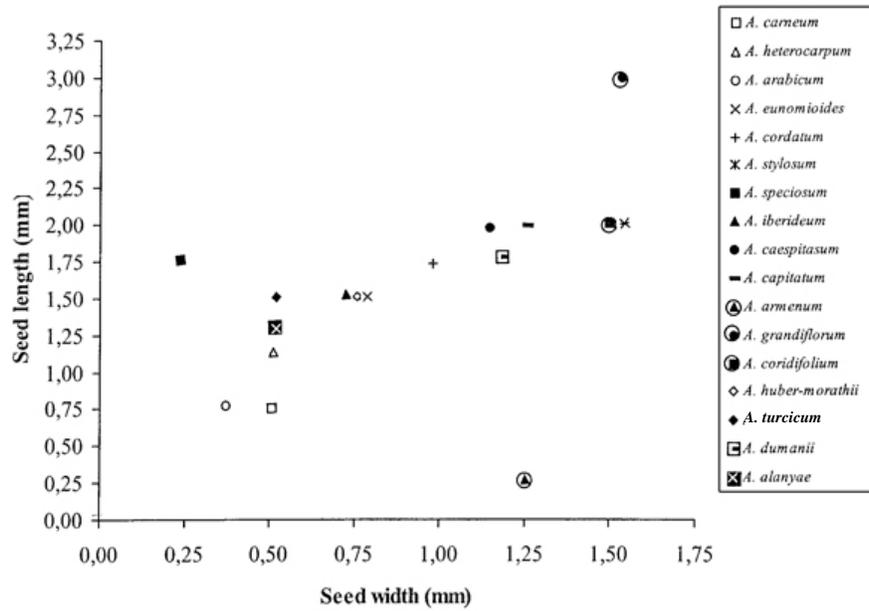
Specimens investigated	Material collecting region in Turkey	Code no.
<i>Ae. carneum</i> (Banks & Sol.) Fedtsch.	Şanlıurfa	2760
<i>Ae. heterocarpum</i> J.Gay	Adana	4505
<i>Ae. arabicum</i> Andrzej ex DC.	Adana	2219
<i>Ae. eunomioides</i> (Boiss.) Bornm.	Kahramanmaraş	5219
<i>Ae. cordatum</i> (Desf.) Boiss.	Ankara	4073
<i>Ae. stylosum</i> DC.	İçel	2992
<i>Ae. speciosum</i> Boiss. & Huet	Kahramanmaraş	5219
<i>Ae. ibericum</i> (Boiss.) Boiss.	Adiyaman	2779
<i>Ae. caespitosum</i> (Boiss.) Boiss.	Kayseri	4695
<i>Ae. capitatum</i> Boiss. & Bal.	Kahramanmaraş	5074
<i>Ae. armenum</i> Boiss.	Ankara	2790
<i>Ae. grandiflorum</i> Boiss. & Hohen.	Kahramanmaraş	3293
<i>Ae. coridifolium</i> DC.	Kahramanmaraş	5173
<i>Ae. huber-morathii</i> Davi & Hedge	Adana	3007
<i>Ae. turcicum</i> DC.	Ankara	3807
<i>Ae. dumaii</i> Vural & Adıgüzel	Ankara	2787
<i>Ae. alanyae</i> Duman	Antalya	4976

## Results

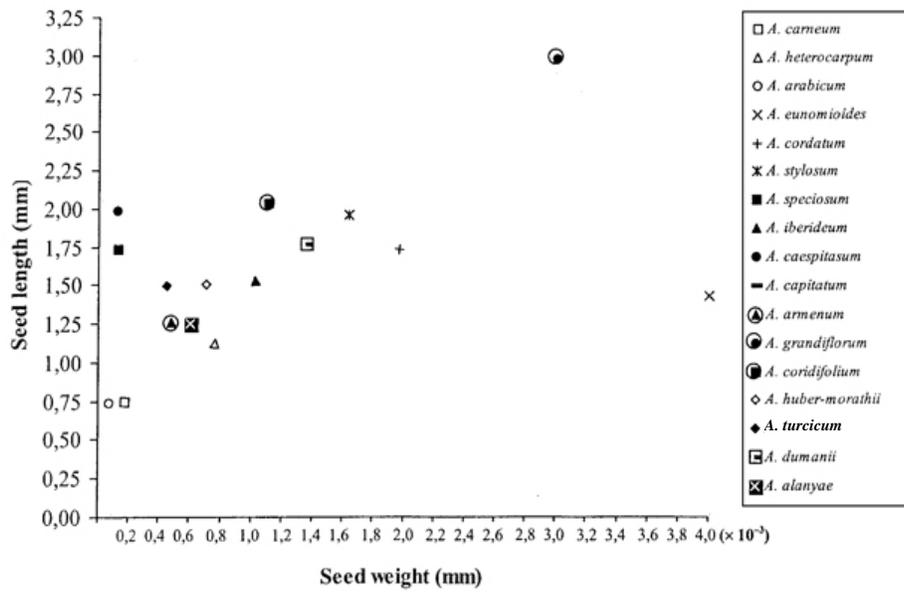
**Seed Micromorphology:** Quite a large variations in seed size, shape and weight was found among species (Table 2). There is correlation between seed length and seed width ( $r=0,501-0,543$ ) (Fig. 1-a). The seed weight is correlated with seed length ( $r=0,4036$ ,  $p<0,0005$ ) (Fig. 1-b). The smallest seeds are observed in *A. carneum* (average length 0.85 mm, width 0.5 mm, and weight 0.0002 gr) and in *A. arabicum* (average length 0.75 mm, width 0.3 mm, and weight 0.0001 gr). In contrast, very large and heavy seeds are observed in *A. grandiflorum*; the seeds of this species are, on an average, 3 mm long, 1.5 mm wide, and weigh 0.003 gr (Table 2).

Although outlines of the seeds are generally elliptic, in *A. speciosum* outline of the seeds is rectangular and in *A. armenum* it is sickle shaped (Table 2). The seeds of *A. carneum*, *A. heterocarpum*, *A. stylosum*, *A. iberideum* and *A. dumaii* were clear brown; the seeds of *A. arabicum*, *A. eunomioides*, *A. cordatum*, *A. speciosum*, *A. armenum*, *Ae. turcicum* and *A. huber-morathii* were dark brown and the seeds of *A. caespitosum*, *A. capitatum*, *A. grandiflorum* and *A. coridifolium* are dark green (Table 2).

**Seed Macromorphology:** The important features of the seed testa topographies of 17 taxa examined are presented in Table 3, 4, 5 and 6. Taxa representing different surface pattern groups are given in Table 3. At higher magnification (SEM X 500, 800 and 1000), the seed surface ornamentations could be divided into a total of four different patterns: reticulate, reticulate-clavate, reticulate-verrucate and verrucate. The majority of species represented the reticulate-verrucate type (8 species), followed by reticulate (4 species), verrucate (4 species). The ruminant is represented by a single species (Table 3). These pattern groups are distinguished by the generally species-species variation in microsculpturing features (Table 4, 5 and 6). *A. iberideum*, *A. stylosum*, *A. eunomioides* and *A. dumaii* show a reticulate pattern, but they vary in the reticulum.



(a)



(b)

Fig. 1. (a) Correlation among seed length and seed width, (b) Correlation among seed length and seed weight.

Table 2 Seed morphology of *Aethionema* R.Br. Seed length (mm), width (mm) and weight (gr) are based on mean values for seeds of 17 species.

Species	Length (mm)	Width (mm)	Length/ Width	Weight (gr)	Outline	Colour
<i>Aethionema carneum</i> (Banks & Sal.) tedtsch	0.75	0.5	1.5	0.0002	eliptic	clear brown
<i>A. heterocarpum</i> Gay	1.1	0.5	2.2	0.0008	eliptic	clear brown
<i>A. arabicum</i> Andrzej ex DC.	0.75	0.3	2.5	0.00011	eliptic	dark brown
<i>A. eunomioides</i> (Boiss.) Bornm.	1.5	0.75	2	0.005	eliptic	dark brown
<i>A. cordatum</i> (Desf.) Boiss.	1.75	1	1.75	0.002	eliptic	dark brown
<i>A. stylosum</i> DC.	2	1.5	1.3	0.0017	eliptic	clear brown
<i>A. speciosum</i> Boiss. & Huet ssp. <i>speciosum</i>	1.75	0.25	7	0.00016	rectangular	dark brown
<i>A. iberideum</i> (Boiss.) Boiss.	1.5	0.75	2	0.001	eliptic	clear brown
<i>A. caespitosum</i> (Boiss.) Boiss.	2	1.1	1.8	0.00016	eliptic	dark green
<i>A. capitatum</i> Boiss. & Bal.	2	1.25	1.6	0.001	eliptic	dark green
<i>A. armenum</i> Boiss.	1.25	0.25	5	0.0005	sickle	dark brown
<i>A. grandiflorum</i> Boiss. & Hohen	3	1.5	2	0.003	eliptic	dark green
<i>A. coridifolium</i> DC.	2	1.5	1.3	0.001	eliptic	dark green
<i>A. huber-morathii</i> Davis & Hedge	1.5	0.75	2	0.00075	eliptic	dark brown
<i>A. turcicum</i> DC.	1.5	0.5	3	0.0005	eliptic	dark brown
<i>A. dumanii</i> Vural & Adgüzel	1.75	1.2	1.46	0.0014	eliptic	clear brown
<i>A. alaryae</i> Duman	1.25	0.5	2.5	0.0006	eliptic	dark brown

**Table 3. Different seed coat pattern groups and distribution of species of *Aethionema* (using terminology of Brochmann, 1992).**

Seed coat ornamentation			
Reticulate	Ruminate	Reticulate-verrucate	Verrucate
<i>A. iberideum</i>	<i>A. caespitosum</i>	<i>A. cordatum</i>	<i>A. heterocarpum</i>
<i>A. stylosum</i>		<i>A. alanyae</i>	<i>A. arabicum</i>
<i>A. eunomioides</i>		<i>A. capitatum</i>	<i>A. turcicum</i>
<i>A. dumanii</i>		<i>A. coridifolium</i>	<i>A. carneum</i>
		<i>A. grandiflorum</i>	
		<i>A. armenum</i>	
		<i>A. speciosum</i> ssp. <i>Specitasum</i>	
		<i>A. huber-morathii</i>	

In *A. iberideum*, the reticulum wall is thick and smooth with wide, undulations transversing the interspace (Fig. 9). In *A. stylosum*, reticulum wall is thin and smooth with wide, papilated undulations transversing the interspace (Fig. 7 and Table 4). In *A. eunomioides* (Fig. 3) and *A. dumanii* (Fig. 20) reticulum walls are thin and undulate. Among the species with the reticulate-verrucate pattern, i.e. *A. cordatum* (Fig. 6), *A. alanyae* (Fig. 21), *A. capitatum* (Fig. 12), *A. coridifolium* (Figs. 16, 17), *A. grandiflorum* (Figs. 14, 15), *A. armenum* (Fig. 13), *A. speciosum* (Fig. 8) and *A. huber-morathii* (Fig. 18), variations exist in the reticulum wall thickness and characteristics of warts. In *A. alanyae*, *A. capitatum*, *A. armenum*, *A. coridifolium*, *A. huber-morathii* the walls are rather smoother, in *A. cordatum*, *A. grandiflorum* and *A. speciosum* the walls are rather undulate (Table 5). With the verrucate pattern, *A. heterocarpum* (Fig. 5), *A. arabicum* (Fig. 2), *A. turcicum* (Fig. 19) and *A. carneum* (Fig. 4), show a verrucate pattern. In some species smaller projections are intermingled with layer ones; the projections can be smooth or granulate. *A. caespitosum* (Figs. 10,11) shows ornamentation of the ruminate type.

### Discussion

Color, size and ornamentation of seeds provide important characters to distinguish some taxa (Brochmann, 1992; Koul *et al.*, 2000; Juan *et al.*, 1999). The seeds of *Aethionema* are 0.75-3 mm long and 0.25-1.5 mm wide. They are larger than seed of *Draba* L., species (0.76-1.3 mm long and 0.49-0.9 wide ) (Brachmann, 1992). The biggest seed size was found in *Ae. grandifolium*. There was only one elliptic seed type seeds in *Draba* species. Three seed shapes were observed in *Aethionema* viz., rectangular, sickle and elliptic types (Table 2). There was a linear relation between the seed weight and seed length and seed width in *Draba*. We also observed a correlation between the seed length and seed weight in *Aethionema* (Fig. 1.a, b).

The color of the seeds is very important in distinction of *Draba* and *Bolboschoenus maritimus* L. (Palla.) (Browning *et al.*, 1997; Brochmann, 1992). There were three colors light brown, dark brown and dark green observed in *Aethionema* (Table 2).

The surface ornamentations are also of great importance for this species. There was one type of major surface ornamentation in *Draba* species (Brochmann, 1992). This number is 10 in the seeds of *Brassica* L., (Koul *et al.*, 2000) and 4 in the seeds of *Aethionema* (Table 3).

Table 4. Microsculpturing features in species showing reticulate type of seed coat pattern.

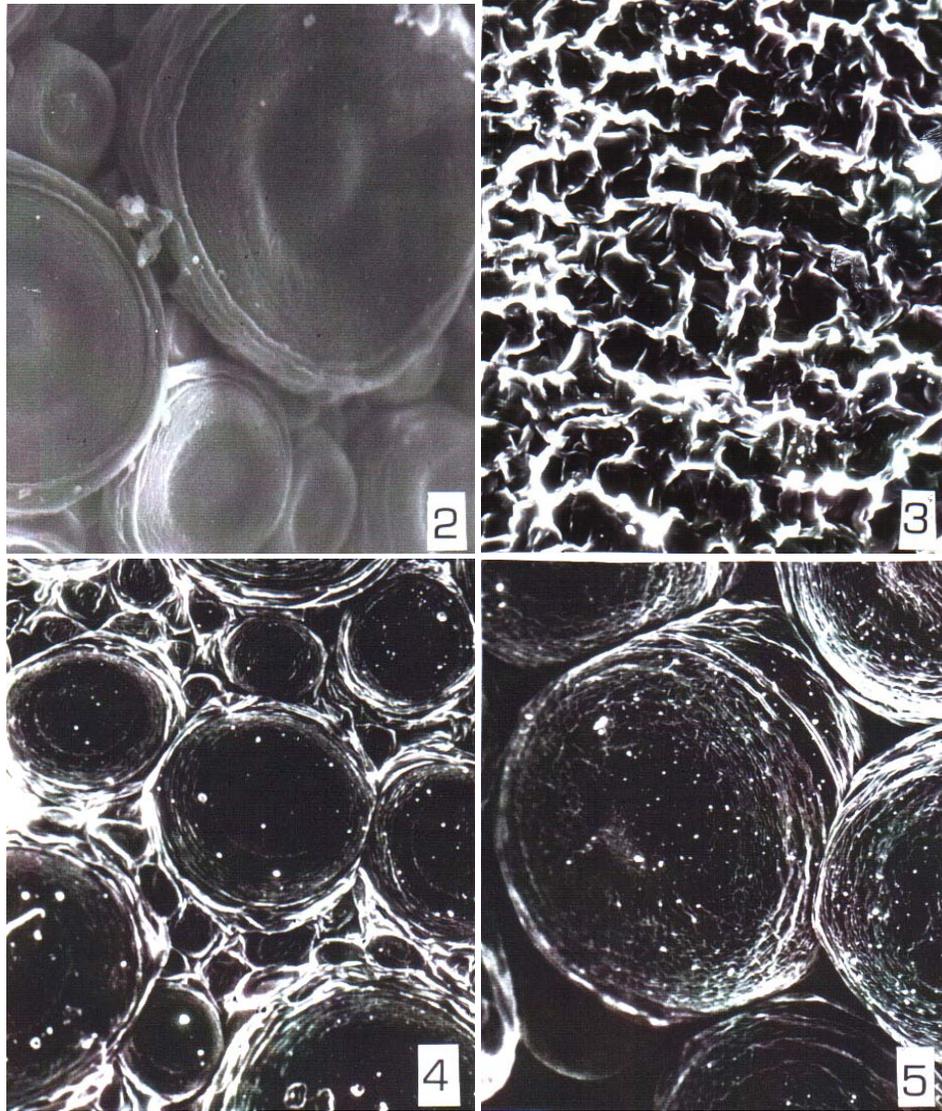
	Reticulum wall				Interspace			
	Thick	Thin	Smooth	Undulate	Narrow	Wide	Undulate	Papilate
<i>A. iberideum</i>	+	-	+	-	-	+	+	-
<i>A. dumani</i>	-	+	-	+	+	-	+	-
<i>A. eunomioides</i>	-	+	-	+	+	-	+	-
<i>A. stylosum</i>	-	+	+	-	-	+	+	+

Table 5. Microsculpturing features in species showing reticulate-verrucate type of seed coat pattern.

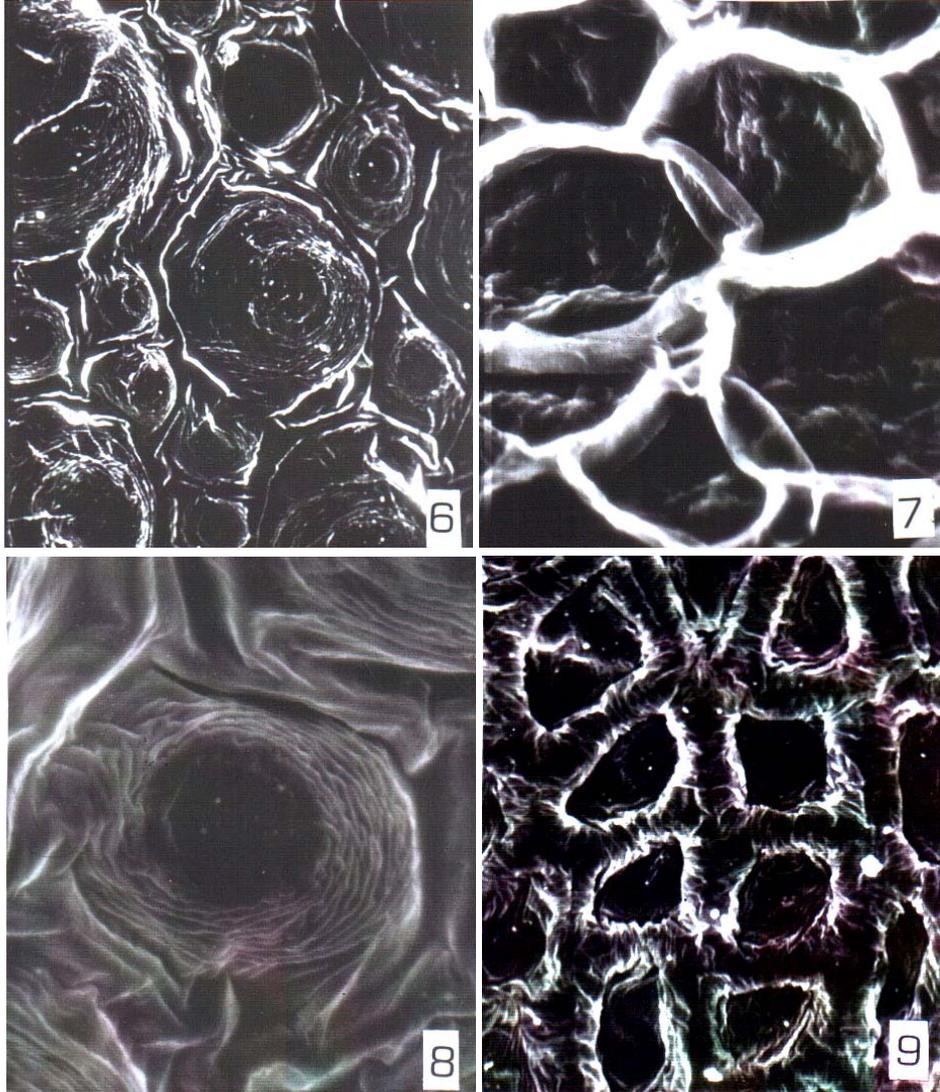
	Reticulum wall				Characteristics of warts			
	Thick	Thin	Smooth	Undulate	Striate	Smooth	Showing equal size	Showing unequal size
<i>A. alanyae</i>	-	+	+	-	-	+	+	-
<i>A. armenum</i>	-	+	+	-	+	-	-	+
<i>A. capitatum</i>	-	+	+	-	+	-	+	-
<i>A. coridifolium</i>	+	-	+	-	+	-	-	+
<i>A. cordatum</i>	-	+	-	+	+	-	-	+
<i>A. grandiflorum</i>	-	+	-	+	-	+	+	-
<i>A. huber-morathii</i>	-	+	+	-	-	+	+	-
<i>A. speciosum ssp. specitosum</i>	-	+	-	+	+	-	-	+

Table 6 Microsculpturing features in species showing verrucate type of seed coat pattern.

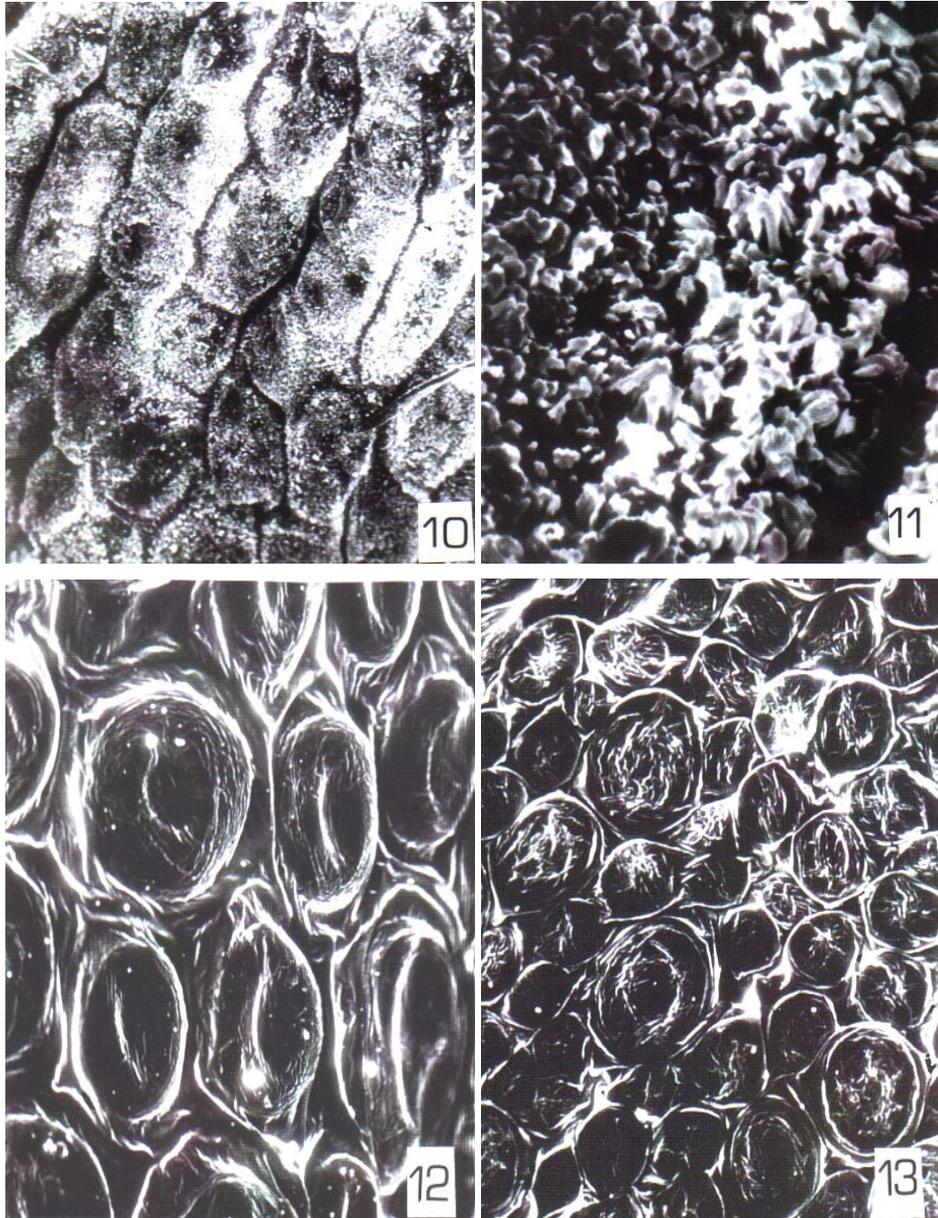
	Characteristics of warts			
	Striate	Smooth	Showing equal size	Granulate
<i>A. arabicum</i>	+	-	-	-
<i>A. carneum</i>	+	-	-	+
<i>A. heterocarpum</i>	+	-	+	+
<i>A. turcicum</i>	+	-	-	-



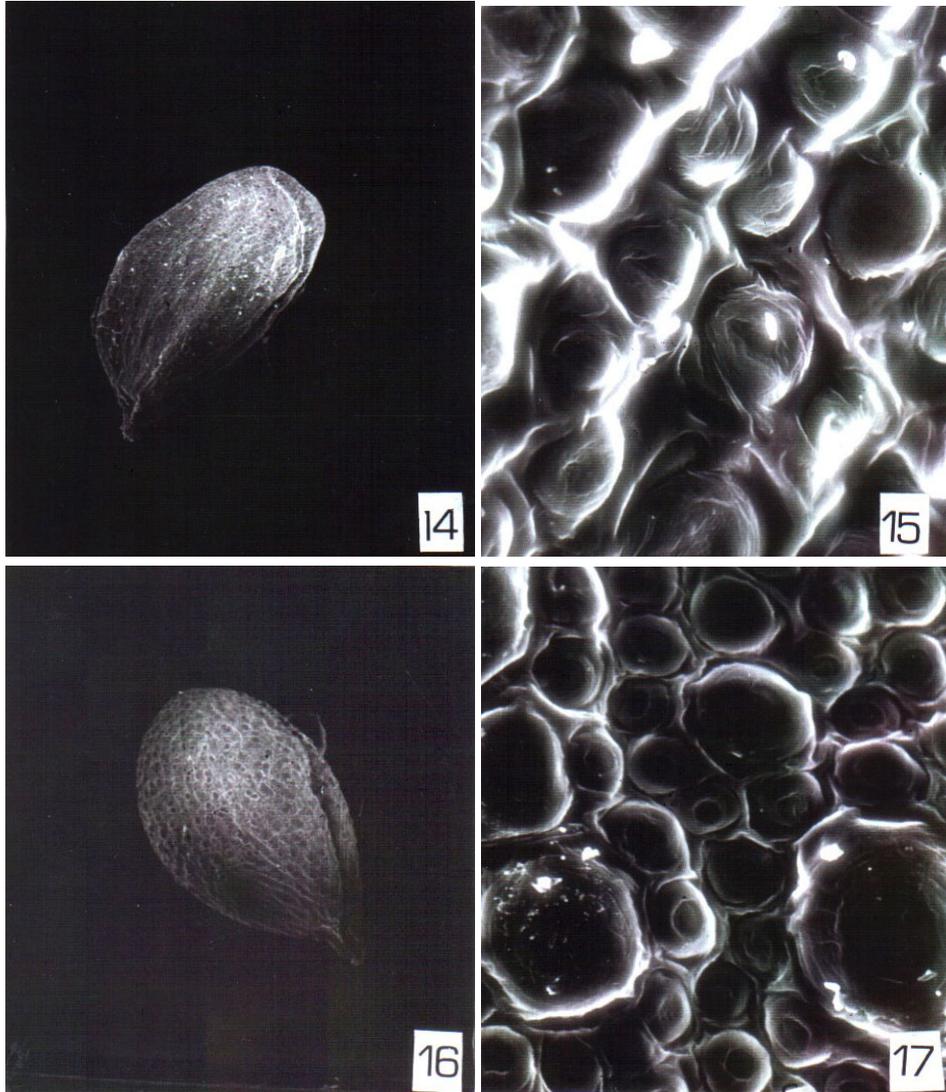
Figs. 2-5. SEM micrographs of seed surface. Fig. 2. *Aethionema arabicum*, verrucate type, SEMx800. Fig. 3. *A. eunomioides*, reticulate type, SEMx500. Fig. 4. *A. carneum*, verrucate type, SEMx500. Fig. 5. *A. heterocarpum*, verrucate type, SEMx800.



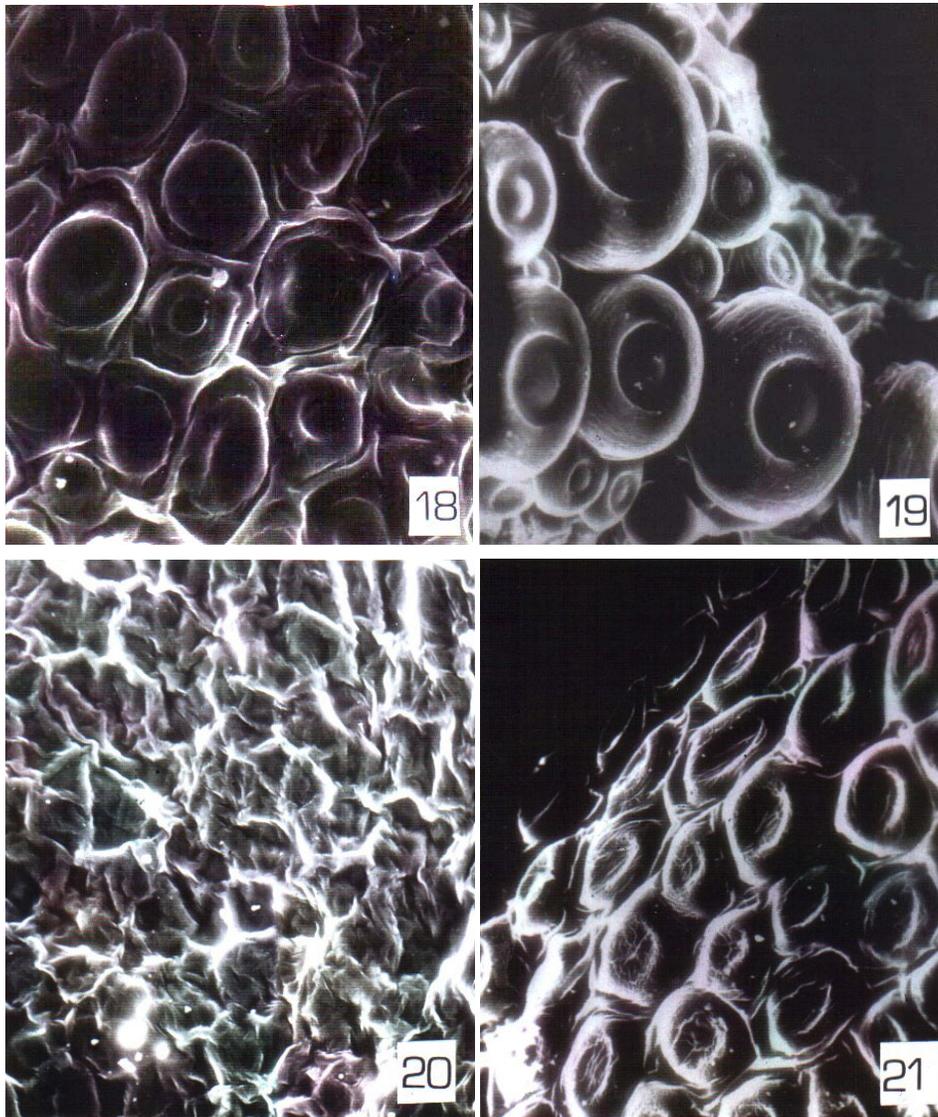
Figs. 6-9. SEM micrographs of seed surface. Fig. 6. *A. cordatum*, reticulate-vernucate type, SEMx800. Fig. 7. *A. stylosum*, reticulate type, SEMx800. Fig. 8. *A. speciosum*, reticulate-vernucate type, SEMx1000. Fig. 9. *A. iberideum*, reticulate type, SEMx1000.



Figs. 10-13. SEM micrographs of seed surface. Fig. 10-11. *A. caespitosum*, ruminated type, SEMx500, Fig. 12. *A. capitatum*, reticulate- verrucate type, SEMx1000. Fig. 13. *A. armenum*, reticulate- verrucate type, SEMx800.



Figs. 14-17. SEM micrographs of seed morphology and seed surface. Figs. 14-15. *A. grandiflorum*, reticulate- verrucate type, SEMx20, SEMx1000. Figs. 16-17. *A. coridifolium*, reticulate- verrucate type, SEMx20, SEMx500.



Figs. 18-21. SEM micrographs of seed surface. Fig. 18. *A. huber-morathii*, reticulate-verrucate type, SEMx800. Fig. 19. *A. turcicum*, verrucate type, SEMx800. Fig. 20. *A. dumanii*, reticulate type, SEMx500. Fig. 21. *A. alanya*, reticulate-verrucate type, SEMx1000.

**Type I. The ones with reticulated seed surface ornamentation:** The species with this type of seed surface ornamentation are *A. iberideum* (Fig. 9), *A. stylosum* (Fig. 7) *A. eunominoide*s (Fig. 3) and *A. dumanii* (Fig. 20). *A. iberideum* is distinguishable from the others by its thick muri and wide diameter of the lumina, *A. eunominoide*s and *A. dumanii* are distinguishable by the thin wavy muri and the narrow diameter of the lumina. Although the seeds of *A. eunominoide*s and *A. dumanii* are quite similar as regards to

surface ornamentations they show differences in weight (*A. eunominoides*; 0.0005 gr, *A. dumanii*; 0.0014 gr) and in color (*A. eunominoides* dark brown, *A. dumanii* light brown)

**Type II: The ones with ruminant seed surface ornamentation :** This is only observed in *A. caespitosum* (Figs. 10, 11).

**Type III: The ones with reticulate- verrucated seed surface ornamentation:** The seeds, which show this type of surface ornamentation are *A. cordatum* (Fig. 6), *A. alanyae* (Fig. 21), *A. capitatum* (Fig. 12), *A. coridifolium* (Figs. 16, 17), *A. grandiflorum* (Figs. 14, 15), *A. armenum* (Fig. 13), *A. speciosum* (Fig. 8), and *A. huber-morathii* (Fig. 18). *A. cordatum* and *A. alanyae* have thin and straight muri and smooth wart, *A. capitatum* with thin and straight muri and striated warts, *A. coridifolium* has thick muri, *A. grandiflorum* has thin and undulated muri and smooth wart and *A. armenum* has thin and smooth muri and striated warts. *A. speciosum* and *A. cordatum* and *A. huber-morathii* and *A. alanyae* are very similar as regards to surface ornamentations and they are very hard to distinguish from each other. *A. huber-morathii* and *A. alanyae* are very much alike as regards to other features while *A. speciosum* is easily distinguishable from *A. cordatum* with its rectangular seed shape (Table 1)

**Type IV: The ones with verrucated seed surface ornamentation :** Among these are *A. heterocarpum* (Fig. 5), *A. arabicum* (Fig. 2), *A. turcicum* (Fig. 19), and *A. carneum* (Fig. 4). *A. arabicum* and *A. turcicum* have the same surface ornamentation as regards to wart features, *A. heterocarpum* can be separated with similar size wart distribution and *A. carneum* can be distinguished with its granulated and different size distribution (Table 6). The seeds of *A. turcicum* are larger in size than those of *A. arabicum* (Table 6).

## References

- Adigizel, N. 2000. *Aethionema* R.Br., in Güner A, Özhatay N., Ekim T., Bazer KHC (Eds.): Flora of Turkey and the East Aegean Islands. Vol. 11: 31-34, Edinburgh Univ. Press, Edinburgh.
- Brochmann, C. 1992. Pollen and seed anatomy of Nordic *Draba* (*Brassicaceae*) phylogenetic and ecological implications. *Nordic J. of Botany*, 12(6): 657-673.
- Browning, J., K.D. Gray-Gordon, S.G. Smith and J.V. Staden. 1997. *Bolboschoenus maritimus*. I. In the Netherlands: a study of pericarp anatomy based on the work of Irene Robertus-Koster. *Ann. Bot. Fennici.*, 34: 115-126.
- Buth, G.M. and A. Roshan. 1983. Seed coat anatomy of some cultivated *Brassica*. *Phytomorphology*, 31: 69-78.
- Davis, P.H., R.R. Mill and K. Tan. 1988. Flora of Turkey and the East Aegean Islands. 10: 35-39, Edinburgh Univ. Press, Edinburgh.
- Hedge, I.C. 1965. *Aethionema* R. Br., In: *Flora of Turkey and the east Aegean Islands*. (Ed.): P.H. Davis. 1: 314-330, Edinburgh, Univ. Press.
- Heywood, V.H. 1971. The characteristics of the scanning electron microscopes and their importance in biological studies. In: *Scanning electron microscopy: Systematic and Evolutionary applications*, (Ed.): V.H. Heywood. 4: London.
- Koul, K.K., R. Nagpal and S.N. Raina. 2000. Seed coat microsculpturing in *Brassica* and Allied genera (Subtribes *Brassicinae*, *Raphaninae*, *Morcardinae*). *Annals of Botany*, 86: 385-397.
- Murley, M.R. 1951. Seeds of the *Cruciferae* of North Eastern America. *American Midle Naturalichen*, 46:1-8.

(Received for publication 1 August 2002)