



## Research Article

**Pollen Morphologies of Some Taxa of the Genus *Alyssum* L. (Brassicaceae)**Gulden Dogan<sup>1\*</sup>, Dilara Celayir Yılmaz<sup>2</sup>, Azize Demirpolat<sup>3</sup>, Yasar Kiran<sup>4</sup>, Serkan Doğan<sup>5</sup><sup>1</sup> Firat University, Science Faculty, Biology Department, Elazığ, Türkiye; <https://orcid.org/0000-0002-7668-3368><sup>2</sup> Firat University, Science Faculty, Biology Department, Elazığ, Türkiye; <https://orcid.org/0000-0002-1062-2490><sup>3</sup> Vocational School of Food, Agriculture and Livestock, University of Bingöl, Türkiye; <https://orcid.org/0000-0001-7192-185X><sup>4</sup> Firat University, Science Faculty, Biology Department, Elazığ, Türkiye; <https://orcid.org/0000-0002-3225-2080><sup>5</sup> Firat University, Science Faculty, Biology Department, Elazığ, Türkiye; <https://orcid.org/0009-0005-3805-920>\* Corresponding author: [gdogan@firat.edu.tr](mailto:gdogan@firat.edu.tr)

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**Abstract:** In this study, genera of *Alyssum* from the family Brassicaceae, *A. condensatum* subsp. *flexibile* (Nyár.) T.R. Dudley, *A. filiforme* Nyár., *A. xanthocarpum* Boiss., *A. simplex* Rudolph, *A. macropodium* Boiss. & Balansa, *A. contemptum* Schott & Kotschy, *A. trichostachyum* Rupr., *A. callichorum* Boiss. & Balansa, *A. strigosum* subsp. *strigosum* Banks & Sol., *A. strictum* Willd., *A. praecox* Boiss. & Balansa and *A. peltarioides* subsp. *virgatiforme* (Nyár.) T.R. Dudley taxa the morphologies of the pollen were revealed using light microscopy (LM) and scanning electron microscopy (SEM). As a result of this study, some common features were found in pollen such as monad, radial symmetry, isopolar, pollen shapes being mainly subprolate and prolate, aperture type tricolpate and exine tectate. However, it was determined that the pollen shape in *A. contemptum* species is prolate-spheroidal unlike other species. In addition, the largest pollens were found in *A. xanthocarpum* and *A. strigosum* species, and the smallest pollens were found in *A. peltarioides* subsp. *virgatiforme* and *A. callichorum* species. SEM microphoto also indicated that ornamentation structures were reticulate.

**Keywords:** *Alyssum*; Brassicaceae; LM; pollen morphology; SEM.**1. Introduction**

The Brassicaceae family is widespread in all continents except Antarctica (Koch and Kiefer, 2006). It consists of 49 tribes, about 321 genera and 3660 species (Al-Shehbaz, 2012). The Alysseae tribe consists of 24 genera and about 277 species, the majority of which are in *Alyssum* (Warwick et al., 2006; Al-Shehbaz 2012; Španiel et al., 2015). *Alyssum* L. is one of the largest genera with approximately 230 species in Brassicaceae and its main distribution areas are Eastern Europe and Turkey (Al-Shehbaz and Beilstein, 2006). The genus *Alyssum* is among the large genera of Turkey's Flora and represented by 90 species, 54 of these species are endemic (Davis, 1985; Davis et al., 1988; Guner et al., 2012).

Some *Alyssum* species have been cultivated and used as ornamental plants in parks and gardens. In general, *Alyssum* species (especially perennial ones) can be used as pioneer plants in erosion studies because they are resistant to drought and are not very selective in terms of soil requirements (Kursat et al.,



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2008). In addition to this, the fact that some *Alyssum* species have the ability to accumulate nickel is a very important feature in terms of environmental pollution. In recent years, terrestrial plants have come to the fore as a natural solution for the economical removal of heavy metal pollution. These plants can be used in many types of soil and can absorb and detoxify heavy metals in a non-destructive way, and thanks to these features, they have become a very valuable plant group.

According to Khan, the pollens of the Brassicaceae family are generally isopolar, three-six colpate, colpate, intersubangular, sub-angular, semi-angular, circular. Colpuses are usually found in depressions or between lobes, rarely located in the corners. Pollens have prolate and oblate-spheroidal shapes (Khan, 2003). Appel and Al-Shehbaz (2003) made an important study on the morphology of the pollen grains of the Brassicaceae family. In this study, they stated that the ornamentation of the pollen grains was reticulate type and the pollen grains were tricolpate type. Qaiser and Perveen (2004) determined that the Brassicaceae family pollens are very similar to the Tamricaceae family in terms of general external characteristics and that both families have reticulated, thick-walled and tricolpate pollens. Erdtman (1952) reported that this family is more similar to the Capparaceae family.

The pollen morphology of *Alyssum* taxa is homogeneous, with pollen shape varying from subprolate to prolate, as demonstrated by studies on *Alyssum* taxa by Faegri and Iversen (1989) and Moore et al. (1991). This also confirms that pollen shape can vary both among species and among populations of a species. Palynological studies have been carried out on members of the genus by different researchers. These include İnceoğlu and Karamustafa (1977), İnce and Vural (1994), Khan (2003), Orcan and Binzet (2003, 2004), Khalik (2005), Bolurian (2009), Kursat et al. (2008), Bahrami et al. (2012) and Baser et al. (2018). In most of these studies, it was reported that there are 3 pollen types (subprolate, prolate-spheroidal and prolate) and reticulate exine ornaments in members of the genus *Alyssum*. The aim of this study is to provide detailed information about the palynological features and morphology of *Alyssum* and to contribute to the systematics of the genus.

## 2. Materials and Methods

We employed LM and SEM in order to conduct palynological studies of 12 taxa of the genus *Alyssum*. Voucher specimens and they locality are listed in Table 1. Voucher specimens are deposited in the Herbarium of Firat University (FUH). Pollen grains were prepared for light (LM) by standard methods described by Wodehouse (1935). For light microscopy, pollen grains were placed in unstained glycerin jelly and observations of pollen grains were made with an Olympus Binocular Microscope at 1000× magnification. Measurements are scored for at least 30 mature pollen grains per specimen. Polar axis (P), equatorial diameter (E), P/E ratio, exine (ex), intine (i), colpi long axis (Clg), colpi short axis (Clf) and apocolpium (t) were also measured (Table 2).

For scanning electron microscopy examination, pollen grains were placed on gold-plated logs. SEM examination was performed with the help of a “ZEISS Sigma 300” brand scanning electron microscope located in the Van Yuzuncu Yil University Central Research Laboratory (BAUM). The terminology used is in accordance with Faegri and Iversen (1989), Moore et al. (1991), Punt et al. (2007) and Erdtman (1952).

**Table 1.** Voucher specimens and they locality.

Taxa	Province	Locality
<i>A. condensatum</i> subsp. <i>flexibile</i>	B7: Elazığ	Baltaşı Village, roadside, 1050 m
<i>A. filiforme</i>	B7: Elazığ	Kömürhan, Kuş Palace, roadside, 900 m
<i>A. xanthocarpum</i>	B6: Malatya	Kubbe Mountain, northern slopes, 2000 m
<i>A. simplex</i>	B6: Malatya	Darende-Gürün roadside, 1200 m
<i>A. macropodum</i>	B6: Malatya	Gülek Gorge, southern slopes, 1050 m
<i>A. contemptum</i>	B6: Malatya	Kubbe Mountain, steppe areas, 1930 m
<i>A. trichostachyum</i>	C5: Içel	Gülek Gorge, southern slopes, 1000 m
<i>A. callichroum</i>	B6: Malatya	Gülek Gorge, southern slopes, 1020 m
<i>A. strigosum</i> subsp. <i>strigosum</i>	B7: Elazığ	Keban, Cabbar Uşağı Village, 1200 m
<i>A. strictum</i>	B7: Elazığ	Yaylım Mountain, roadside, 2000 m

<i>A. praecox</i>	B6: Malatya	Nemrut Mountain, roadside, 1950 m
<i>A. peltarioides</i> subsp. <i>virgatiforme</i>	B7: Elazığ	Kup Mountain, northern slopes, 1900 m

### 3. Results

12 taxa belonging to the *Alyssum* and *Odontarrhena* sections of the *Alyssum* genus in Turkey were studied palynologically. As a result of all examinations, it was determined that the pollen grains were radially symmetrical and isopolar, the pollen grains were tricolpate type and monad. Also, all pollen ornamentation is reticulate. It was observed that the polar axis varied between 21.63  $\mu\text{m}$  and 40.70  $\mu\text{m}$ , and the equatorial axis varied between 15.67  $\mu\text{m}$  and 25.65  $\mu\text{m}$ . The largest pollen grains are *A. xanthocarpum* with an average polar axis of 40.70  $\mu\text{m}$ , and *A. strigosum* with an approximate equatorial axis of 25.65  $\mu\text{m}$ . The smallest pollen grains are *A. A. peltarioides* subsp. *virgatiforme* with an average polar axis of 21.63  $\mu\text{m}$ , and *A. callichorum* with an approximate equatorial axis of 15.67  $\mu\text{m}$  (Table 2).

The colpus length (Clg) of the pollen grains ranges from 12.97 to 33.21  $\mu\text{m}$ , and the colpus width (Clt) ranges from 0.82 to 1.43  $\mu\text{m}$ . The species with the highest approximate Clg and Clt values is *A. xanthocarpum*, while the lowest is *A. callichorum*. The colpus is long and flat, and has a structure that tightens towards the polar. The apocolpium (t) value varies between 8.09 and 20.97  $\mu\text{m}$ , and the highest value is found in *A. condensatum* subsp. *flexibile*. The exine thickness of the pollen grains examined is between 0.81 and 1.35  $\mu\text{m}$ , and the ornamentation of all pollen grains is reticulate. The intine thickness varies between 0.40 and 0.60  $\mu\text{m}$ .

#### 3.1. *Alyssum condensatum* subsp. *flexibile* (Nyár.) T.R. Dudley

The pollen shape was prolate (P/E= 1.35) with a polar axis of 31.92  $\mu\text{m}$  and an equatorial diameter of 23.51  $\mu\text{m}$ . The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 24.12  $\mu\text{m}$  and width of 1.11  $\mu\text{m}$ . Exine thickness was 1.00  $\mu\text{m}$ , intine thickness was 0.49  $\mu\text{m}$ . Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1A, 2A, 3A).

#### 3.2. *Alyssum filiforme* Nyár.

The pollen shape was subprolate (P/E: 1.27) with a polar axis of 21.74  $\mu\text{m}$  and an equatorial diameter of 17.09  $\mu\text{m}$ . The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 19.13  $\mu\text{m}$  and width of 1.09  $\mu\text{m}$ . Exine thickness was 0.95  $\mu\text{m}$ , intine thickness was 0.41  $\mu\text{m}$ . Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1B, 2B, 3B).

#### 3.3. *Alyssum xanthocarpum* Boiss.

The pollen shape was prolate (P/E: 1.61) with a polar axis of 40.70  $\mu\text{m}$  and an equatorial diameter of 23.39  $\mu\text{m}$ . The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 33.21  $\mu\text{m}$  and width of 1.43  $\mu\text{m}$ . Exine thickness was 1.35  $\mu\text{m}$ , intine thickness was 0.55  $\mu\text{m}$ . Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1C, 2C, 3C).

#### 3.4. *Alyssum simplex* Rudolph

The pollen shape was subprolate (P/E: 1.18) with a polar axis of 24.09  $\mu\text{m}$  and an equatorial diameter of 20.41  $\mu\text{m}$ . The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 21.01  $\mu\text{m}$  and width of 1.03  $\mu\text{m}$ . Exine thickness was 0.99  $\mu\text{m}$ , intine thickness was 0.60  $\mu\text{m}$ . Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1D, 2D, 3D).

#### 3.5. *Alyssum macropodum* Boiss. & Balansa

The pollen shape was subprolate (P/E: 1.24) with a polar axis of 23.01  $\mu\text{m}$  and an equatorial diameter of 18.46  $\mu\text{m}$ . The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 18.89  $\mu\text{m}$  and width of 1.13  $\mu\text{m}$ . Exine thickness was 0.96  $\mu\text{m}$ , intine thickness was 0.50  $\mu\text{m}$ . Ornamentation was reticulate and reticulum was shallow (Table 1, Figure 1E, 2E, 3E).

### 3.6. *Alyssum contemptum* Schott & Kotschy

The pollen shape was prolate-spheroidal (P/E: 1.14) with a polar axis of 21.90 µm and an equatorial diameter of 19.12 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 17.18 µm and width of 0.98 µm. Exine thickness was 0.81 µm, intine thickness was 0.42 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1F, 2F, 3F).

### 3.7. *Alyssum trichostachyum* Rupr.

The pollen shape was prolate (P/E: 1.74) with a polar axis of 35.17 µm and an equatorial diameter of 20.17 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 16.09 µm and width of 0.95 µm. Exine thickness was 0.95 µm, intine thickness was 0.47 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1G, 2G, 3G).

### 3.8. *Alyssum callichroum* Boiss. & Balansa

The pollen shape was prolate (P/E: 1.61) with a polar axis of 25.33 µm and an equatorial diameter of 15.67 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 12.97 µm and width of 0.82 µm. Exine thickness was 0.89 µm, intine thickness was 0.43 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1H, 2H, 3H).

### 3.9. *Alyssum strigosum* subsp. *strigosum* Banks & Sol.

The pollen shape was subprolate (P/E: 1.29) with a polar axis of 33.17 µm and an equatorial diameter of 25.65 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 21.02 µm and width of 1.12 µm. Exine thickness was 0.99 µm, intine thickness was 0.55 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1I, 2I, 3I).

### 3.10. *Alyssum strictum* Willd.

The pollen shape was prolate (P/E: 1.50) with a polar axis of 37.41 µm and an equatorial diameter of 24.87 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 19.91 µm and width of 0.93 µm. Exine thickness was 1.03 µm, intine thickness was 0.56 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1J, 2J, 3J).

### 3.11. *Alyssum praecox* Boiss. & Bal.

The pollen shape was prolate (P/E: 1.58) with a polar axis of 30.77 µm and an equatorial diameter of 19.47 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 16.93 µm and width of 0.92 µm. Exine thickness was 0.93 µm, intine thickness was 0.41 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1K, 2K, 3K).

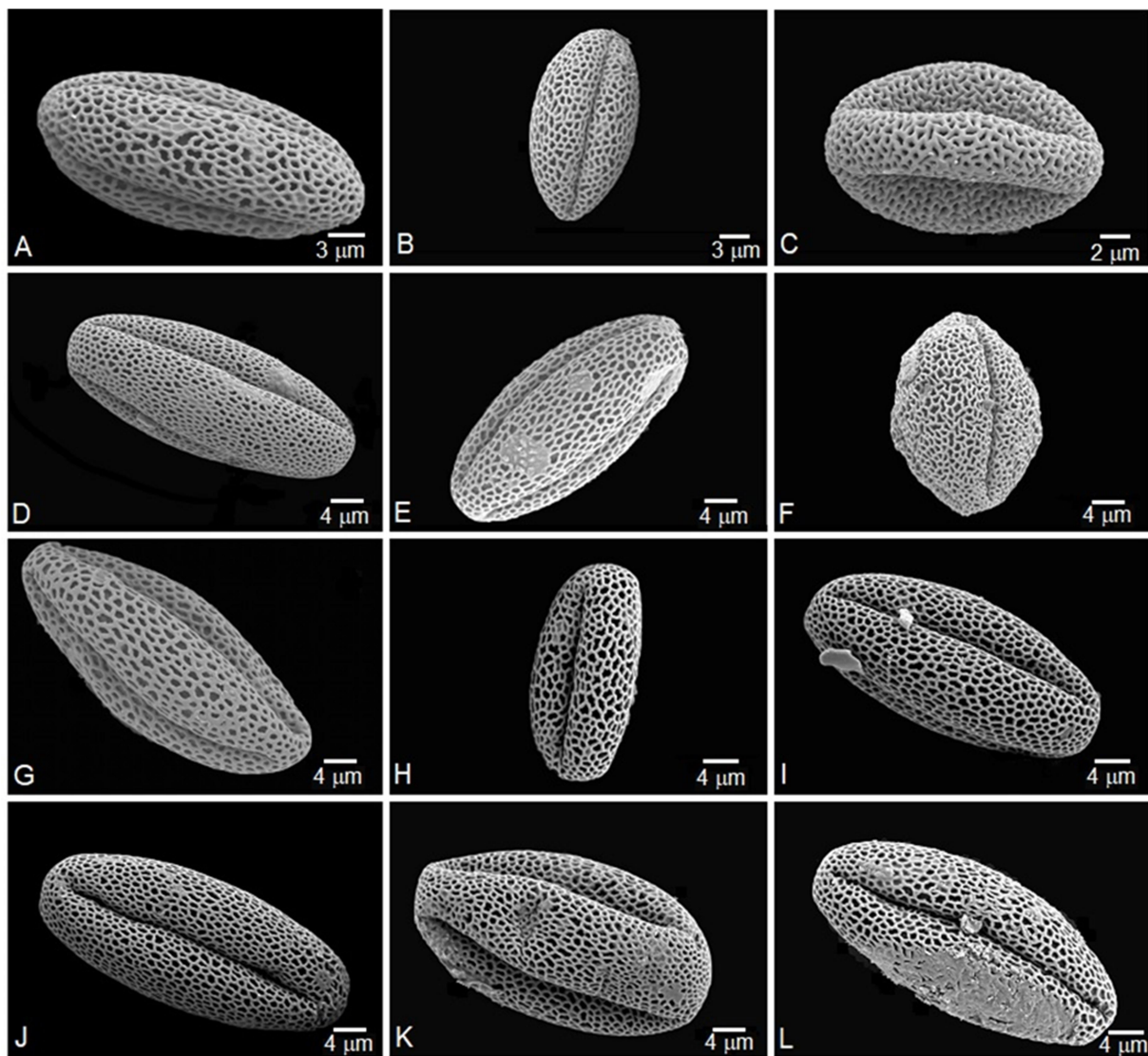
### 3.12. *Alyssum peltaroides* subsp. *virgatiforme* (Nyár.) T.R.Dudley

The pollen shape was subprolate (P/E: 1.25) with a polar axis of 21.63 µm and an equatorial diameter of 17.30 µm. The aperture type of pollen was trizonocolpate. The colpus was in long-acute ended with a colpus length of 14.43 µm and width of 0.95 µm. Exine thickness was 1.28 µm, intine thickness was 0.40 µm. Ornamentation was reticulate and reticulum was shallow (Table 2, Figure 1L, 2L, 3L).

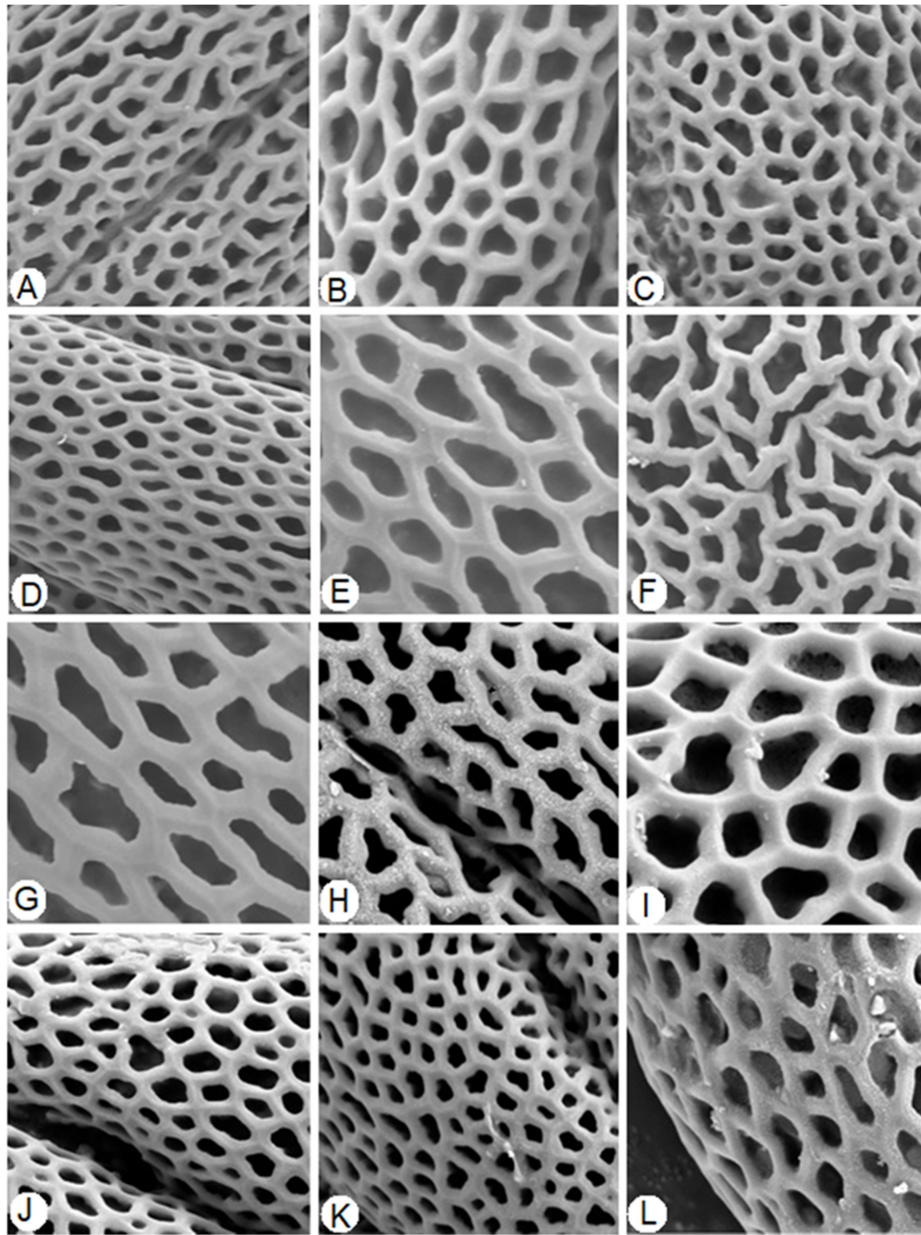
**Table 2.** Quantitative pollen morphological parameters of *Alyssum* taxa.

Taxa	P (μm)	E (μm)	P/E ratio	Ex (μm)	In (μm)	Clt (μm)	Clg (μm)	t	Or.
<i>A. condensatum</i> subsp. <i>flexibile</i>	31.92±1.97	23.51±1.31	1.35	1.00±0.33	0.49±0.18	1.11±0.14	24.12±0.51	20.97±1.13	Reticulate
<i>A. filiforme</i>	21.74±0.75	17.09±1.15	1.27	0.95±0.11	0.41±0.12	1.09±0.47	19.13±0.96	14.21±1.72	Reticulate
<i>A. xanthocarpum</i>	40.70±1.65	25.17±1.20	1.61	1.35±0.23	0.55±0.16	1.43±0.28	33.21±0.92	10.22±0.72	Reticulate
<i>A. simplex</i>	24.09±1.73	20.41±1.76	1.18	0.99±0.45	0.60±0.13	1.03±0.12	21.01±0.92	18.09±0.72	Reticulate
<i>A. macropodium</i>	23.01±1.01	18.46±1.03	1.24	0.96±0.23	0.50±0.33	1.13 ±0.24	18.89±1.23	8.23 ±0.13	Reticulate
<i>A. contemptum</i>	21.90±0.99	19.12±1.45	1.14	0.81±0.20	0.42±0.12	0.98±0.19	17.18±0.10	14.18±1.03	Reticulate
<i>A. trichostachyum</i>	35.17±1.70	20.17±0.53	1.74	0.95±0.54	0.47±0.99	0.95±0.19	16.09±0.23	11.23±0.10	Reticulate
<i>A. callichorum</i>	25.33±0.23	15.67±0.16	1.61	0.89±0.29	0.43±0.01	0.82±0.19	12.97±0.04	8.09±1.02	Reticulate
<i>A. strigosum</i> subsp. <i>strigosum</i>	33.17±0.41	25.65±0.13	1.29	0.99±0.16	0.55±0.99	1.12±0.99	21.02±0.99	13.45±0.28	Reticulate
<i>A. strictum</i>	37.41±1.02	24.87±1.09	1.50	1.03±0.11	0.56±0.25	0.93±0.08	19.91±1.27	12.93±0.49	Reticulate
<i>A. praecox</i>	30.77±0.31	19.47±0.95	1.58	0.93±0.17	0.41±0.99	0.92±0.47	16.93±0.51	15.97±0.26	Reticulate
<i>A. peltaroides</i> subsp. <i>virgatiforme</i>	21.63±1.80	17.30±1.30	1.25	1.28±0.46	0.40±0.70	0.95±0.21	14.43±0.97	8.96±1.09	Reticulate

P: Polar axis, E: Equatorial diameter, Clg: Colpus length, Clt: Coplus width, Ex: Exine thickness, In: Intine thickness, t: Apocolpia, Or: Ornamentation

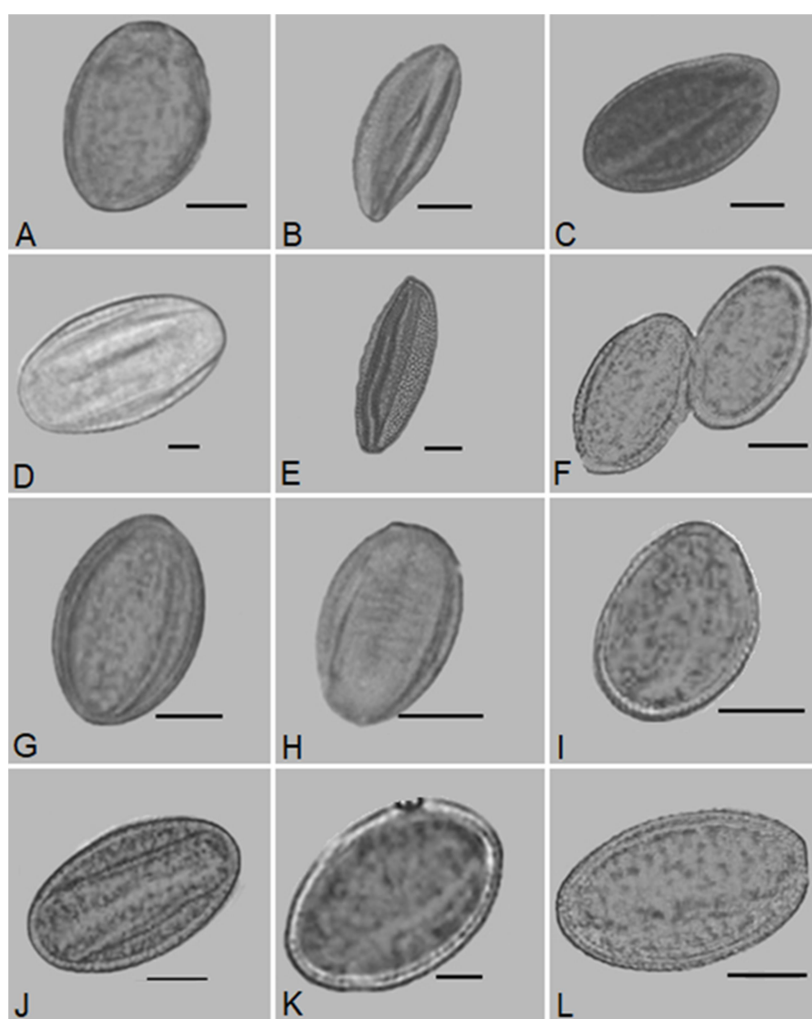


**Figure 1.** General view SEM micrograph of studied taxa **A.** *A. condensatum* subsp. *flexibile*. **B.** *A. filiforme*. **C.** *A. xanthocarpum*. **D.** *A. simplex*. **E.** *A. macropodum*. **F.** *A. contemptum*. **G.** *A. trichostachyum*. **H.** *A. callichorum*. **I.** *A. strigosum* subsp. *strigosum*. **J.** *A. strictum*. **K.** *A. praecox*. **L.** *A. peltaroides* subsp. *virgatiforme*.



**Figure 2.** Ornamentation view SEM micrograph of studied taxa. **A.** *A. condensatum* subsp. *flexibile*. **B.** *A. filiforme*. **C.** *A. xanthocarpum*. **D.** *A. simplex*. **E.** *A. macropodum*. **F.** *A. contemptum*. **G.** *A. trichostachyum*. **H.** *A. callichorum*. **I.** *A. strigosum* subsp. *strigosum*. **J.** *A. strictum*. **K.** *A. praecox*. **L.** *A. peltaroides* subsp. *virgatiforme*.





**Figure 3.** LM micrograph of studied taxa. **A.** *A. condensatum* subsp. *flexibile*. **B.** *A. filiforme*. **C.** *A. xanthocarpum*. **D.** *A. simplex*. **E.** *A. macropodum*. **F.** *A. contemptum*. **G.** *A. trichostachyum*. **H.** *A. callichorum*. **I.** *A. strigosum* subsp. *strigosum*. **J.** *A. strictum*. **K.** *A. praecox*. **L.** *A. peltaroides* subsp. *virgatiforme* (Scale bar: 10  $\mu$ m).

#### 4. Discussion and Conclusions

Pollen morphological features of 12 taxa belonging to the *Alyssum* genus of the Brassicaceae family were examined using light microscopy and SEM. According to Erdtman, Brassicaceae is considered a stenopalynous family. He also reported that the Brassicaceae family is closer to the Capparaceae family (Erdtman, 1952). On the other hand, in their study, Qaiser and Perveen (2001) determined that the family Capparaceae was eurypalynous and its pollen shape was tricolpate. At the same time, Appel and Al-Shehbaz (2003) identified that ornamentation of pollens was reticulate and tricolpate in the family Brassicaceae.

Pollen grains of the genus *Alyssum* were described by Faegri and Iversen as having 3-zonocolpate pollen grains and reticulate ornamentation and were classified as Hornungia type (Faegri and Iversen, 1989). A study on species of the genus *Alyssum* reported that the colpi of all species were long, shallow and got narrower towards poles (Pavlova et al., 2016).

Pollen of the 8 taxa (*A. strictum*, *A. contemptum*, *A. macropodum*, *A. strigosum* subsp. *strigosum*, *A. xanthocarpum*, *A. trichostachyum*, *A. praecox* and *A. simplex*) studied in the *Alyssum* section are radially symmetrical and 3-colpate. The pollen shape of one taxon is prolate-spheroidal, while the others are either prolate or subprolate. In all 8 taxa, the polar axis is longer than the equatorial axis. Although the structure of the exine is tectate, the ornamentations were observed to be reticulate in the detailed study conducted in SEM. In a study in which the pollen characteristics of *A. umbellatum* species belonging to *Alyssum* section were determined; it was reported that the shape of the pollen



was prolate and the ornamentation was reticulate (Inceoğlu and Karamustafa, 1977). In the 8 taxa we studied from the same section; we detected different pollen shapes as prolate, subprolate and prolate-spheroidal, and we also determined that the ornamentation of all taxa in this section was reticulate.

Pollen of the 4 taxa (*A. callichorum*, *A. filiforme*, *A. condensatum* subsp. *flexibile* and *A. peltarioides* subsp. *virgatiforme*) studied in the *Odontarrhena* section are radially symmetrical and 3-colpate. The pollen shape of two species is prolate (*A. callichorum* and *A. condensatum* subsp. *flexibile*), while the other two species (*A. filiforme* and *A. peltarioides* subsp. *virgatiforme*) is subprolate. In all three species, the polar axis is much longer than the equatorial axis. The exine structure is tectate and detailed examination in SEM showed that their ornamentations are reticulate. In a study conducted on *A. obtusifolium* species in the *Odontarrhena* section by Orcan and Binzet; it was reported that the pollen shape was subprolate, the P value was 15.4 µm, the E value was 13.5 µm, and the exine thickness was 1.09 µm (Orcan and Binzet, 2003). In the 3 taxa we examined from this section, we found that the pollen shapes were prolate and subprolate, the polar axis (P) was 21.74-31.92, the equatorial axis (E) was 15.67-23.51, the exine thickness was 0.89-1.00, and the intine thickness was 0.41-0.49. When the polar and equatorial measurement values of the three taxa we studied from this section are examined, it can be said that they have larger pollen than *A. obtusifolium* pollen. However, their exine thicknesses are almost the same.

In the pollen morphology study conducted on 9 taxa (*A. simplex*, *A. trichocarpum*, *A. armenum*, *A. praecox*, *A. lepidoto-stellatum*, *A. sulphureum*, *A. murale* subsp. *murale*, *A. pateri* subsp. *pateri*, *A. linifolium* var. *teheranicum*) belonging to the genus *Alyssum* by Baser et al. (2018), it was reported that the polar axis was between 21.90-40.73 µm, the equatorial axis was between 15.78-26.15 µm, the exine thickness was between 0.41-0.54 µm, the intine thickness was between 0.40-0.54, the colpus width was between 0.92-1.63 µm, the colpus length was between 17.14-33.66, the meseocolpium was between 3.42-5.24 µm, the apocolpium was between 15.81-27.85 µm, additionally the pollen shapes were prolate and subprolate, and the ornamentation of all pollen was reticulate. In our study, we found that *A. callichorum*, unlike other taxa, has a smaller colpus width and length, and *A. contemptum* has a prolate-spheroidal pollen shape.

In a palynological study conducted by Arslan (2019) on the *Alyssum strigosum* species, it was determined that the P, Clg and Clt values, as well as the exine thickness and the P/E ratio, were higher than the values we obtained, and there was no significant difference in terms of intine thickness. While the pollen shape was reported to be prolate, it was observed as subprolate in our study. Şirin et al. (2022), in their palynological study of two subspecies of *A. strigosum* (subsp. *strigosum* and subsp. *cedrorum*), they determined that the pollen grains of both subspecies were monad, isopolar, prolate and tricolpate and that the exine ornamentation was reticulate. Although the pollen grains of the *A. strigosum* subsp. *strigosum* taxon included in our study are similar to their findings in terms of monad, isopolar, tricolpate and reticulate exine ornamentation, they differ in terms of pollen shape being subprolate.

In a study conducted by Vural and Ince on the pollen of the species *A. praecox*, it was determined that the pollen was prolate, tricolpate, the P value was 24.8 µm, the E value was 18.33 µm, the exine thickness was 1.02 µm and the intine thickness was 0.94 µm (Vural and Ince, 1994). As a result of our examinations on this species, we determined that the pollen was tricolpate, the pollen shape was prolate, the polar axis was 30.77, the equatorial axis was 19.47, the exine thickness was 0.93 µm and the intine thickness was 0.41 µm. Although the data of Vural and Ince and our data are largely similar, there is a significant difference in terms of intine thickness. As a result of their palynological study on 14 *Alyssum* species, Bulbul et al. (2019) reported that the pollen grains of the genus members were subprolate or prolate, the pollen grains were tricolpate and the exine ornamentation was mostly reticulate. The findings of this study are largely similar to the findings of our study.

In conclusion, this study revealed the morphological characteristics of pollen grains of 12 taxa belonging to the *Alyssum* genus of the Brassicaceae family. We believe that the data obtained here will be useful in many fields, especially plant taxonomy.

### Conflicts of Interests

The authors have no conflict of interest to declare.

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### Statement contribution of the authors

In this study, the collection of plant material were carried out by GD, DCY, SD; pollen analyses of by AD, YK, DCY; planning of this study, identification of the plants and writing of the Article were done by GD.

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