

A study of *Alyssum floribundum* (*Brassicaceae*)

Nermin Orcan & Rıza Binzet

Department of Biology, Science and Art Faculty, Mersin University, 33342 Mersin, Turkey,
e-mail: norcan@mersin.edu.tr; rbinzet@mersin.edu.tr

Received: August 28, 2003 ▷ Accepted: November 20, 2003

Abstract. Normal and modified (abnormal) specimens of *Alyssum floribundum*, with deformations registered in the exterior and interior morphology, caused by insects of the *Aphididae* family, have been morphologically, anatomically and palynologically examined. The pollen shape of the normal specimens is prolate and of the abnormal – subprolate.

Key words: *Alyssum floribundum*, anatomy, *Brassicaceae*, pollen morphology

Introduction

Alyssum floribundum Boiss. & Balansa belongs to section *Odontarrhena* (C. A. Mey.) Koch. It is an endemic to Turkey species and is distributed in the map squares B2, B6, C2, C5 and C6 (Dudley 1964, 1965; Donner 1990). The flowering time of the species is in June–October.

The morphological characters of *A. floribundum* were recorded by Nyarady (1949). *Odontarrhena* section is a group of plants regarded as nickel hyperaccumulators (Brooks & al. 1979).

Pollen morphology of some *Alyssum* species was examined by İnceoğlu & Karamustafa (1977). Some insects registered at the root of *Alyssum desertorum* Stapf. var. *desertorum* specimens, causing gall formation, belong to genus *Ceuthorrynchus* of the family *Curculionidae* (Orcan & Mısırdalı 1995).

Normal and modified (abnormal) specimens of *A. floribundum* with deformations registered in the exterior and interior morphology, caused by insects of the *Aphididae* family, have been morphologically, anatomically and palynologically examined.

Materials and methods

The examined specimens were collected from C5: Mersin: Centre, Müğlü stream, İcmeler place, under-forest, c. 1100 m, 36°49' N, 034°19' E, 05.11.2000, coll. N. Orcan, 01.06.2001, Herb. no: Orcan 25 & Orcan 26. The specimens are deposited in the Herbarium of Biology Department, Mersin University.

For anatomical studies, the root, stem and leaves of the specimens were soaked in 70% alcohol and Sartur, Sudan III and Safranin dyes were used for tissue distinguishing (Orcan & Binzet 2003). Some insects found on the collected specimens, belonging to the *Aphididae* family, were identified by the Plant Protection Department, Agricultural Faculty, Çukurova University.

The pollen grains were obtained from the herbarium specimens. The pollen slides were prepared according to the method of Wodehouse (1965). Measurements and microphotographs of the pollen grains were made one month later, after the normal dimensions and forms were restored.

The measurements of the polar axis (P) and equatorial diameter (E) of pollen grains have been made by

the Olympus light microscope with a $\times 100$ lens, until the Gaussian curve was obtained. Other measurements (exine-ex, colpus length-clg, colpus width-clt) were based on 20 pollen grains. The results were evaluated according to the formulas

$$M = m + a \frac{1}{n} \cdot \Sigma xy, \sigma = \pm a \sqrt{\frac{1}{n} \Sigma (x^2 y - u^2)} \text{ (Aytuğ 1967)}$$

Results

I. Morphological characteristics (Figs 1, 2)

Perennial, 35–50 cm high, flowering shoots 40–50 cm long, leaves linear-oblongate, 5–20 \times 1–3 mm, lower surface covered more densely with equally rayed stellate hairs; abnormal stems flattened and wider, 4–5 mm wide, thinly sulcate and pubescent-sublepidote; sterile shoots 25–30 cm long, leaves linear-oblongate, 1–3 \times 2–4 mm, increasing upwards in size, inner surface canescent, covered more densely with equally rayed hairs, outer surface pale-green. Pedicels 1.5–2 mm, \pm flexuous, sparsely stellate. Inflorescence of abnormal specimens modified and its inflorescence is conferted on the upper part of the shoots up to 8 cm, in normal ones in corymbs, up to 15 cm; sepals 1.3–1.5 \times 0.6–1 mm, ovate, acute-

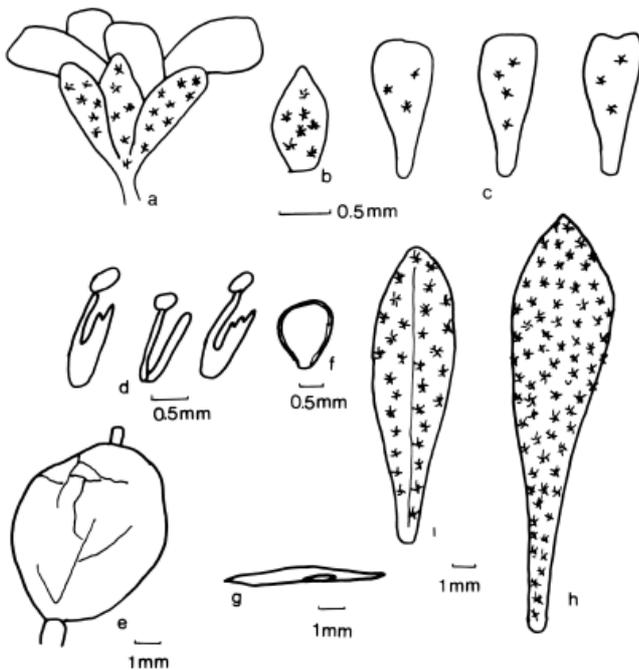


Fig. 1. *Alyssum floribundum* morphological characters: a – flower; b – sepal; c – petals; d – stamens; e – fruit; f – seed; g – cross-section of silicula; h – sterile shoot leaf; i – fertile shoot leaf.

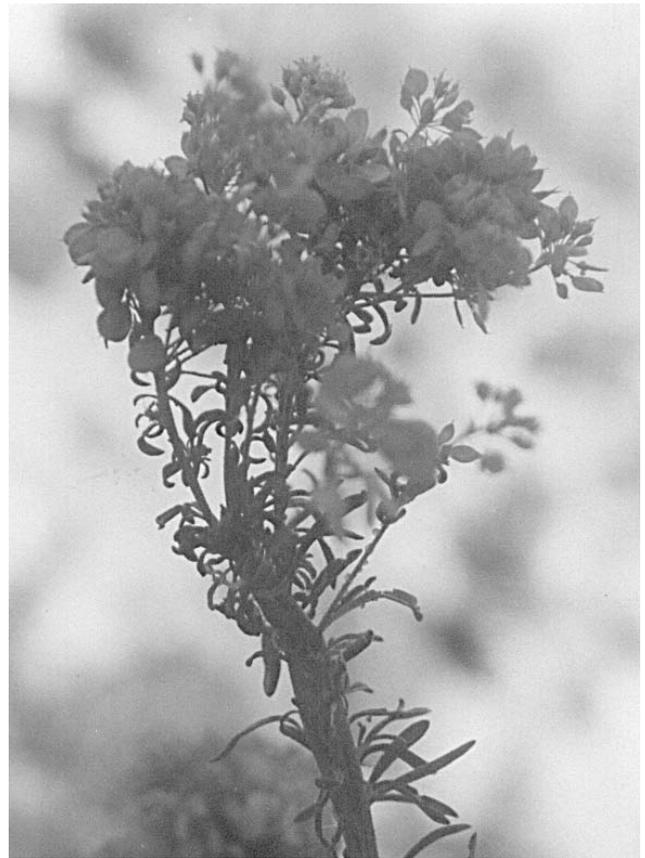


Fig. 2. *A. floribundum* (abnormal) general habit.

acuminate, inner surface glabrous, outer surface sparsely stellate; petals 1.5–2 \times 0.5–1.5 mm, glabrous on the inner surface and sparsely stellate on the outer surface, entire or retuse-rotundate; filaments of longer stamens 1.5–2 mm, appendages 1–1.5 mm, connate at the base, 1–2 dentate; filaments of shorter stamens 1–1.5 mm, appendages c. 1 mm, connate at the base and 2–3 dentate; siliculae 4–8 \times 3–5.5 mm, obovate, rotundate-retuse, venation conspicuous, glabrous, \pm undulate; style 0.2–0.5 mm, glabrous; seed c. 0.5 \times 0.5 mm, pale-brown, narrowly winged.

Flowering time: June–October; habitat: underforest, at altitudes of 1100 m.

Total distribution: endemic to Turkey.

II. Anatomical characteristics

Root (Plate I, Figs 1, 2)

The outside periderm sparsely lenticelled. Collenchyma with 3–4 layers placed under the epidermis. Parenchymatic cortex with multi-layers is between the endodermis and collenchyma. Sclerenchyma groups are observed in the parenchymatic cortex. Cambium with 2–3 layers is located between the phloem and xy-

lem. The secondary xylem is found below the cambium and the primary xylem is seen towards the inner part. The primary xylem has sclerenchyma groups. Some sclerenchyma groups occur from pith to the secondary xylem. The pith consists of parenchymatous cells. One-to-three layered parenchyma cells with thickened walls are found along the outer line of the pith. Some of them are amply covered with crystals.

Stem (Plate II, Figs 1, 2)

On the outside, the one- to several-layered epidermis is surrounded by a thick cuticle. Stomata are sparse and equally sunken below the surface. The 1–4 layered plate collenchyma observed below the epidermis and cortex has 5–8 layered parenchymatous cells that are rounder than the parenchymatous cells in the root cortex parenchyma. A several layered sclerenchyma is usually arranged outside the vascular cylinder. One-to-three layered endodermis lies under the parenchymatous tissue. The cambium is located between the xylem and phloem. The xylem elements and sclerenchyma have longitudinally alternating lines and enclose the stem. At the tip of the bundles occurring towards the pith, phloem groups were found along with some wide bundles. The pith consists of parenchymatous cells covering a wide area.

Leaf (Plate III, Fig. 1; Plate IV, Figs 1, 2; Plate V, Figs 1, 2)

In the transverse sections – isolarteral type, cuticle at the outside, epidermis with a thick membrane and stomata are found on both surfaces. The mesophyll is composed of 2–4 layered palisade and 1–2 layered spongy parenchyma. The vascular bundles are collateral and surrounded by a parenchymatous bundle sheath. In the bundles – xylem is near the upper surface and phloem covering a wider area than xylem is near the lower surface. The vascular bundles are surrounded by the sclerenchyma, the lower surfaces of the leaves are more densely covered with hairs than the upper surfaces, and bundle sheath extensions are seen in the upper part of the bundle.

In the surface sections stomata are of the *Cruciferae* type, hair base cell surrounded by 5–8 cells. On the lower surface, the number of stomata and the density of hairs is greater and the epidermis membranes are more undulate than on the upper surface. Stomata are of the anisocytic type.

III. Palynological characteristics (Plate VI, Figs 1-5)

Normal specimens:

Pollen type: tricolpate; pollen shape: prolate, P/E (polar to equatorial diameter ratio): 1.70 μm (W); exine: average thickness: 1.63 μm (W); apertures: colpi narrow and long, margins \pm clear, clg/clt: 11.50 μm (W); structure: intectate, ect/end \cong 3/2; sculpture: baculate seen as reticulate; intine: very thin = 0.40 μm .

Abnormal specimens:

Pollen type: tricolpate; pollen shape: subprolate, P/E: 1.18 μm (W); exine: average thickness 1.44 μm (W); apertures: colpi narrow and long, margins \pm clear, clg/clt: 9.92 μm (W); structure: intectate, ect/end \cong 5/2; sculpture: baculate seen as reticulate; intine: very thin = 0.45 μm .

The values of the palynological measurements of the normal and abnormal samples are given in Table 1.

Table 1. *A. floribundum*: values of the pollen grains measurements

Features	Normal specimens		Abnormal specimens	
	average (M)	standard deviation (s)	average (M)	standard deviation (s)
Polar axis (P)	19.95 μm	\pm 1.45 μm	16.35 μm	\pm 0.66 μm
Equatorial diameter (E)	11.71 μm	\pm 1.14 μm	13.78 μm	\pm 0.65 μm
Colpus length (clg)	17.54 μm	\pm 1.13 μm	13.10 μm	\pm 0.92 μm
Colpus width (clt)	1.58 μm	\pm 0.27 μm	1.32 μm	\pm 0.31 μm
Exine (ex)	1.63 μm		1.44 μm	
Intine (i)	0.40 μm		0.45 μm	

Discussion

The morphological characteristics obtained during investigations were compared with the other references in the Table 2.

During the morphological studies of modified specimens, caused by the insects belonging to the *Aphididae*, it was discovered that their fertile shoots have become broader and flattened, densely clustered at inflorescence and leaves at the top of the shoots.

During the anatomical studies, no distinct differences have been observed between the normal and abnormal specimens. Only in the stem sections, while the normal stem was round in shape, the abnormal stem was transversely.

Furthermore, some authors mentioned certain modifications in the plant structure caused by ecolog-

ical and physiological factors. Such is the effect of temperature changes on the speed of development of the plant vegetative structures. The plants grown in sunny weather have flatter and more rigid stems, short internodes, and close to each other. The flowering-encouraging hormone occurs in the photophyll (= daylight) phase (Öztürk & Seçmen 1996). The second flowering in autumn is due to abnormal ecological reasons (Öztürk & al. 1997). The sunlight causes an increase

in the amount of abscisic acid and prevents the development of internodes (Akman & Darici 1998). These information show us that ecological and physiological factors cause some modifications on plant structure as like in our specimens.

The shape of pollen grains of normal and abnormal specimens is different. The pollen of normal specimens is prolate (P/E = 1.70), while that of abnormal specimens is subprolate (P/E: 1.18).

Table 2. Comparison of the identified morphological characters with the descriptions of Nyarady (1949) and Davis (1965)

Features	Nyarady (1949)	Davis (1965)	In this study
Stem length	20-120 cm	60-100 cm	35-50 cm
Sterile shoots		5-20 × 0.5-3 mm;	25-30 cm
Leaves		linear-oblanceolate, oblanceolate	linear-oblanceolate, bicoloured, 1-3 × 2-4 mm
Fertile shoots	0.5-1 cm, shortened, densely set at the tip of the shoots	equally distributed leaves, increasing in size upwards	40-50 cm, increasing in size upwards, on abnormal specimens flattened and broader, leaves dense at the tip
Inflorescence	corymbs, 10 cm wide, dense at the tips of shoots		shortened, gathered at tips, 8 cm on abnormal specimens
Pedicels	thin, flexious,		
S-shaped, + backwards inclined	2-3.5 mm filiform, sigmoid, glabrous	1.5-2 mm, + sigmoid, sparsely stellate	
Sepals			ovate, acute-acuminate
Petals		2-2.5 × 0.5-1 mm, sparsely hairy	1.5-2 × 0.5-1.5 mm, sparsely stellate
Stamens			with appendages, long filaments (1.5-2 mm), short filaments (1-1.5 mm)
Siliculae	flattened smooth, oblanceolate-obovate, + cuneate	5-8 × 4-4.5 mm, obovate, glabrous, + undulate, venation conspicuous	4-8 × 4-5.5 mm, obovate, rotundate-retuse, glabrous, + undulate
Style		0.5-0.8 mm, glabrous	0.2-0.5 mm, glabrous
Seeds	widely or narrowly winged	narrowly winged	narrowly winged

Plate III

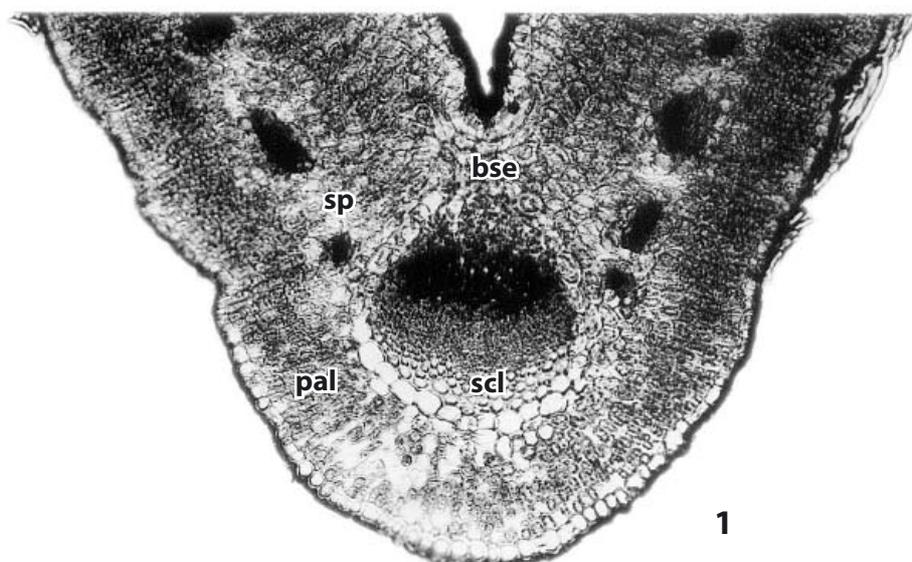
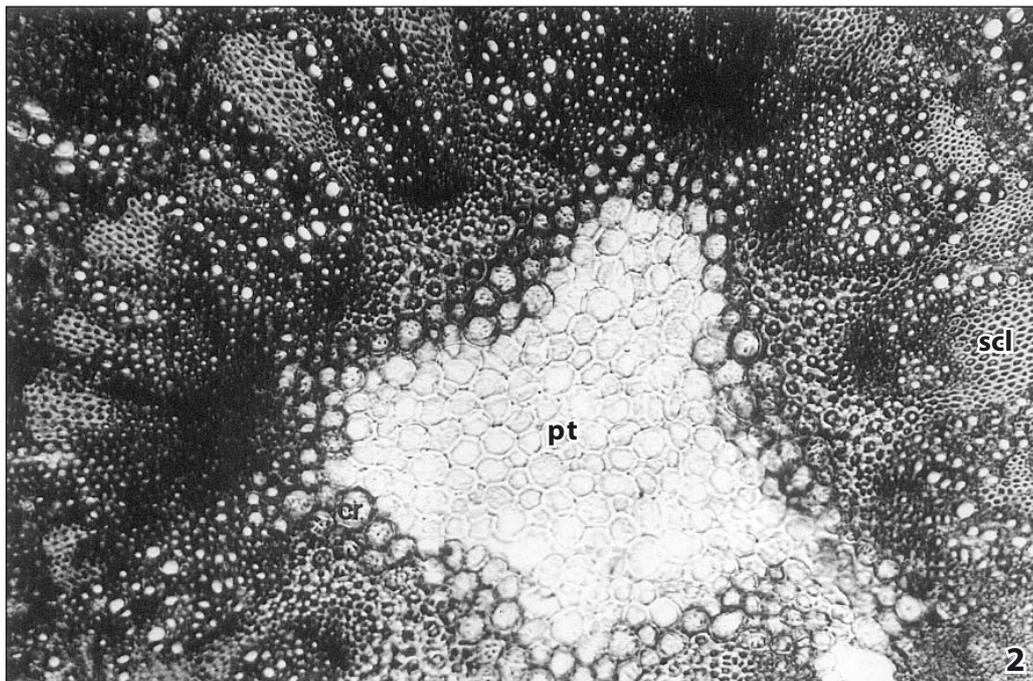
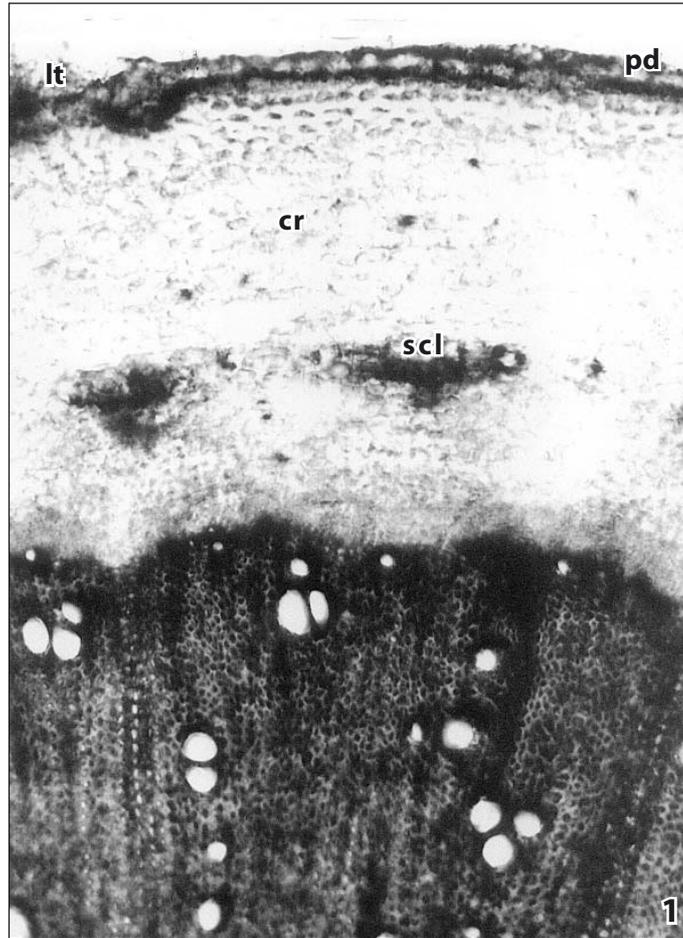


Fig. 1. *A. floribundum* leaves cross-section (×10):

bse – bundle sheath extensions; sp – spongy parenchyma; pal – palisade parenchyma; scl – sclerenchyma.

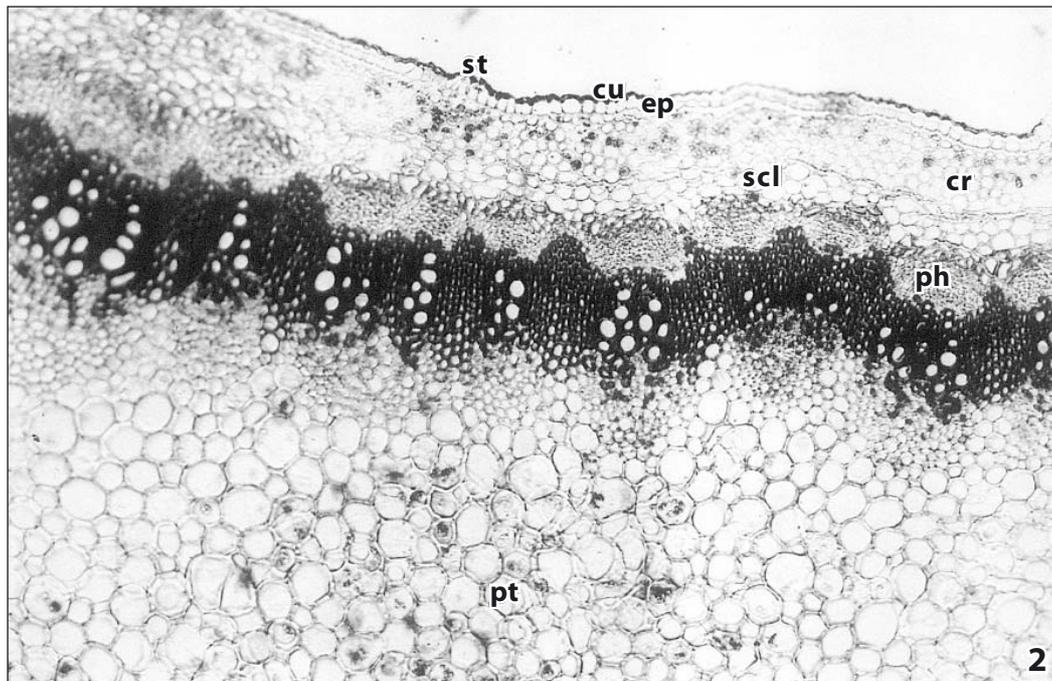
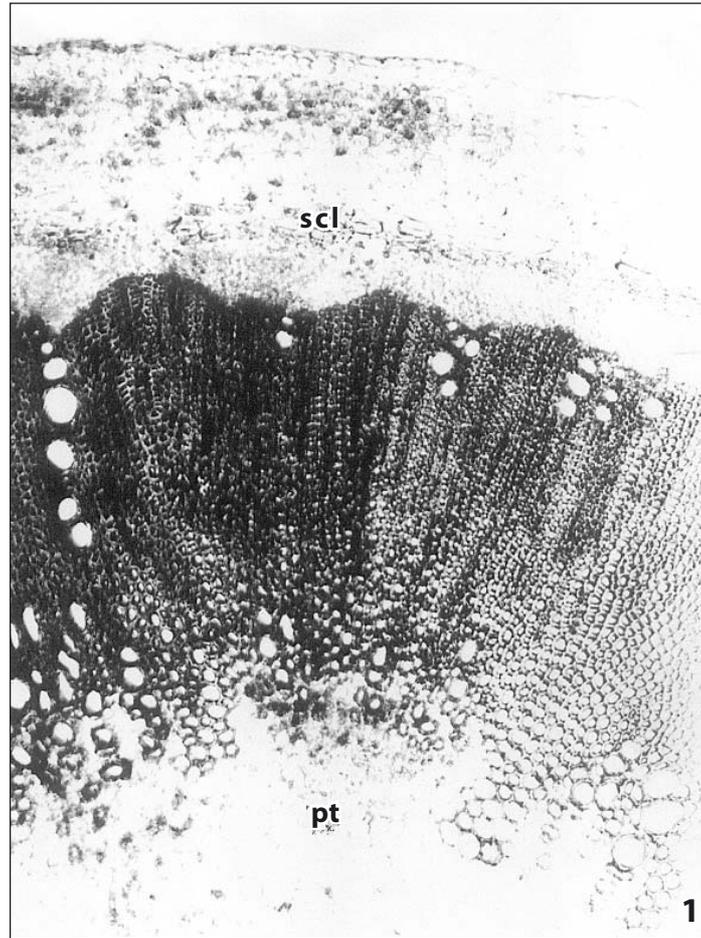
Plate I



Figs 1-2. *A. floribundum* root ($\times 10$):

1, root cross-section; 2, the pith and central area: scl – sclerenchyma; lt – lenticel; pd – periderm; cr – cortex; pt – pith.

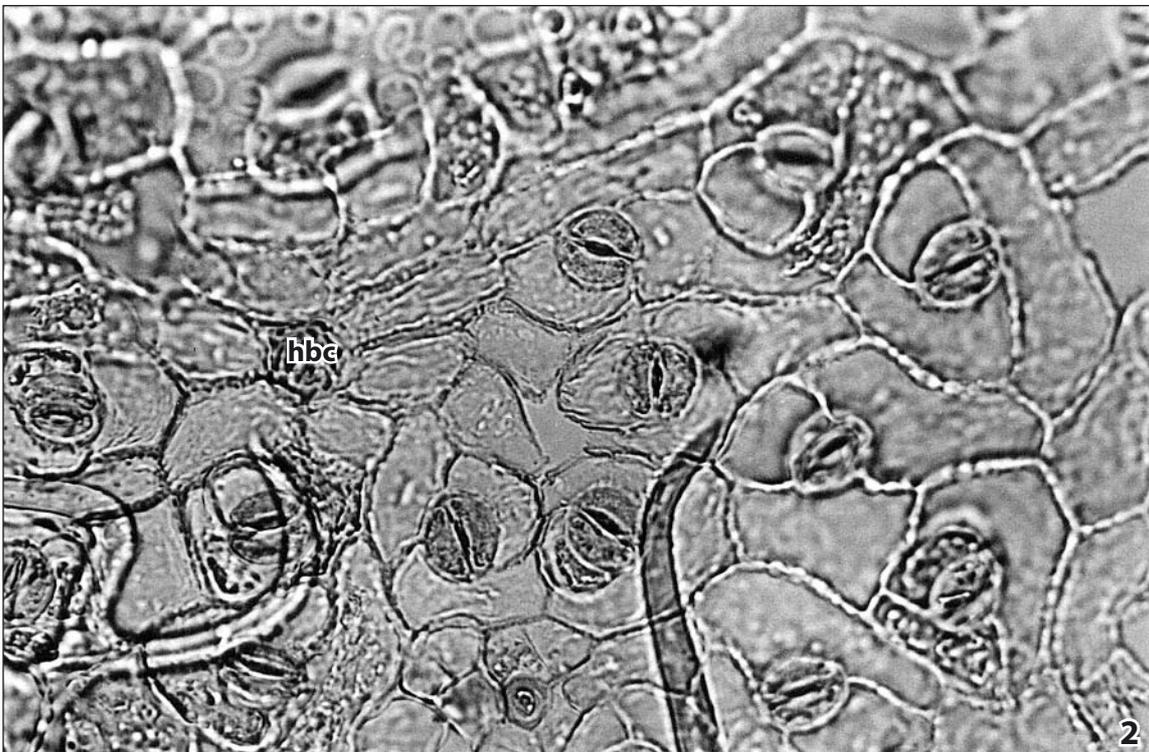
Plate II



Figs. 1-2. *A. floribundum* stem cross-section ($\times 10$):

1, normal stem; 2, flattened (abnormal) stem: **cu** – cuticle; **ep** – epidermis; **st** – stomata; **cr** – cortex; **scl** – sclerenchyma; **ph** – phloem; **pt** – pith.

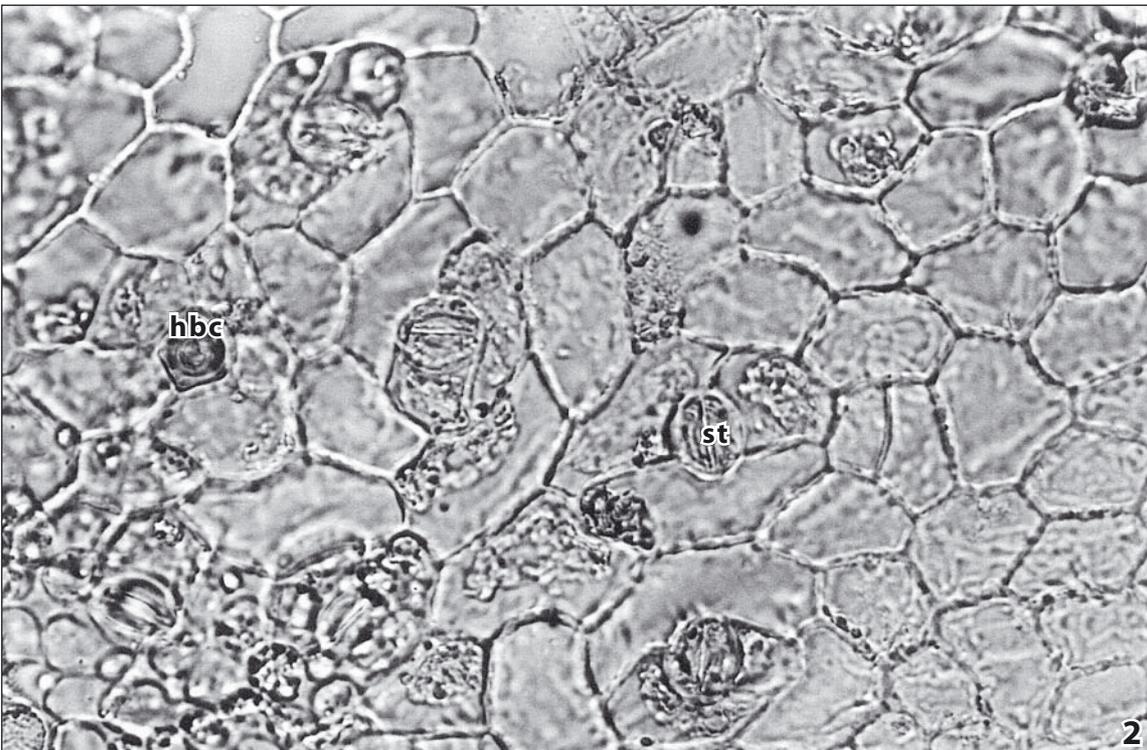
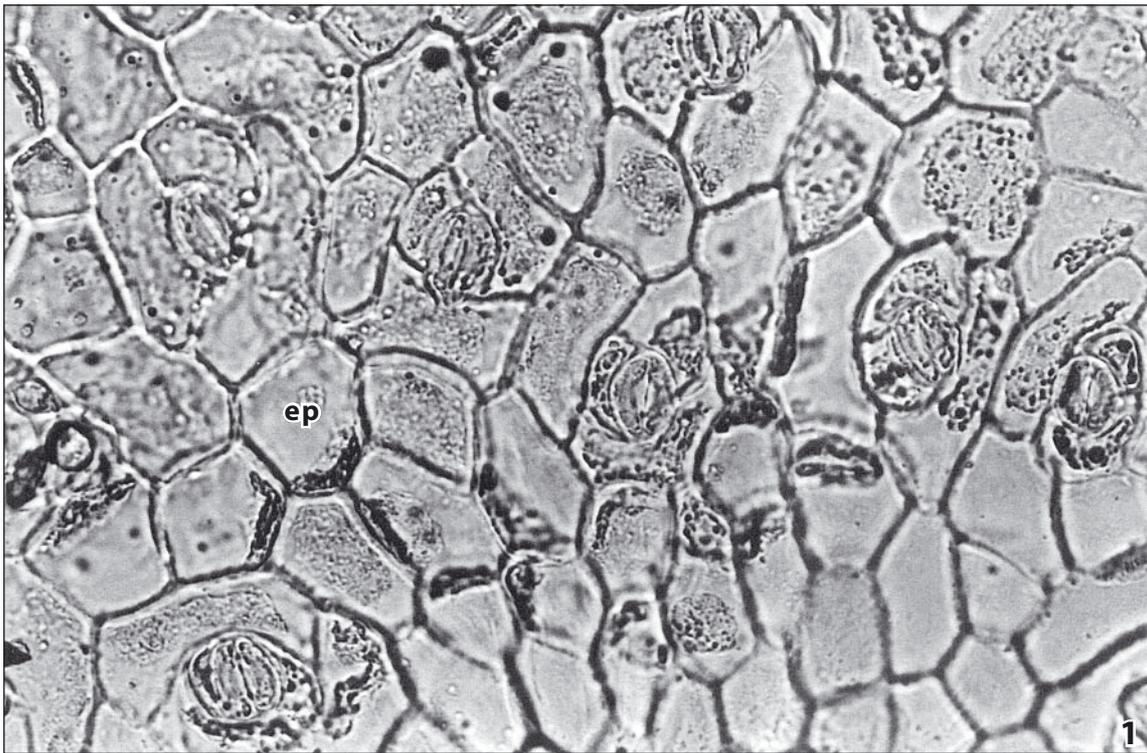
Plate IV



Figs 1-2. *A. floribundum* leaves of lower surface sections ($\times 40$):

1, fertile shoot leaf; 2, sterile shoot leaf: st – stomata; ep – epidermis; hbc – hair base cell.

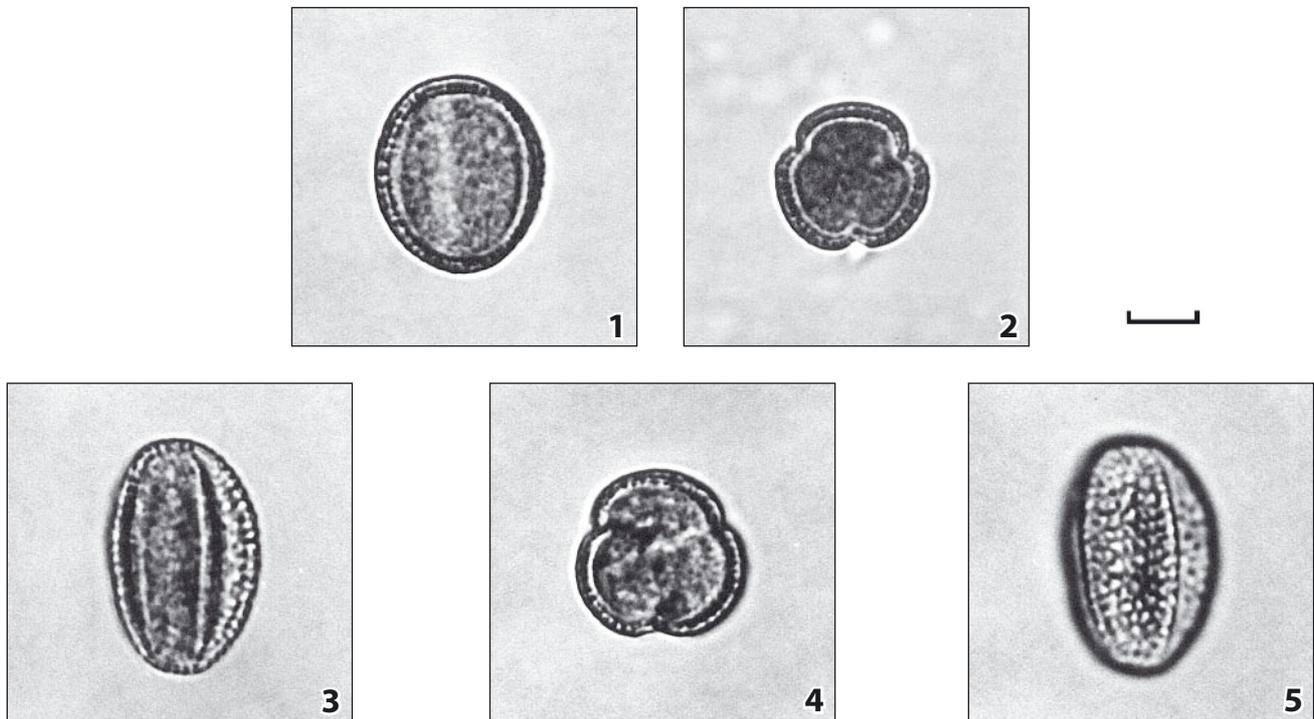
Plate V



Figs 1-2. *A. floribundum* leaves of upper surface section ($\times 40$):

1, fertile shoot leaf; 2, sterile shoot leaf: st – stomata; ep – epidermis; hbc – hair base cell.

Plate VI



Figs 1-5. Pollen grains of *A. floribundum* (scale 10 μ m):
1-2, abnormal pollen grains; 3-5, normal pollen grains.

References

- Akman, Y. & Darici, C. 1998. Plant Physiology. Nutrition and Development Physiology. Kariyer Matbaacilik, Ankara.
- Aytuğ, B., 1967. Polen Morphology and Palynological Researches about the Important Gymnosperms of Turkey. Kutulmuş Matbaası, İstanbul.
- Brooks, R. R., Morrison, R. S., Reeves, R. D. & Dudley, T. R. 1979. Hyperaccumulation of Nickel by *Alyssum* L. (*Cruciferae*). – Proc. R. Soc. Lond., B 203: 387-403.
- Donner, J. 1990. Distribution maps to P. H. Davis "Flora of Turkey, 1-10". – Linzer. Biol. Beitr., 22(2): 381-515.
- Dudley, T. R. 1964. Synopsis of the genus *Alyssum*. – J. Arnold Arbor., 45(3): 358-373.
- Dudley, T. R. 1965. *Alyssum* L. – In: Davis, P. H. (eds.), Flora of Turkey and the East Aegean Islands. Vol. 1, pp. 362-409. Edinburgh Univ. Press, Edinburgh.
- İnceoğlu, Ö. & Karamustafa, F. 1977. The pollen Morphology of Plants in Ankara Region II. *Cruciferae*. – Commun. Fac. Sci. Univ. Ankara Sér. C, Sci. Nat., 21(6): 111-118.
- Nyarady, E. J. 1949. Synopsis Speciorum, Variationum et Formarum Sectionis *Odontarrhena* Generis *Alyssum*. – Anal. Acad. Republ. Populare Române, 1(3): 1-133.
- Orcan, N. & Misirdali, H. 1995. Studies on the gall formation in *Alyssum desertorum* Stapf. var. *desertorum*. – In: Öztürk, M. A. (eds.), 4th Pl. Life of Southwest Asia Symp. Announc. Book. Pp. 1049-1057. Ege Univ. Press., İzmir.
- Orcan, N., Binzet, R. 2003. The anatomical and palynological properties of *Alyssum obtusifolium* Steven ex DC. – Turk. J. Bot., 27(1): 63-68.
- Öztürk, M. & Seçmen, Ö. 1996. Plant Ecology. Ege Univ. Press., İzmir.
- Öztürk, M., Pirdal, M. & Özdemir, F. 1997. The Practice of Plant Ecology. Ege Univ. Press., İzmir.
- Wodehouse, R. P. 1965. Pollen Grains. Hafner Publishing Company, New York & London.

