Bangladesh J. Plant Taxon. **16**(2): 157-164, 2009 (December)

MICROMORPHOLOGICAL AND ANATOMICAL STUDIES ON PETALS OF 11 TURKISH *ONOSMA* L. (BORAGINACEAE) TAXA

ÖZNUR ERGEN AKÇIN[1]

Department of Biology, Faculty of Science & Arts, Ordu University, Ordu, Turkey.

Keywords: Anatomy; Micromorphology; *Onosma*; Scanning Electron Microscope (SEM).

Abstract

The petal epidermis and petal anatomy of 11 taxa of *Onosma* L. were studied using light and scanning electron microscopy. Differences in epidermal patterns were observed on the dorsal surface. Domed epidermal cells and non-papillae epidermal cells were seen on the petal surface. Papillae types were lithops, cone-like, finger-like or skittle-cell type. Areolate and rugose types were observed on the non-papillae surface. Principal anatomical structures of petals were similar. Micromorphological features on dorsal surfaces of petals could be useful for species-level diagnosis along with other selected morphological and micromorphological features.

Introduction

The genus *Onosma* L. (Boraginaceae) is represented by more than 100 taxa (97 species) in Turkey (Riedl, 1978; Davis *et al.,* 1988; Riedl *et al.,* 2004; Binzet and Orcan, 2007). This genus is important in the Flora of Turkey because of its large number of species and endemism. Some *Onosma* species are used as vegetables, folk medicines and dyes. The flowers of some species are eaten as vegetables. *Onosma* species are grown in garden as ornamental plants because of their beautiful flowers (Oztürk and Ozçelik, 1991). There have been anatomical studies (Akçin and Engin, 2001, 2005; Akçin, 2004), karyological studies (Teppner, 1981, 1988), micromorphological studies (Akçin, 2007; Binzet and Akçin, 2009), and chemical studies (Khajuria and Jain, 1993; Ozgen *et al.*, 2004) of many *Onosma* species. General corolla structures of *O. isauricum* Boiss. & Heldr. and *O. stenolobum* Hausskn. *ex* H. Riedl were studied with other anatomical features (Akçin and Engin, 2001).

Petal morphology has major taxonomic importance in *Onosma.* Corolla colour, shape and size are used as taxonomic characters in this genus (Riedl, 1978). However, detailed observations of the micromorphology and anatomy of petals of *Onosma* species are lacking. The use of scanning electron microscopy (SEM) has greatly increased the knowledge of surface features of some vegetative and reproductive organs and has provided valuable taxonomic information (Barthlott, 1984; Stace, 1984; Özcan, 2002). According to Riedl (1978) most of the Turkish representatives of *Onosma* are poorly-defined and require additional characters for proper identification. In the present study, the anatomical and micromorphological features of petals were studied to provide more detailed information for 11 *Onosma* taxa.

[1] E-mail: oakcin@odu.edu.tr; oakcin@gmail.com

Materials and Methods

Plant specimens of 11 *Onosma* taxa were collected from north Anatolia, Turkey during 1997-2000 (Table 1). Voucher specimens are kept at Ordu University Herbarium. Samples for anatomical studies were fixed in 70% alcohol. Cross and surface sections of petals were excised by hand and they were covered with glycerin-gelatin (Vardar, 1987). Their photographs were taken with Nikon FDX-35 microscope. All measurements and observations were made using imaging software (NIS-Elements, Version 3.00 SP5). Epidermal terminology of petals was used as in Reule (1937), Stearn (1973) and Metcalfe and Chalk (1979). For SEM, dried corolla samples were mounted on stubs using double-sided adhesive tape. Samples were coated with 12.5-15 nm of gold. Coated leaves were examined and photographed with a JMS-6400 Scanning Electron Microscope.

Table 1. Information on 11 examined *Onosma* taxa.

Taxon	Locality
O. ambigens Lacaita	Çorum: İskilip to Tosya, 450m, Ergen 1008.
O. armenum DC.	Ankara: Around Çubuk 2. Dam, 1150m, Barbaros 1007.
O. bornmuelleri Hausskn.	Kastamonu: Ilgaz, 890 m, Akçin 1031.
O. bourgaei Boiss.	Çankırı: Ilgaz, 2000m, Ergen 1010.
O. bracteosum Hausskn. & Bornm.	Samsun: Ladik, 950 m, Akçin 1016.
O. intertextum Hub.- Mor.	Tokat: Around Niksar, 350m, Akçin 1047.
O. isauricum Boiss. & Heldr.	Amasya: Akdag, 1150 m, Akçin 1015.
O. roussaei DC.	Samsun: Çakallı, 350 m, Akçin 1049.
O. sericeum Willd.	Ankara: Around Çubuk 2. Dam, 110m, Barbaros 1008.
O. stenolobum Hausskn. *ex* H. Riedl	Amasya: Vermiş village, 1200 m, Akçin 1010.
O. tauricum var. *tauricum* Pallas *ex* Willd.	Kastamonu: Tosya, 900 m, Akçin 1048.

Results

Morphological characteristics of the epidermal cells in abaxial surface of *Onosma* such as size, shape and pattern of anticlinal walls are studied. The epidermal cells of *Onosma* as seen under light micropcope are similar and usually polygonal, isodiametric-polygonal or polygonal-rectangular (Table 2). The pattern of anticlinal cells are straight to curved in all studied species. On dorsal surface, sizes of epidermis cells vary in the range 15-175 × 10-67.5 µm (Table 2). *Onosma armenum* has the longest cells (123.0± standard error of the mean 4.15 × 39.25±0.98 µm) and *O. sericeum* has the smallest cells (30±0.85 × 18±0.32 µm) (Table 2, Figs 1-11).

Micromorphological properties of petal surfaces show some variations (Tables 2 & 3). Domed epidermal cells and non-papillae epidermal cells are seen on the surface of petals. Surface patterns are generally papillae type in studied species (Figs 13-14, 16-22). Papillae types are lithops, cone-like, finger-like or skittle-cell type (Table 3). Only in *O. bourgaei,* surface pattern is ribbed-rugose type; here ribbed-rugose structures are

interconnected with each other (Fig. 15). These structures are generally arranged flexuous or longitudinally and latitudinally. There are a few papillae on the abaxial surface of *O. ambigens* (Fig. 12). In *O. armenum*, in contrast, the whole abaxial surface is covered by papillae. Domed epidermal cells are seen on the surface. Cell generally has a small, apically rounded papilla or smooth dome. Apical parts of papillae are generally slanted.

Table 2. Petal epidermal features of 11 *Onosma* taxa studied under light microscope.

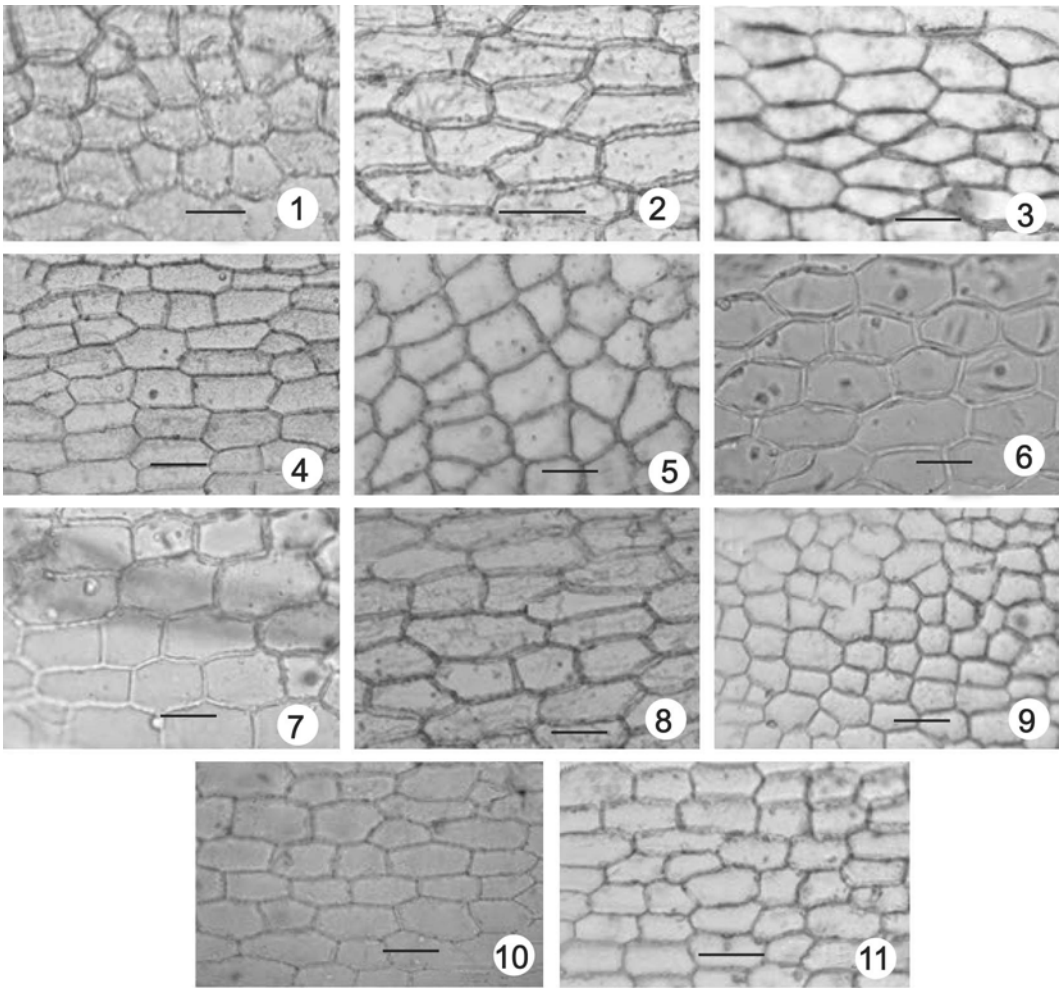
Taxon	Epidermal cell size (Mean±SE*)		No. of parenchyma layer	Shape of epidermal cells
	Length	Width		
O. ambigens	28.8 ± 3.07	22.0 ± 2.13	4-5	Isodiametric-polygonal
O. armenum	123.0 ± 4.15	39.3 ± 0.98	5-6	Rectangular
O. bornmuelleri	65.0 ± 3.87	48.3 ± 2.88	5-6	Polygonal-rectangular
O. bourgaei	74.0 ± 1.05	34.8 ± 2.15	5-6	Rectangular
O. bracteosum	31.4 ± 1.49	21.3 ± 1.40	5-6	Isodiametric-polygonal
O. intertextum	68.8 ± 3.69	30.3 ± 2.28	4-5	Polygonal-rectangular
O. isauricum	31.0 ± 1.66	21.8 ± 1.50	5-7	Rectangular
O. roussaei	80.1 ± 0.65	30.4 ± 0.30	4	Rectangular
O. sericeum	30.0 ± 0.85	18.0 ± 0.32	5-6	Isodiametric-polygonal
O. stenolobum	63.5 ± 2.74	23.3 ± 1.62	4-5	Rectangular
O. tauricum var. *tauricum*	91.3 ± 2.72	34.5 ± 0.64	4	Rectangular

*SE = Standard error of the mean.

Table 3. Petal epidermal features of 11 *Onosma* taxa studied under SEM.

Taxon	Surface pattern	Papillae type	Anticlinal wall of epidermis	Trichome
O. ambigens	Areolate	Rarely present	Visible	–
O. armenum	Papillae	Lithops type	Not visible	Simple, porrect-stellate with ornamental wall
O. bornmuelleri	Papillae	Skittle-cell type	Not visible	–
O. bourgaei	Ribbed-rugose	–	Visible	Simple with ornamental wall
O. bracteosum	Papillae	Skittle-cell type	Not visible	Simple with ornamental wall
O. intertextum	Papillae	Skittle-cell type	Not visible	Simple with ornamental or smooth wall
O. isauricum	Papillae	Cone-like papillae	Not visible	Simple with ornamental or smooth wall
O. roussaei	Papillae	Skittle-cell type	Visible	Simple with ornamental wall
O. sericeum	Papillae	Finger-like papillae	Not visible	Simple, densely arranged with ornamental wall
O. stenolobum	Papillae	Skittle-cell type	Visible	Simple, short with ornamental wall
O. tauricum var. *tauricum*	Papillae	Cone-like papillae with silica	Not visible	Simple with ornamental walls

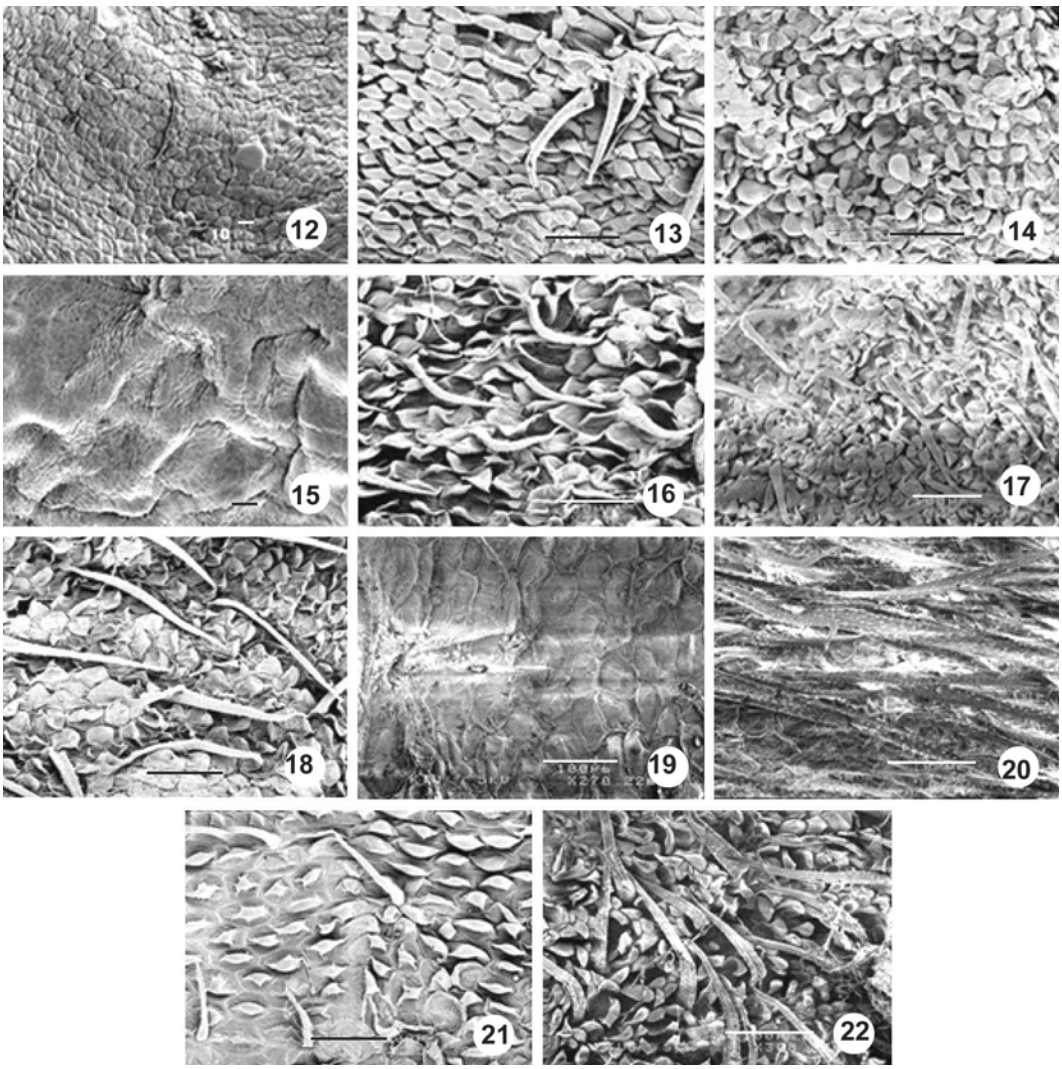
There are also simple or porrect-stellate trichomes with ornamental walls on the epidermal cells (Fig. 13). In *O. bracteosum*, there are some cavities among papillae. Here cell walls are generally elevated (Fig. 16). In *O. intertextum*, apical parts of papillae are generally slanted and wider compared with the other skittle-cell types. Trichomes are in general adpressed and densely arranged (Fig. 17). *Onosma isauricum* generally has domed epidermal cells, usually smooth, and uncommonly non-papillose cells (Fig. 18). The outer periclinal walls of the epidermal cells are slightly bulged in *O. roussaei* (Fig. 19). In *O. sericeum*, densely and adpressed trichomes are present on the surface (Fig. 20).



Figs 1-11. Epidermal cells on abaxial surface of petals of 11 *Onosma* taxa under light microscope. 1. *O. ambigens*; 2. *O. armenum*; 3. *O. bornmuelleri*; 4. *O. bourgaei*; 5. *O. bracteosum*; 6. *O. intertextum*; 7. *O. isauricum*; 8. *O. roussaei*; 9. *O. sericeum*; 10. *O. stenolobum*; 11. *O. tauricum* var. *tauricum*. (Bars: Figs 1, 5, 7, 9 = 30 µm; Figs 3, 6, 10 = 60 µm; Figs 4, 8 = 75 µm; Figs 2, 11 = 100 µm).

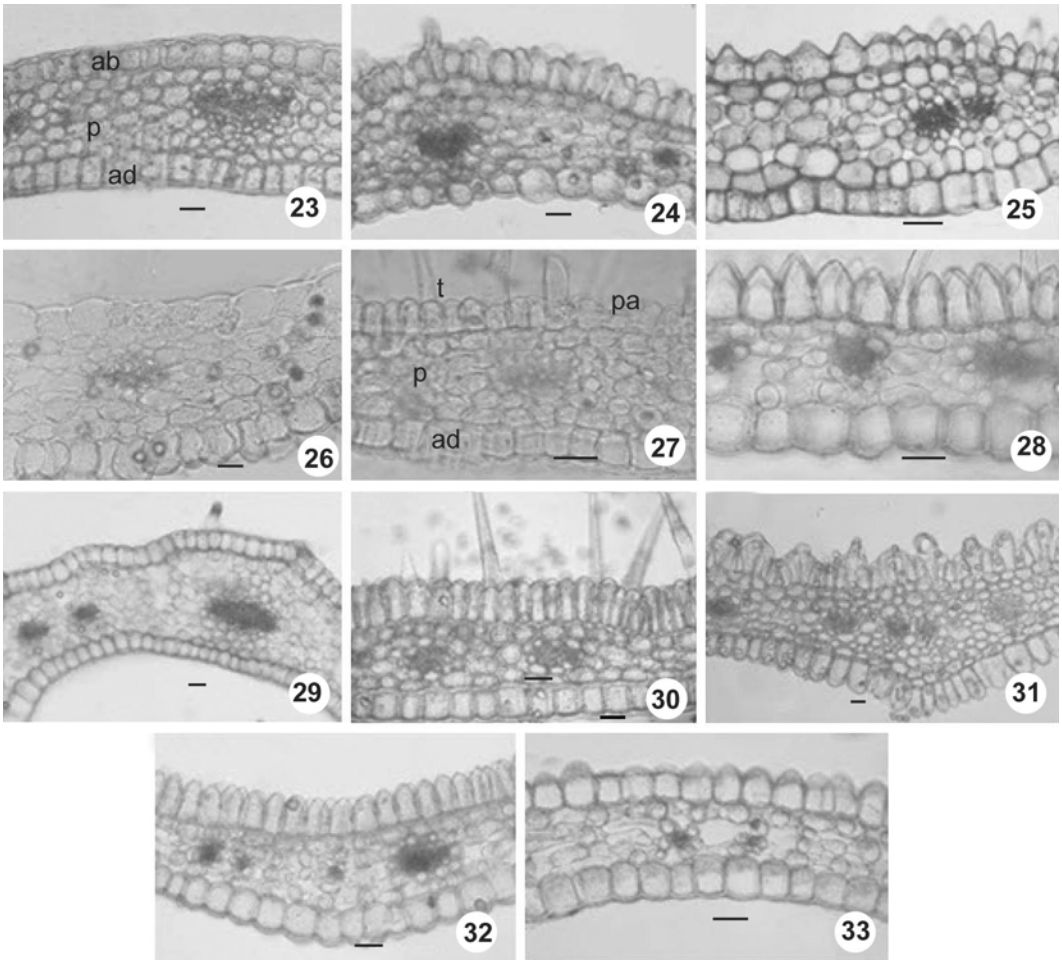
Papillae do not cover the whole surface in *O. stenolobum*. Here boundaries of cells are seen clear (Fig. 21). The epidermal cells of *O. tauricum* var. *tauricum* contain silica (Fig. 22).

The corolla of all examined species are clavate, cylindrical or campanulate. So they are seen as a lobed ring in transverse section. The principal architecture of all species is similar. The adaxial epidermal cells are larger than abaxial epidermal cells. Both adaxial



Figs 12-22. Scanning electron micrographs of petal surface of 11 *Onosma* taxa. 12. *O. ambigens*; 13. *O. armenum*; 14. *O. bornmuelleri*; 15. *O. bourgaei*; 16. *O. bracteosum*; 17. *O. intertextum*; 18. *O. isauricum*; 19. *O. roussaei*; 20. *O. sericeum*; 21. *O. stenolobum*; 22. *O. tauricum* var. *tauricum*. (Bars: Fig. 12 = 10 µm; Figs 13-22 = 100 µm).

and abaxial epidermis are covered with cuticula. Mesophyll consists of oval or cylindrical and multilayered parenchymatic cells (Table 2). Parenchymatic cells have intercellular cavities. Large intercellular cavities are present in *O. intertextum*, *O. isauricum*, *O. stenolobum* and *O. tauricum* var. *tauricum*. Vascular bundles are small and consist of several xylem and phloem vessels. Bundle sheath generally surrounds each vascular bundle, and these are small parenchymatic cells (Figs 23-33).



Figs 23-33. Cross-sections of petals of 11 *Onosma* taxa under light microscope. 23. *O. ambigens*; 24. *O. armenum*; 25. *O. bornmuelleri*; 26. *O. bourgaei*; 27. *O. bracteosum*; 28. *O. intertextum*; 29. *O. isauricum*; 30. *O. roussaei*; 31. *O. sericeum*; 32. *O. stenolobum*; 33. *O. tauricum* var. *tauricum*. ad, adaxial epidermis; p, parenchyma; ab, abaxial epidermis; pa, papillae; t, trichome. (Bars: Figs 23, 27 = 20 µm; Figs 26, 30 = 30 µm; Figs 24, 29, 31 = 35 µm; Figs 25, 33 = 40 µm; Figs 28, 32 = 45 µm).

Discussion

Petal morphology and micromorphology are distinctive features in taxa diagnosis (Metcalfe and Chalk, 1979; Özcan, 2002). The present micromorphological and anatomical studies on petals of some selected *Onosma* species provide more detailed information on these species. It appeared from the study that the morphological features of the petal epidermis under light microscope are constant with no apparent difference among the studied taxa. The pattern of anticlinal cells were straight to curved in all studied species. Nonetheless, some differences were seen in number of parenchymatic cell layers. Akçin and Engin (2001) studied anatomical structure of petals in *O. isuricum* and *O. stenolobum*. They reported that epidermal cells are covered with a cuticle layer with undulation. According to this study, epidermis cells in abaxial side were generally papillose, supporting the report of Metcalfe and Chalk (1979). The present study further support these findings.

Micromorphological characters of petal surface, on the other hand, showed some variations in studied *Onosma* taxa. Papillae type was determined as a main type according to the ornamentation of the petal surface. Same surface type was seen in more than one species, but there was more or less difference in every species. The presence of crystals in Boraginaceae is an important feature (Metcalfe and Chalk, 1979). Azizian *et al.*, (2000) reported that crystal (calcium carbonate) present in two forms in *Onosma* species: a) deposited in cell wall of hairs, and b) located in the base of large hairs. Crystals were clearly seen in the bases of trichomes in *O. bracteosum* and *O. roussaei*.

According to the present study, micromorphological features of the dorsal surface of petal are important characters and can provide useful information on species-level diagnosis along with other selected morphological and micromorphological features.

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(Manuscript received on 24 September 2008; revised on 1 July 2009)