

## FRUIT COAT PATTERNS AND MORPHOLOGICAL PROPERTIES OF SEVEN SPECIES OF *SYMPHYTUM* L. (BORAGINACEAE) FROM TURKEY

ÖZNUR ERGEN AKÇİN AND HİLAL BAKI

Department of Biology, Faculty of Sciences & Arts, Ordu University,  
Perşembe, 52750, Ordu, Turkey

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### Abstract

Micro- and macro-morphological characters of fruit surface of seven species of *Symphytum* L. in Turkey were investigated. Fruits of *S. asperum* Lepechin, *S. sylvaticum* Boiss., *S. brachycalyx* Boiss and *S. kurdicum* Boiss. & Hausskn have indistinct basal ring which in *S. ibericum*, *S. orientale* and *S. bornmuelleri* is distinct. Based on the structure and ornamentation of the fruit surface, tuberculate and rugose types can be distinguished. Micro-morphological characters could be useful in solving taxonomic problems of *Symphytum asperum*, *S. kurdicum*, *S. ibericum*, *S. orientale*, *S. bornmuelleri*, *S. brachycalyx* and *S. sylvaticum*.

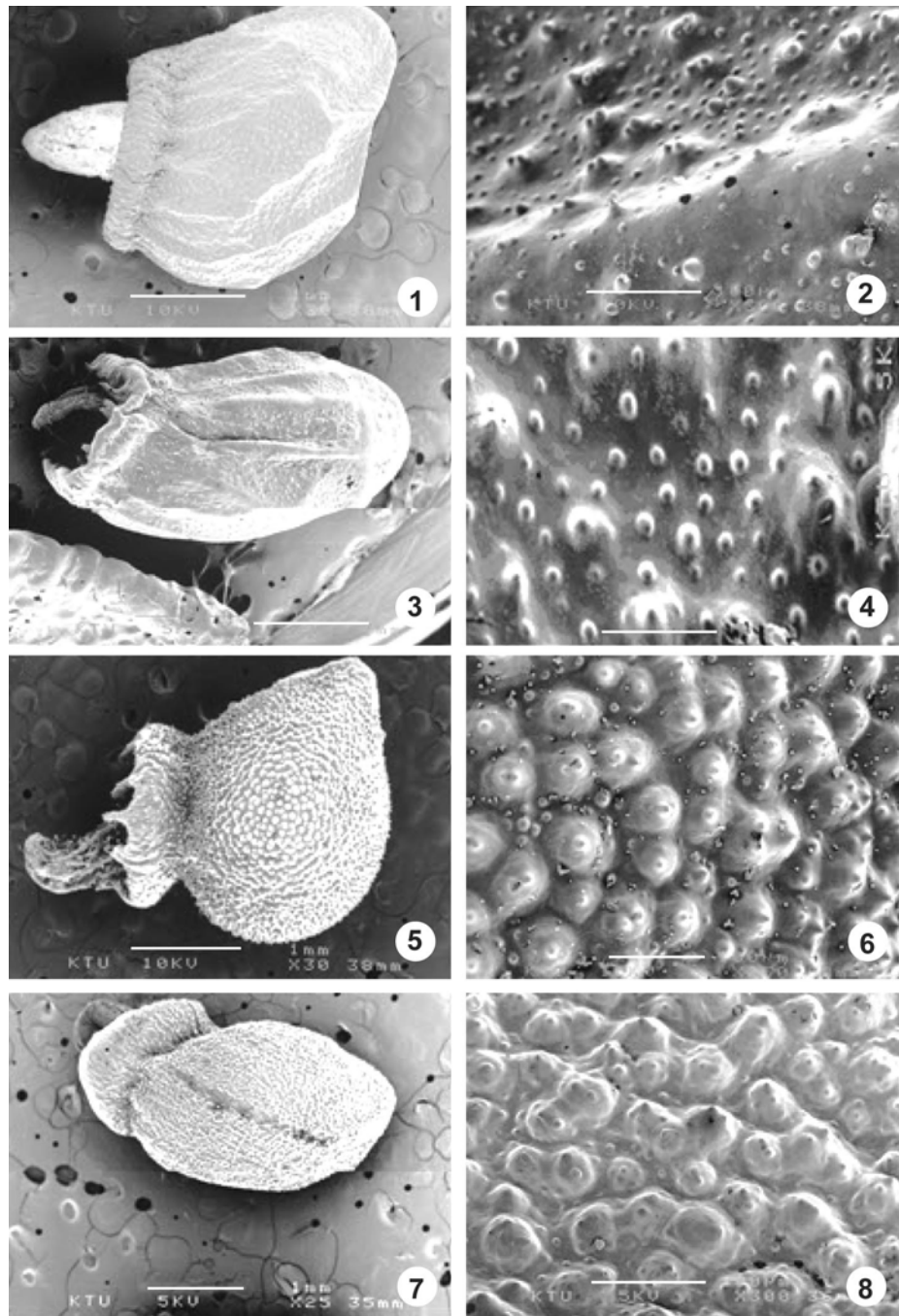
The genus *Symphytum* L. (Boraginaceae) in Turkey is represented by 20 species (Wickens 1978). In recent years, various studies have been carried out on *Symphytum*. Most of them are focused on chemical structure and chromosome number, but no published information available on their detailed anatomy, micromorphology and taxonomy (Ulubelen and Doğanca 1971, Ahmad *et al.* 1993, Mohammad *et al.* 1995). The microstructural properties of the seeds and fruit surface can be useful for delimiting taxa at various levels (Hufford 1995, Juan *et al.* 2000, Karcz *et al.* 2000, 2005, Bobrov *et al.* 2005). The present study is carried out to use micro-morphological characters in the delimitation of some *Symphytum* L. species.

Fruits of seven species of *Symphytum* L. were obtained from Gazi University and Ondokuz Mayıs University Herbaria. For scanning electron microscopy, dried fruits were mounted on stubs using double-sided adhesive tape. Samples were coated with 12.5- 15.0 nm of gold. Coated fruits were examined following Stearn (1973) and photographed with JMS-6400 Scanning Electron Microscope (SEM).

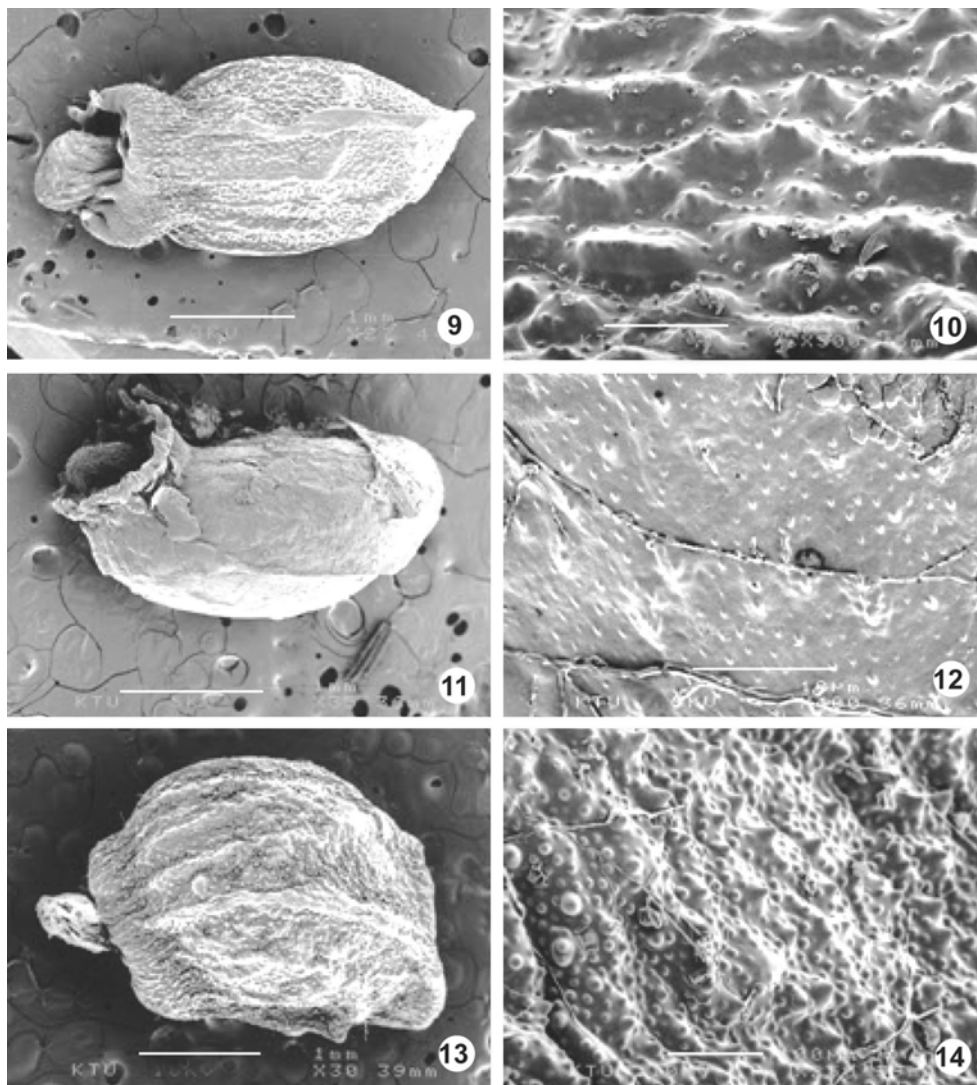
Features of fruit surface, shape, colour and size have been used in distinguishing species. Fruits of *S. asperum* Lepechin, *S. sylvaticum* Boiss., *S. brachycalyx* Boiss and *S. kurdicum* Boiss. & Hausskn have indistinct basal ring. *S. bornmuelleri* Bucknall., *S. ibericum* Steven and *S. orientale* L. have distinct basal ring. Basal rings are thickened, collar-like and toothed in fruits of *S. ibericum* Steven, *S. brachycalyx* Boiss, *S. kurdicum* Boiss. & Hausskn and *S. bornmuelleri* Bucknall. The fruits of *S. bornmuelleri*, *S. kurdicum* Boiss. & Hausskn, *S. sylvaticum* Boiss. and *S. asperum* Lepechin are obliquely keeled. No keel was found in fruits of *S. orientale* L. and *S. ibericum* Steven. However, *S. orientale* have 1-2 splits on the fruit's surface. The species have similar nutlet size. Nutlets of *S. ibericum* are smaller than the others. Colour of fruits varies from light brown to dark brown. Based on the structure and ornamentation of the fruit surface, tuberculate and rugose types can be distinguished.

**Tuberculate type:** Tuberculate type is most common among the species and is of three types as described below.

**Pusticulate tuberculate:** This type is characterized by bulges and big or small tuberculates on surface and is seen in *S. asperum* and *S. kurdicum*. The conspicuous and infrequent bulges are seen on the surface of *S. asperum* (Figs. 1-2) and *S. kurdicum* (Figs. 3-4). Big and small tuberculates are present both on surface and on bulges of these two species. Bulges and tuberculates are bigger in *S. kurdicum* than other species. Nutlets of *S. asperum* are 3-4 mm long and brown in colour. In *S. kurdicum*, nutlets are 3.0-4.5 mm long and brownish.



Figs 1-8. Scanning electron micrographs of *Symphytum* fruits. General view on the left (Bars = 1 mm), fruit surface on the right (Bars = 100  $\mu$ m). 1-2. *S. asperum*, 3-4. *S. kurdicum*, 5-6. *S. ibericum*, 7-8. *S. orientale*.



Figs 9-14. Scanning electron micrographs of *Symphytum* fruits. General view on the left (Bars: 1 mm); fruit surface on the right (Bars: 100  $\mu$ m, only Fig. 12: 10  $\mu$ m.). 9-10. *S. bornmuelleri*, 11-12. *S. brachycalyx*, 13-14. *S. sylvaticum*.

*Colliculate tuberculate*: This type is found in *S. ibericum*, *S. orientale* and *S. bornmuelleri*. But some differences are seen in fruit surface of these species. The diagnostic characters of colliculate type are dense and big bulges. In *S. ibericum*, dense and big bulges covered all fruit surface. There are tuberculates on the bulges. Also, small tuberculates are seen among the bulges (Figs. 5-6). Nutlets are 2-3 mm long and light brown in colour. *S. orientale* has small colliculate tuberculate surface type. The surface of this species is covered with dense and irregular bulges. There are 1-5 tuberculates and aculeates on the bulges. Small tuberculates are present among the bulges (Figs. 7-8). Fruits are 3-4 mm and brown in colour. In *S. bornmuelleri*, bulges are generally united and long like mountain ranges. There are dense tuberculates between bulges (Figs. 9-10). Nutlets are 3.0- 3.5 mm long and light brown in colour.

*Punctate tuberculate*: This surface type is found only in *S. brachycalyx*. In comparison with the above types, punctate type was more basic. The most smooth surface is found in this species. Fruit surface is formed of small tuberculate structures. These structures can be seen under high magnification (Figs. 11-12). Nutlets are 3-4 mm long and brown in colour.

*Rugose type*: The rugose surface type is found in *S. sylvaticum*. There are bulges, big and small tuberculates and aculate ornamentation on the surface (Figs. 13-14). This type is like combination of pusticulate and punctate surface types. Small tuberculates are common on the fruit surface. Nutlets are 3.0-4.5 mm long and light brown in colour.

Wickens (1978) reported that the fruits of *Symphytum* species are smooth or verruculose and often rugose. The micrographs show that the morphology of the fruit surface of studied species is generally verruculose. In this study, *S. ibericum* and *S. orientale* have similar types. But there are irregular bulges and small 1-5 tuberculates and aculeates on the bulges in *S. orientale*. *S. ibericum* has been found to have regular bulges and there are big 1-2 tuberculates on the bulges. *S. asperum* and *S. kurdicum* have pusticulate-tuberculate. In *S. kurdicum*, tuberculates are bigger and more dense than others.

The fruits of Boraginaceae are characterized by one-seeded mericarpids (nutlets) with a sclerified exocarp protecting the seeds (Diane *et al.* 2002). The number of seeds produced per capsule can serve as a diagnostic character (Juan *et al.* 2000). *Symphytum* species has one-seeded nutlet. Micro-morphological characters could be useful in solving taxonomic problems of the *Symphytum* species.

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