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DOI: 10.26672/anatolianbryology.465122

Anatolian Bryology
Anadolu Briyoloji Dergisi
Research Article
e-ISSN:2458-8474 Online

Morphological, Anatomical and Reproductive Differences between *Riccia cavernosa* Hoffm. and *Riccia crystallina* L. in the Liverwort Flora of Turkey

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Received: 28.09.2018

Revised: 10.10.2018

Accepted: 18.10.2018

Abstract

Riccia is the largest genus among Turkish Liverwort Flora with 26 taxa (24 species and 2 varieties). Identification of *Riccia* species are quite difficult because of too similar morphology of the especially closely related taxa. *R. cavernosa* and *R. crystallina* are morphological similar taxa and generally confused together in field trips. In this study, morphological, anatomical, reproductive, ecological and distributional information's with detailed photos and drawings of these species were given.

Key words: *Riccia*, *Riccia cavernosa*, *Riccia crystallina*, morphological characters, anatomical characters, reproductive characters

Türkiye Ciğerotları Florasında ki *Riccia cavernosa* Hoffm. ve *Riccia crystallina* L. Arasındaki Morfolojik, Anatomik ve Üreme Farklılıkları

Öz

Riccia 26 takson (24 tür ve 2 varyete) ile Türkiye Florası içindeki en büyük cinstir. *Riccia* cinsinin tayini, cinse ait türlerin morfolojik olarak birbirlerine çokbenzemelerinden dolayı oldukça zordur. *R. cavernosa* ve *R. crystallina* morfolojik olarak birbirlerine çok benzer ve bu taksonlar arazi çalışmalarında birbirlerine karıştırılırlar. Bu çalışmada adı geçen türlere ait morfolojik, anatomik, üreme, ekolojik ve dağılımlarına dair bilgiler, ayrıntılı fotoğraflar eşliğinde verilmiştir.

Anahtar kelimeler: *Riccia*, *Riccia cavernosa*, *Riccia crystallina*, morfolojik özellikler, anatomik özellikler, üreme özellikleri

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To cite this article: Özenoğlu H. Kırmacı M. 2018. Morphological, Anatomical and Reproductive Differences between *Riccia cavernosa* Hoffm. and *Riccia crystallina* L. in the Liverwort Flora of Turkey. *Anatolian Bryology*. 4:2, 79-83.



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1. Introduction

It is well known that bryophytes are very small (thalli generally 0.5 - 4 mm wide, 2 – 30 mm long) and variable plants. Sometimes it is very difficult to identify closely related taxa, especially, if you don't have own floras. *Riccia* is the largest genus among Turkish Liverwort Flora with 26 taxa (24 species and 2 varieties) (Ros et al., 2007; Özenoğlu Kiremit and Keçeli, 2009; Özenoğlu Kiremit and Hugonnot, 2010; Özenoğlu Kiremit, 2011; Özenoğlu Kiremit et al., 2016). *R. cavernosa* Hoffm. and *R. crystallina* L. are often mixed together because of morphological similarities.

In the present study, it was planned to show differences between *R. cavernosa* and *R. crystallina*. Both taxa naturally growing in Turkey were compared and illustrated in term of morphologically and anatomically.

2. Materials and Methods

The materials of this study were collected from different localities between the years 1999 and 2014 and identified using related floras, revisions, and monographs. Identified taxa were stored in the herbarium of Adnan Menderes University (AYDN).

The illustrations of the species are expanded on the basis of the descriptions given in Jovet-Ast, 1986; Paton, 1999; Bischler, 2004; Frey et al., 2006; Kürshner and Frey, 2011; Özenoğlu Kiremit et al., 2016.

Images of the habits of species were photographed by the authors during the field studies. The microstructure of spore surfaces was studied using a scanning electron microscope (SEM) at Selçuk University. Transverse sections and spore were photographed under a light microscope (N2203720 OLYMPUS CX41RF-5 Trinocular Microscope). The digital photographs

were used by anatomical measurement and anatomical drawing (Adobe Illustrator CS5).

3. Findings

3.1. Specimens examined: *R. cavernosa*: **Sinop, Boyabat**, Ilıca Village, Gökırmak streambed, on wet soil, 300 m, 41° 32' 47.17" N 34° 42' 21.19" E, 10.08.2013, AYDN 3456. *R. cavernosa* has been found on wet soils in river bank, in *Populus alba* L. *Rubus* sp. and *Salix* sp. plantations. The species was growing on wet or muddy soil near stream, pond and lake (Özenoğlu Kiremit, et al., 2016; Arslan, et al., 2018).

Riccia crystallina: **Aydın, Nazilli**, on soil in garden, 80 m, 07.02.1999, Özenoğlu C11/110; **Söke**, Sazlıköy, olive plantation, on soil, 57 m, 37° 46' 18,4" N 27° 25' 32,4" E, 26.03.2013, Özenoğlu TR/211, TR/258; **Merkez**, ADU Campus, Science Faculty, on soil under the olive trees, 184 m, 37° 51' 20,3" N 27° 51' 13,8" E, 25.03.2013, Özenoğlu TR/213; **Nazilli**, Hamzalı Village, on soil under the orange trees, 81 m, 37° 54' 11,4" N 28° 25' 24,4" E, Özenoğlu TR/286; **Balıkesir, Erdek**, Narlı, on soil, 10 m, 40° 28' 42,2" N 27° 41' 20,0" E, 27.01.2013, Özenoğlu TR/107; **Mersin, Anamur**, Emirşah Village, *Eupcalyptus* sp. plantation, on soil, 40 m, 36° 04' 54" N 32° 47' 28,7" E, 03.03.2014, Özenoğlu TR/295; **Muğla, Datça**, Knidos Antique City, on soil, 10 m, 36° 41' 09,3" N 27° 22' 24,8" E, 02.03.2013, Özenoğlu TR/176. *R. crystallina* grows on soil in open areas and was collected from olive and citrus garden and various places with under anthropogenic pressure. Especially, *Sphaerocarpos texanus* Austin is the common accompanying species in these areas.

4. Results and Discussion

Detailed results of the species are presented in the form of a table showing similar and different characteristics (Table 1, Figure 1 and Figure 2).

Table 1. Anatomical, morphological and reproductive differences between *Riccia cavernosa* and *Riccia crystallina*.

<i>Riccia cavernosa</i> Hoffm.	<i>Riccia crystallina</i> L.
Plants forming rosettes of 15-20 mm in diameter (A1)	Plants forming rosettes of 6 - 10 mm in diameter (B1)
Thallus light green frequently, whitish-green to base (A1)	Thallus glaucous or blue-green, crystalline when moist (B1)
Thalli 2 - 4 furcate, ultimate branches to 2 mm, oblong, rounded to emarginate apically (A2)	Thalli 2 - 3 furcate, ultimate branches 2 - 3.5 (4.5) mm wide, broad, truncate or rounded apically, lobe width increase towards the apex (B2)
Thallus with irregular perforations on the dorsal surface, it's especially distinct on thallus base (A3)	Dorsal epidermis without pores in the young parts, perforate in median parts (B3)
Thallus sections of lobes 3 - 5 times wider than	Thallus sections of lobes 3 - 5 times wider than

high, spongy (A4)	high (B4)
<i>Riccia cavernosa</i> Hoffm.	<i>Riccia crystallina</i> L.
Chlorenchyma with one air-chambers layer but obliquely orientated and appearing multi-layered in transverse section, chlorenchyma 500-550 µm high (A5)	Chlorenchyma with numerous air-chambers layer, chlorenchyma 400 - 450 µm high (B5)
Parenchyma green, 100-120 µm high (A6)	Compact parenchyma below, parenchyma 120 - 180 µm high (B6)
Mature capsules 450 - 500 × 550 - 600 µm, not conspicuous any side of lobes and open on dorsal side of lobes (A7-8)	Mature capsules 550 - 600 × 720 - 760 µm, more conspicuous on ventral than on dorsal side of lobes (B7-8)
Spores (65) 75 - 85 µm, reddish to brownish (A9)	Spores (60) 65 - 75 µm, light yellow-brown (B9)
Spore distal face with irregularly delimited alveolae with thick wall provided at wall corners with small tubercles (A10)	Spore distal face with 8 - 10 alveolae across diameter, limited by regular walls provided at wall corners with obtuse and bifid tubercles (B10)
Proximal faces with similar ornamentation to distal face (A11)	Proximal faces with similar ornamentation to distal face (B11)
Wing 3 - 6 µm wide, regularly and slightly crenulate distal face with irregular ridges (A12)	Wing 4 - 6 µm wide, strongly crenulate margin (B12)
The species grows on wet or muddy soil near stream, ponds or lake (A13)	The species grows on soil in open areas with under anthropogenic pressure (B13)

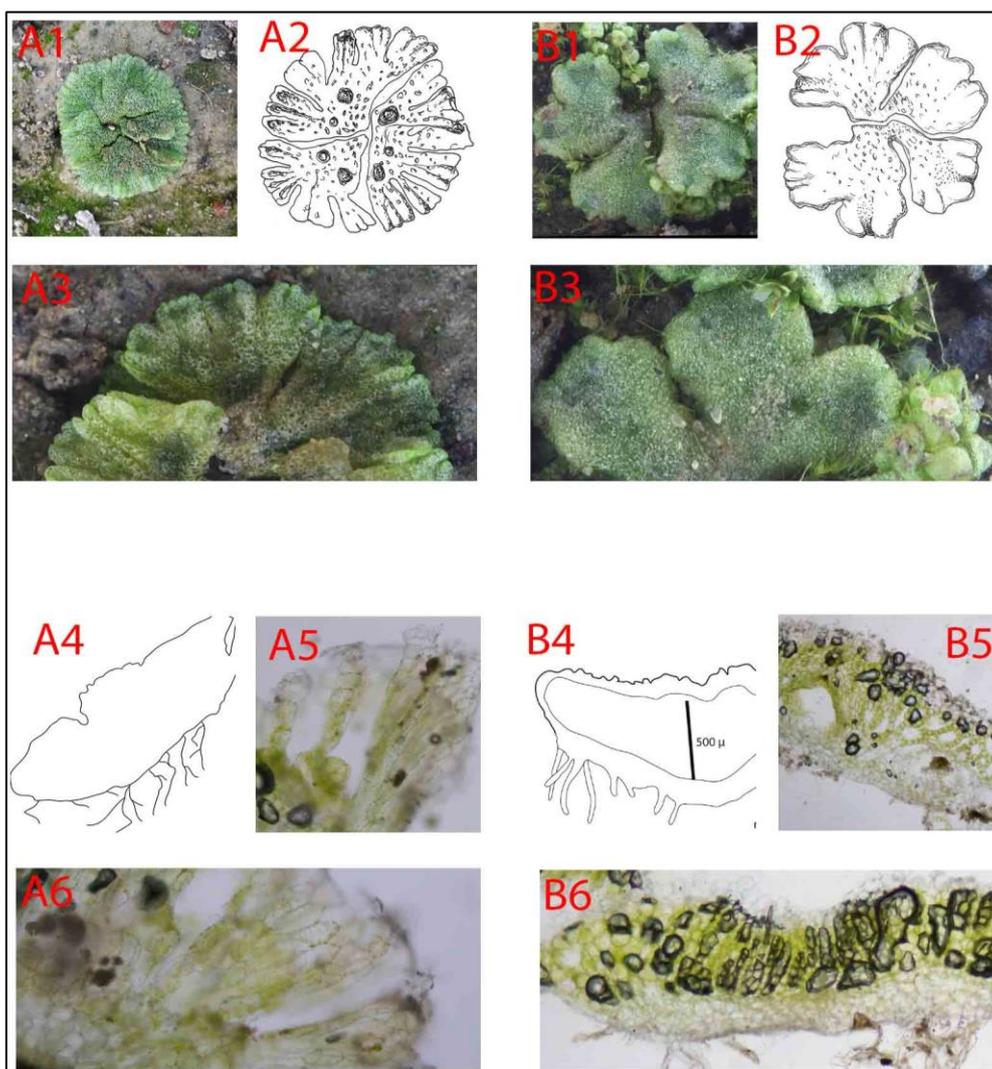


Figure 1. Anatomical and morphological differences between *Riccia cavernosa* and *Riccia crystallina*.

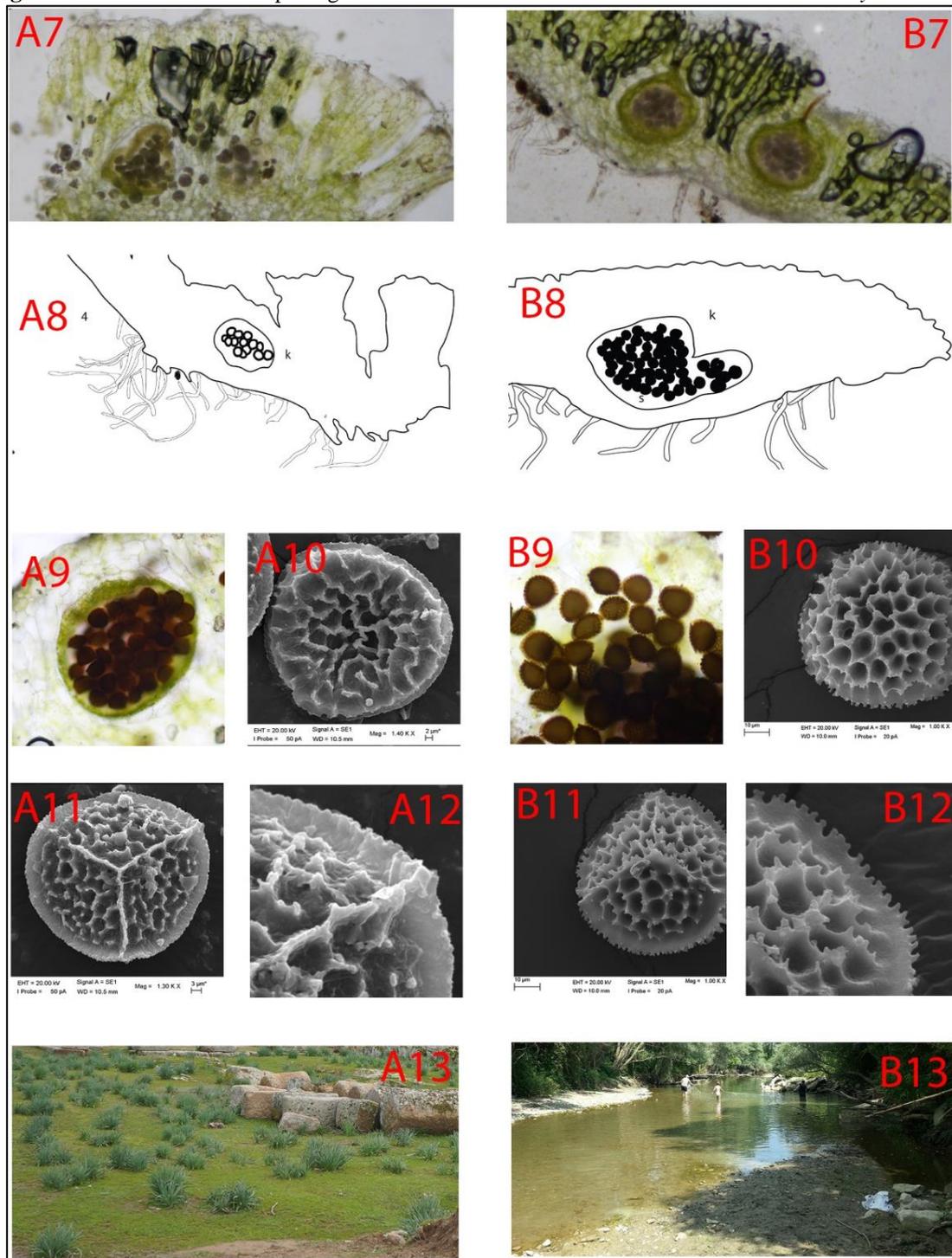


Figure 2. Reproductive differences between *Riccia cavernosa* and *Riccia crystallina*.

Although spore morphology has less taxonomic value in some groups, it is extremely useful in differentiating some taxa at genus and species level, even higher groups. For example, Buck has indicated that the spore morphology is useful to separate two different families *Bruchiaceae* and *Dicranaceae* (Buck, 1979). This study was

confirmed by Luizi-Ponzo and Barth (1998; 1999). Many studies showed that it has been useful in resolving taxonomic problems for especially closely related genera such as *Acaulon*, *Phascum*, *Tortula*, *Crossidium* and *Pottia* (Lewinsky, 1974; Stone, 1989; Carrión et al., 1990; Guerra et al., 1991; Guerra et al., 1992;

Cano et al., 1993; Carrión et al., 1993;). On the other hand, spore morphology has been of limited value in the taxonomy of *Pterygoneurum* (Limpricht, 1890; Smith, 1978; Catcheside, 1980; Crum and Anderson, 1981; Zander, 1993). It is too difficult to separate *R. crystallina* and *R. cavernosa* because of morphologically similarities. The sporophytic characters of them are different and use to identify. *R. cavernosa* differs from *R. crystallina* as the thallus color, strongly alveolate of dorsal surface, air chambers layer number and spore distal face with imperfect areolation. Also, the habitats are quite different to these species. *R. cavernosa* grows on wet or muddy soil near stream, ponds or lake in the Turkey.

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