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New findings of *Riccia* species (Marchantiophyta) in Turkey and Southwest Asia

Hatice ÖZENOĞLU KİREMİT[a], Mesut KIRMACI[b] & Ferhat KİREMİT[c]*

[a]Adnan Menderes Üniversitesi, Eğitim Fakültesi, İlköğretim Bölümü, 09010 Kepez-Aydin, Turkey

[b]Adnan Menderes Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, 09010 Kepez-Aydin, Turkey

[c]Adnan Menderes Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, 09100 Çakmar-Aydin, Turkey

Abstract – *Riccia beyrichiana* Hampe *ex* Lehm., *R. cavernosa* Hoffm. and *R. crinita* Taylor are recorded for the first time in Turkey. *Riccia beyrichiana* is also recorded for the first time in Southwest Asia. Morphological diagnostic characteristics that allow the distinction from closely related taxa, Mediterranean distribution, ecological and habitat data in Turkey, and a map of collection sites are given.

Liverworts / Taxonomy / Bryophyte flora / Distribution

INTRODUCTION

Riccia L. genus is represented approximately by more than 150 species in the world (Jovet-Ast, 2005). The genus is widely distributed in Europe with 36 taxa (33 species and three varieties), in the Mediterranean with 40 taxa (36 species and four varieties) and in Southwest Asia with 33 taxa (31 species, one variety and one subspecies) (Heyn & Herrnstadt, 2004; Frey *et al*., 2006; Ros *et al*., 2007; Kürschner & Frey, 2011).

Riccia is the largest genus among Turkish liverwort flora (Ros *et al*., 2007; Özenoğlu Kiremit & Keçeli, 2009; Özenoğlu Kiremit & Hugonnot, 2010; Özenoğlu Kiremit, 2011). Up to now 23 taxa (21 species and two varieties), have been reported from Turkey. *Riccia bifurca* Hoffm. (Penther & Zederbauer, 1905), *R. macrocarpa* Levier (Schiffner, 1908), *R. ciliifera* Link *ex* Lindenb. (Bornmüller, 1931) and *R. frostii* Austin (Jovet-Ast, 1957) were the early *Riccia* records in Turkey. Thus, prior to 1960, the total number of *Riccia* species recorded was only four. After this time Walter (1967, 1970) reported four taxa from the Western part of Turkey which were *R. ciliata* Hoffm., *R. rhenana* Lorb. *ex* Müll. Frib., *R. crystallina* L. *emend.* Raddi and *R. sorocarpa* Bisch. Following these records, five taxa, *R. bicarinata* Lindb., *R. glauca* L., *R. gougetiana* Durieu & Mont., *R. michelii* Raddi and *R. nigrella* DC. were given by Crundwell & Nyholm (1979). The last records belonging to

* Corresponding author: mkirmaci@gmail.com

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genus published from Turkey were *R. canaliculata* Hoffm. and *R. lamellosa* Raddi (Jovet-Ast, 1986), *R. papillosa* Moris (Çetin, 1988), *R. trabutiana* Steph. (Gökler & Öztürk, 1991), *R. fluitans* L. (Gökler & Aysel, 1998), *R. crozalsii* Levier (Gökler *et al.,* 2000), *R. perennis* Steph. (Özenoğlu Kiremit & Hugonnot, 2010) and *R. subbifurca* Warnst. *ex* Croz. (Özenoğlu Kiremit, 2011).

MATERIAL AND METHODS

Numerous new *Riccia* records were collected between 2012 and 2014 within the frame work of a project (supported by the Scientific and Technological Research Council of Turkey) on the revision of *Riccia* genus in Turkey by the authors. All voucher specimens are kept at the Herbarium of Adnan Menderes University (AYDN).

The *Riccia* genus is more frequent in areas with Mediterranean-type climate in Turkey. This genus is recorded from Northwest, West and South Anatolia areas with Mediterranean-type climate (Walther, 1967, 1970; Crundwell & Nyholm, 1979; Gökler and Aysel, 1998; Gökler *et al.*, 2000; Özenoğlu Kiremit, 2007; Özenoğlu Kiremit & Kırmacı, 2012).

As it is known, three different types of climate exist in Turkey . The West and South parts of the country is under the influence of the Mediterranean climate. While the northern areas are affected by the European-Siberian climate; central and Eastern part of Turkey have Continental climate (Avcı, 2005). In addition, Turkey is a plateau which rises from the West to the East. The average height above sea-level is 1000 m in the central Anatolia and 2000 m in the East. For this reason, climatic factors, geology and geomorphology have been taken into account when planning fieldwork (Gemici & Gemici, 2006). It is also known that *Riccia* species are ephemeral taxa (Kürschner *et al.*, 2007). Therefore, fieldwork was mainly carried out within the months of January and April in Western and Southern Anatolia. *Riccia* species are widespread in these areas and were consequently more frequently surveyed. In the Black Sea area, field work began at a later time due to receiving a greater amount of precipitation; and fieldwork on the areas near the summits of mountains continued until August-September. Fieldwork began in February-March in central Western Anatolia and continued until July-August relative to the increase in sea level towards the East of the country.

During long fieldwork periods, the samples, without being spoiled, were taken to laboratories in special containers and conservation in herbarium was made after identification was carried out. Images of spores belonging to all the taxa were taken with an electron microscope. Geographical areas from which reproductive organs could not be collected were survey more than once.

RESULTS

A total of 25 different *Riccia* taxa were identified by the authors in Turkey in the frame of the mentioned project. Three of them were first records for the country*: R. beyrichiana* Hampe *ex* Lehm.*, R. cavernosa* Hoffm. and *R. crinita* Taylor. They increase the total previos known number of *Riccia* taxa in Turkey to

26 (24 species and two varieties). For each species, Turkish locality data of the specimens studied and comments about morphological distinction with respect to closely related species, distribution data and habitat in Turkey are given.

***Riccia beyrichiana* Hampe *ex* Lehm.**

Aydın, Söke, between Güllübahçe and Doğanbey, 2 km to Doğanbey, road side, on soil, 10 m a.s.l., 37°37′19.93″ N, 27°11′42.52″ E (Fig. 1, number 1), 23.03.2012, leg. *E. Agcagil and M. Kırmacı*, det. M. Kırmacı and H. Özenoğlu Kiremit (AYDN 3452).

Aydın, Ortaklar, Selatin Village, on wet soil, 351 m a.s.l., 37°58′11.57″ N, 27°29′57.01″ E (Fig. 1, number 2), 13.01.2013, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3453).

Aydın, Güzelçamlı, Panionion Ancient City, on soil under olive and *Pinus brutia* Ten. trees, 49 m a.s.l., 37°42′46.40″ N, 27°13′57.50″ E (Fig. 1, number 3), 24.03.2013, leg. *E. Agcagil* and *M. Kırmacı,* det. H. Özenoğlu Kiremit (AYDN 3454).

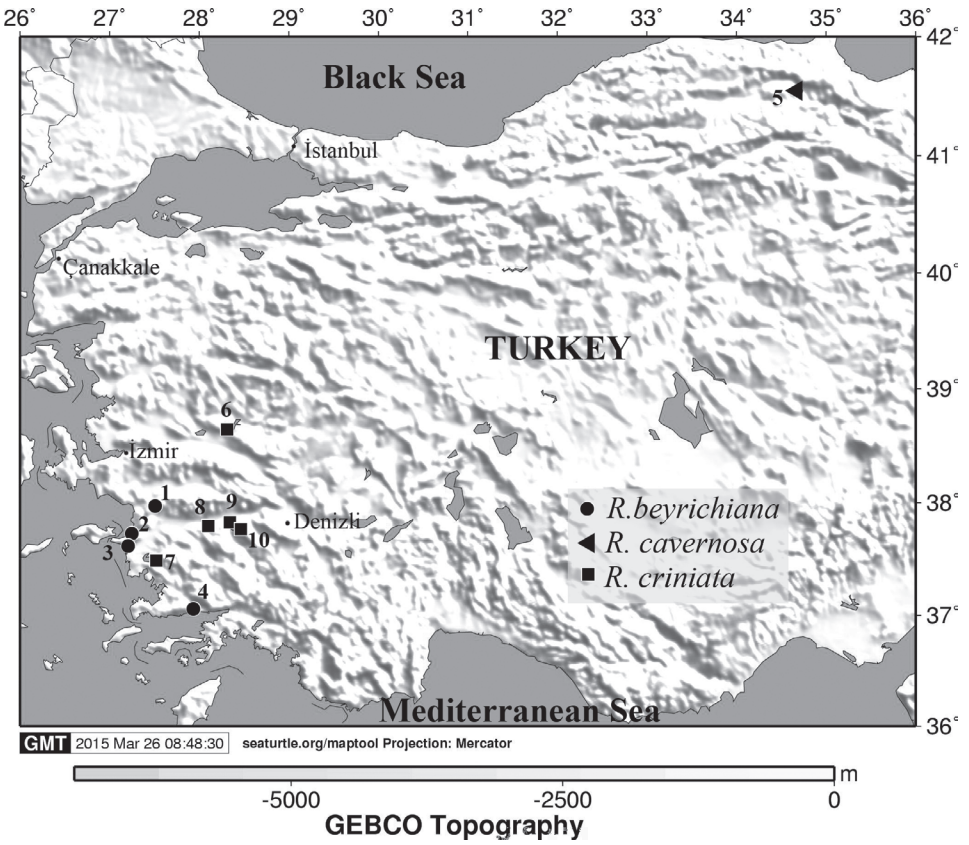


Fig 1. Map of collection sites of the new *Riccia* species in Turkey (taken from Seaturtle.org, 2015).

Muğla, Akkaya-Oren road, 10 km to Oren, on soil in stream bed, 15 m a.s.l., 37°03′01.40″ N, 27°57′41.40″ E (Fig. 1, number 4), 03.03.2013, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3455).

This species can be distinguished from other *Riccia* subgenus members by the large, channelled, long-persistent, shiny thalli with swollen margins. Spores pale to dark yellow-brown, 100-120(140) µm in diameter, wing 4-8 µm wide (Figs 2, 3). Jovet-Ast (1986) described the cilia as rare or sometimes absent in Mediterranean species. The material collected in Turkey notably had numerous cilia. From a general point of view, cilia number is changeable in the genus *Riccia* (Jovet-Ast, 1986; Paton, 1999) depending on ecological conditions.

According to Jovet-Ast (1986), Bischler (2004) and Ros *et al.* (2007), in the Mediterranean Region, *R. beyrichiana* was reported from Algeria, Baleares, Corsica, Croatia, France, Greece, Italy, Malta, Portugal, Sardinia, Spain, and Tunisia. The discovery of *R. beyrichiana* is a significant extension range to the Eastern border of its known range. Easternmost localities of *R. beyrichiana* (of Greece and Turkey) appear rather isolated compared with the bulk of localities of France, Portugal, Spain and Northern Africa. According to Kürschner & Frey (2011), *R. beyrichiana* was until now not recorded from Southwest Asia.

The species was growing in a quite open *Ceratonia siliqua* L., *Olea europaea* L., *Pistacia terebinthus* L. and *Quercus coccifera* L. plantation, on soil at road side and in stream bed. Accompanying bryophyte species of *R. beyrichiana* in Turkey were *Barbula unguiculata* Hedw., *Fossombronia echinata* Macvicar, *Microbryum starckeanum* (Hedw.) R.H. Zander, *Oxymitra incrassata* (Broth.) Sérgio & Sim-Sim, *Pseudocrossidium hornschuchianum* (Schultz) R.H. Zander, *Ptychostomum imbricatulum* (Müll. Hal.) Holyoak & N. Pedersen, *Riccia lamellosa*, *R. macrocarpa*, *R. sorocarpa*, and *Sphaerocarpos texanus* Austin.

***Riccia cavernosa* Hoffm.**

Sinop, Boyabat, Ilıca Village, Gökırmak streambed, on wet soil, 300 m a.s.l., 41°32′47.17″ N, 34°42′21.19″ E (Fig. 1, number 5), 10.08.2013, leg. *M. Kırmacı,* det. H. Özenoğlu Kiremit and M. Kırmacı (AYDN 3456).

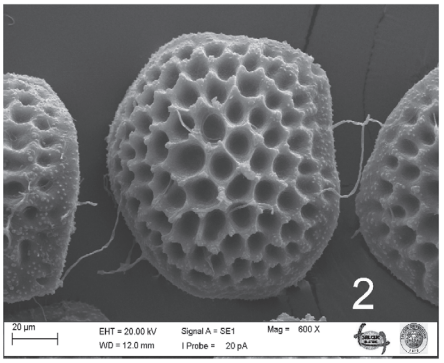
This species can be distinguished from other *Ricciella* subgenus members by the irregular perforated dorsal surface of the thalli and the spores distal face with imperfect areolation, (65)75-85 µm in diameter (Figs 4, 5). *Riccia crystallina* is a similar species but differs from *R. cavernosa* by the thalli dorsal surface alveolate only with age, and spore distal face regularly areolate.

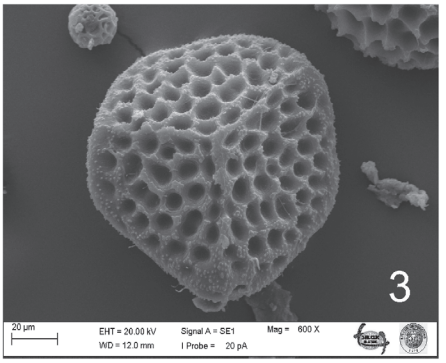
Riccia cavernosa is widely distributed in warm regions of all continents (Jovet-Ast, 1986). In the Mediterranean Region was reported from Baleares, Canary Islands, Croatia, Egypt, France, Italy, Libya, Madeira, Morocco, Portugal, Sicilia, Spain and Tunisia (Jovet-Ast, 1986; Bischler, 2004; Ros *et al*., 2007). Additionally, it was reported in Southwest Asia from Iran, Saudi Arabia, Sinai Peninsula and Yemen (Kürschner & Frey, 2011). In Turkey it was collected in the transition zone between the Middle Black Sea and central Anatolia which has a Mediterranean climate.

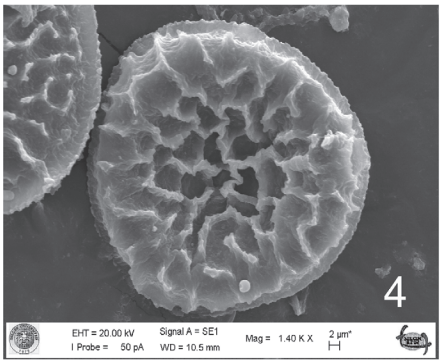
It was growing on wet soils, as a solitary plant, in river banks, in *Populus alba* L., *Rubus* sp. and *Salix* sp. plantations, and on sandy rock ledges in the lowlands.

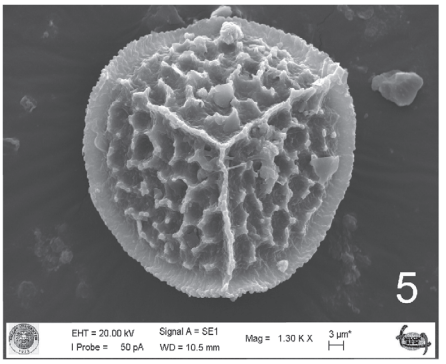
Riccia crinita Taylor

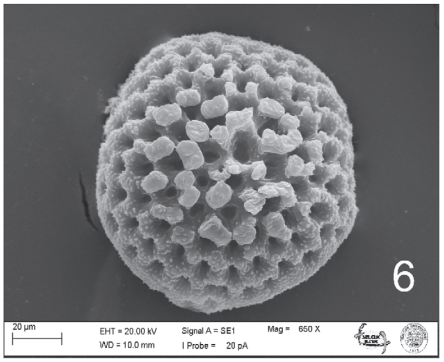
Manisa, Salihli, Sindel Village, in grassland, in a small streambed, on wet soil and soil on the rocks, 316 m a.s.l., 38°38′56.70″ N, 28°18′52.60″ E (Fig. 1, number 6), 06.04.2013, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3457).

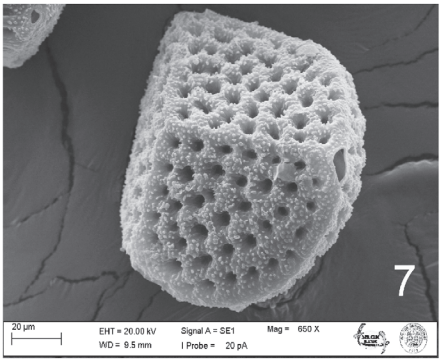












Figs 2-7. Spore SEM micrographas of the new *Riccia* species from Turkey. **2, 3.** *R. beyrichiana* (from AYDN 3452). **4, 5.** *R. cavernosa* (from AYDN 3456). **6, 7.** *R. crinita* (from AYDN 3459) (2, 4, 6 distal face; 3, 5, 7 proximal face).

Muğla, Milas, Heraklea Ancient City, on soil in ancient city, 49 m a.s.l., 37°30′10.47″ N, 27°31′44.16″ E (Fig. 1, number 7), 22.02.2014, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3458).

Aydın, Yenipazar, Alanlı Village, on soil and soil bank, 75 m a.s.l., 37°48′15.60″ N, 28°06′01.60″ E (Fig. 1, number 8), 23.03.2013, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3459).

Aydın, Nazilli, Yellice Village, road side, on soil bank, 488 m a.s.l., 37°46′39.20″ N, 28°23′28.60″ E (Fig. 1, number 9), 07.04.2013, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3460).

Aydın, Nazilli, Uzunçam Village, road side, on soil bank, 600 m a.s.l., 37°46′57.10″ N, 28°22′31.50″ E (Fig. 1, number 10), 07.04.2013, leg. and det. *H. Özenoğlu Kiremit* (AYDN 3461).

This species can be distinguished from other *Riccia* subgenus members by the very long and numerous cilia at margins and dorsal surface of thalli, and the spores (105)110-120(125) µm in diameter, pale brown to dark brown, with a wing to 2(3) µm wide (Figs 6, 7).

According to Jovet-Ast (1986), *R. crinita* is a subcosmopolitan species. In the Mediterranean Region it was reported from Algeria, Baleares, Bosnia-Herzegovina, Canary Islands, Corsica, Crete, Croatia, France, Greece, Italy, Lebanon, Libya, Montenegro, Morocco, Portugal, Serbia, Spain, and Tunisia (Jovet Ast, 1986; Bischler, 2004; Ros *et al.*, 2007). Meanwhile it was reported in Southwest Asia from Iran, Lebanon, Oman, Saudi Arabia, Socotra Island and Yemen (Kürschner & Frey, 2011). In Turkey, *R. crinita* was recorded in the western part of the country. This new record complete the missing piece of the jigsaw between Europe and the Middle East.

The species was growing in a quite open *Olea europaea* and *Pinus brutia* plantation, on soil bank and among rocks at road margins. Accompanying bryophyte species of *Riccia crinita* were *Corsinia coriandrina* (Spreng.) Lindb., *Fossombronia pusilla* (L.) Nees, *Lunularia cruciata* (L.) Lindb., *Mannia androgyna* (L.) A. Evans, *Oxymitra incrassata*, *Pseudocrossidium hornschuchianum*, *Reboulia hemisphaerica* (L.) Raddi, *Riccia bicarinata*, *R. crozalsii*, *R. sorocarpa*, *R. subbifurca*, *Southbya tophacea* (Spruce) Spruce, *Sphaerocarpos texanus* and *Targionia hypophylla* L.

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