

A Contribution to the Bryophyte Flora of Western Turkey: the Bryophyte Flora of Madran Mountain and the Çine Valley (Aydın, Turkey)

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Abstract: This study presents a survey on the bryophyte flora of Madran mountain and Çine valley (Aydın, Turkey). One hundred and thirty-three bryophyte species belonging to 35 families and 69 genera were recorded from the area. *Phaeoceros laevis* (L.) Prosk. is the only member of the hornworts while liverworts are represented by 15 species. The remaining 117 taxa belong to the *Bryopsida*. Thirty-five species are new records for square C11 according to Henderson's (1961) grid system.

Key Words: *Bryophyta*, Flora, West Anatolia, Turkey, Bryogeography.

Batı Türkiye Bryofit Florasına Bir Katkı: Madran Dağı ve Çine Vadisi (Aydın, Türkiye) Bryofit Florası

Özet: Bu çalışma, Madran Dağı ve Çine Vadisi (Aydın, Türkiye) Biryofit florasını sunmaktadır. Toplam olarak, bu bölgeden 35 familya ve 69 cins'e ait 133 bryofit türü kaydedilmektedir. *Phaeoceros laevis* (L.) Prosk. boynuzlu ciğerotlarının tek üyesiiken ciğerotları 15 türle temsil edilir. Kalan 117 takson *Bryopsida*'ya aittir. 35 tür Henderson'un (1961) kareleme sistemine göre C11 karesi için yeni kayıttır.

Anahtar Sözcükler: *Bryophyta*, Flora, Batı Anadolu, Türkiye, Biryocoğrafya.

Introduction

Bryophytes of west Anatolia are relatively better documented than those of other parts of the country. Publications by Henderson (1961), Walther (1967, 1970), Henderson and Prentice (1969), Leblebici (1974), Çetin (1988), Yayıntaş and Iwatsuki (1988), Yayıntaş et al. (1994), Tonguç and Yayıntaş (1996) and Erdağ and Yayıntaş (1999) include bryophyte records. Recent additions to the Turkish bryoflora from west Anatolia, such as *Hedwigia stellata* Hedenäs (Kürschner et al., 1997), *Tortula brevissima* Schiffn. (Kürschner and Parolly, 1998), *Riccia crozalsii* Levier (Gökler et al., 2000), *Orthotrichum sprucei* Mont. (Erdağ and Kürschner, 2000), *Stegonia latifolia* (Schwaegr.) Vent. ex Broth. var. *pilifera* (Brid.) Broth., *Grimmia capillata* De Not., *Pohlia nutans* (Hedw.) Lindl. var. *bicolor* (Hoppe & Hornsch.) Hult. (Erdağ et al., 2001) and a new species, *Cinclidotus bistratosus* Kürschner et Lübenau-Nestle (Kürschner and Lübenau-Nestle 2000) reflect that our knowledge about the bryophyte flora of Turkey is still fragmentary.

Dam construction is an inevitable activity of developing countries to satisfy the increasing energy demand of their developing industries. Many interesting habitats, e.g., valleys, are lost because of their useful condition as a reservoir for the constructions. For this reason, it is important to elucidate the biological richness of such habitats before they disappear. Additionally, increasing mining activities on Madran mountain and in adjacent areas probably will cause the loss of some useful habitats for bryophytes. This study concerns the bryoflora of an endangered area.

I hope that this study will contribute and act as a stimulus to future studies regarding Turkish bryophytes.

Study Area

The south-west Aegean sector of Turkey consists of relatively long mountain series such as Bozdağlar (2159 m), the Aydın mountains (1831 m), and the east and west Mentese mountains (Menderes massif). Madran mountain (1792 m), situated at the north end of the east

Mentese series (lat. 37° 45' E and 37° 24'E; long. 28° 00' N and 28° 27' N) is surrounded by the Aydın plain in the north, the Çine plain in the west and the Bozdoğan plain in the east (Figure 1). The southern border of the mountain faces the northern slopes of Göktepe mountain (1892 m). The main heights of Madran mountain are Topçambaba (1792 m), Tahtacı plateau (1500 m), Bereket Tepe (1471 m), Düdükaya (1374 m) and Çilebaba hill (1361 m).

This study was conducted in the Madran mountain and in the Çine valley, which stretches between Gökbel (1417 m) and Madran (1792 m) mountains of the Menderes massif and lies c. 25 km south of Çine county, close to Yatağan (Fig. 1). The depth of the valley is variable due to increasing heights towards the south. The valley is divided by Çine creek, which flows into the Büyük Menderes river near Aydın. Tributaries of Çine creek include Kayırlı dere, Karamer deresi and Gürlen dere; most of them are winter and spring – active creeks, except Kayırlı dere and Gürlen dere. Heights of the area reach c. 700 m from base level of c. 100 m from the

valley. The Çine valley can be divided into three main zones. In the bottom zone, the width is around 5-7 m (measured in *Liquidambar* L. stands) but becomes more than 50 m in entrance (N) and exit (S) sites. The middle zone is characterized by the highway connecting İzmir and Fethiye. The width of the valley in the middle zone is c. 100 m. The last zone (hill zone) is wider than the middle and includes the hills. As a result of decreasing humidity, in the wider bottom sites, *Liquidambar orientalis* Miller is absent. *Platanus orientalis* L. and *Salix* L. sp. (in wider parts) are common riverine species with *Liquidambar orientalis* (in narrower parts) at the bottom. *Pistacia terebinthus* L., *Spartium junceum* L., *Ficus carica* L., *Olea europaea* L., *Pinus brutia* Ten. and *Quercus coccifera* L. are the prominent species of the zones above the bottom. The hill zone is characterized by olive plantations, the most important economical plant of the area with *Ficus carica* and cotton (*Gossypium* L. sp.). The side walls of the valley consist of schists and sand stones in the north entrance, but heavily weathered rounded gneiss rocks form the main landscape of the remaining parts towards the south.

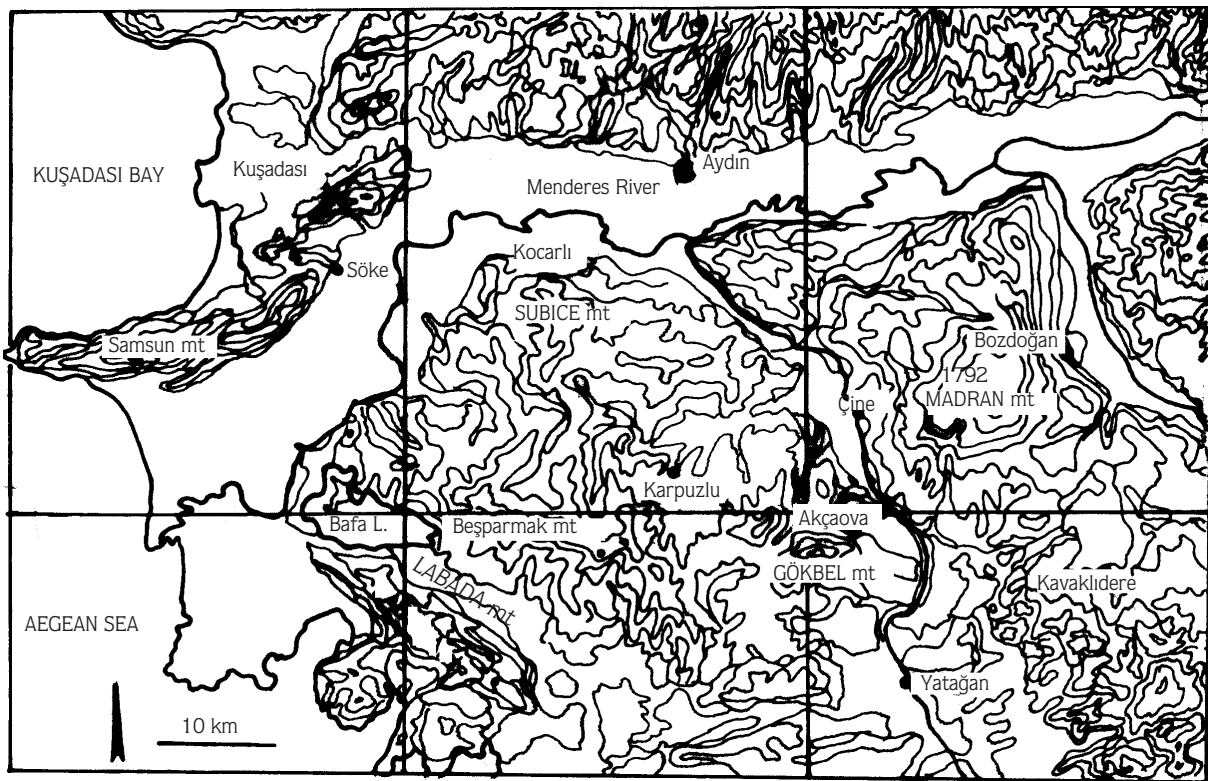


Figure 1. Map of the Menderes basin

Geologically, the core of the Menderes massif consists of granitic and gneiss rocks. Conglomerates, schists and quartz formations cover this massif. Mesozoics and tertiary formations are encountered in different parts of the Menderes massif. Quaternary formations are dominant in tectonic grooves, surrounding the Madran mountain and low elevated parts of the area (Göney, 1975).

Climatic features of the area can be summarized as follows: average annual temperature in the area varies between 17 and 18°C. The temperature decrease 0.04°C each 10 km towards the east. In summer, the average temperature reaches 24°C (27°C) but extreme temperatures such as 45-48°C are not unusual during July and August. The winters are mild and frosts are very seldom. Minimum temperatures vary from -11°C (January) to 0°C (April). Humidity varies between 76% and 78% in winter, 60% and 69% in spring, 48% and 51% in summer, and 54% and 74% in autumn. The mean annual rainfall is 677.5 mm/y and snow is extremely rare.

Depending on the locality and the ecological conditions of habitats, Mediterranean shrubs and forest stands are the dominant formations in the area. The siliceous character of the area may cause some differences in the species composition of these formations. Macchie elements cover large areas at lower elevations including phrygana elements. *Pinus brutia* locally forms well developed forests especially on the south slopes of the mountain between altitudes of 300 m and 900 m. Over an intermixing zone at an elevation of 900 m, a *P. nigra* Arn. subsp. *pallasiana* Lamb) Holmboe climax is found. Subalpine vegetation includes thorn cushions of *Astragalus* L. spp. and *Acantholimon acerosum* (Willd.) Boiss. As a result of erosion caused by deforestation during several civilization periods, the main landscape of the mountain especially on western slopes is rounded and heavily weathered to bare boulders.

Materials and Methods

Bryophyte specimens were collected throughout the valley on different substrata and habitats during 1998 and 2000. Identification of specimens was carried out by using appropriate literature by European (Smith, 1980; Nyholm, 1981; Frahm and Frey, 1983) and north American bryologists (Crum and Anderson, 1981) for

mosses and Arnell (1981), and Watson (1981) and Smith (1991) for liverworts and hornworts. The taxonomic arrangement follows Corley et al. (1981) and Grolle (1983) to genus level. An asterisk indicates that the taxon is a new record for square C11. All specimens are deposited in the author's herbarium in Adnan Menderes University, Biology Department, Aydın, Turkey.

List of species

ANTHOCEROTOPSIDA

Anthocerotaceae Dum.

Phaeoceros laevis (L.) Prosk.

C11, Aydın: Çine valley, Roman bridge, on wet rocks, alt. c. 300m, 28 May 2000, Erd. 1726.

MARCHANTIOPSIDA

Targioniaceae Dum.

Targionia hypophylla L.

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 600m, 20 Feb. 2000, Erd. 1408.

Aytoniaceae Dum.

Reboulia hemisphaerica (L.) Raddi

C11, Aydın: Çine, Gürlendere bridge, on thin soil covering rocks, alt. c. 750m, 9 Apr. 2000, Erd. 1517.

Conocephalaceae K.Müll. ex Grolle

Conocephalum conicum (L.) Underw.

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet rocks, alt. c. 900m, 4 Nov. 1999 Erd. 1346.

Lunulariaceae Klinggr.

Lunularia cruciata (L.) Lindb.

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet soil and rocks, alt. c. 900m, 4 Nov. 1999, Erd. 1343.

Marchantiaceae (Bisch.) Lindl.

Marchantia polymorpha L.

C11, Aydın: Çine valley, Roman bridge, on wet rocks, alt. c. 300m, 28 May 2000, Erd. 1726.

Ricciaceae Reichenb.

**Riccia ciliata* Hoffm.

C11, Aydın: Çine, Babadağ, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1903.

JUNGERMANNIOPSIDA

Pelliaceae Klinggr.

**Pellia epiphylla* (L.) Corda

C11, Aydın: Çine, between Şırlan and Kocahalil garden, on rock, alt. c. 1400m, 11 June 2000, Erd.1933.

Codoniaceae Klinggr.

Fossombronina pusilla (L.) Nees

C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on soil, alt. c. 400m, 25 Feb. 1998, Erd. 989.

F. angulosa (Dicks.) Raddi

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 550m, 20 Feb. 2000, Erd. 1417.

Jungermanniaceae Reichenb.

Jungermannia gracillima Sm.

C11, Aydın: Çine, north of Kavşit village, on wet soil, alt. c. 600m, 25 Feb. 1998, Erd. 1053.

Geocalyceae Klinggr.

**Lophocolea bidentata* (L.) Dum. var. *rivularis* (Raddi) Warnst.

C11, Aydın: Çine, İnedik, on soil, alt. c. 1300m, 11 June 2000, Erd. 1948.

**Chiloscyphus polyanthos* (L.) Corda

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet rocks, alt. c. 900m, 4 Nov. 1999, Erd. 1354.

Cephaloziellaceae Douin

Cephaloziella cf. *divaricata* (Sm.) Schiffn.

C11, Aydın: Çine, Babadağ, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1924.

Porellaceae Cavers

**Porella plathyphylla* (L.) Pfeiff.

C11, Aydın: Çine, Topçam, on boulder, alt. c. 1400m, 11 June 2000, Erd. 1931.

Frullaniaceae Lorch.

**Frullania dilatata* (L.) Dum.

C11, Aydın: Çine valley, Roman bridge, on wet rocks, alt. c. 300m, 14 Apr. 2000, Erd. 1581.

BRYOPSIDA

Polytrichaceae Schwaegr.

Polytrichum juniperinum Hedw.

C11, Aydın: Çine, Kavşit village, stream bed, on soil, alt. c. 600m, 25 Feb. 1998, Erd. 1022.

**P. piliferum* Hedw.

C11, Aydın: Çine, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1913.

Fissidentaceae Schimp.

Fissidens bryoides Hedw.

C11, Aydın: Çine, between Dutluoluk and Kavşit villages, on soil, alt. c. 400m, 23 Feb. 1998, Erd. 999.

**F. crassipes* Willd. ex B., S.&G.

C11, Aydın: Çine valley, on wet rocks near fast flowing river, alt. c. 300m, 18 May 1999, Erd. 1264.

F. viridulus (Web. & Mohr.) Wahl.

C11, Aydın: Kavaklıdere, Tatarcık hill, in rock crevices, alt. c. 700m, 3 Feb. 1998, Erd. 930.

Dicranaceae Schimp.

Dicranoweisia cirrata (Hedw.) Lindb. ex Milde

C11, Aydın: Çine, Girmene hill, on exposed roots of *Pinus brutia*, alt. c. 550m, 20 Feb. 2000, Erd. 1396.

Cheilothela chloropus (Brid.) Lindb.

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 600m, 20 Feb. 2000, Erd. 1002.

Ceratodon purpureus (Hedw.) Brid.

C11, Aydın: Çine, Tahtacı plateau, on soil and rocks, alt. c. 1500m, 11 June 2000, Erd. 1873.

Pleuridium acuminatum Lindb.

C11, Aydın: Kavaklıdere, Tatarcık hill, on soil covering rocks, alt. c. 600m, 3 Feb. 1998, Erd. 923.

Encalyptaceae Schimp.

**Encalypta ciliata* Hedw.

C11, Aydın: Çine, Tahtacı plateau, on rock, alt. c. 1500m, 11 June 2000, Erd. 1881.

E. vulgaris Hedw.

C11, Aydın: Kavaklıdere, Tatarcık hill, on rock, alt. c. 600m, 3 Feb. 1998, Erd. 943.

Pottiaceae Schimp.

**Tortula atrovirens* (Sm.) Lindb.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on soil, alt. c. 400m, 25 Feb. 1998, Erd. 998.

**Tortula cuneifoila* (With.) Turn.

C11, Aydın: Çine, between Dutluoluk and Kavşit villages, on soil, alt. c. 400m, 23 Feb. 1998, Erd. 991.

Tortula inermis (Brid.) Mont.

C11, Aydın: Çine Gürlendere bridge and vicinity, on soil, alt. c. 750m, 9 Apr. 2000, Erd. 1501.

T. intermedia (Brid.) De Not.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1500.

T. laevipila (Brid.) Schwaegr.

C11, Aydın: Çine valley, Roman bridge, on trunk of *Platanus orientalis*, alt. c. 300m, 7 Sept. 1999, Erd. 1373.

T. muralis Hedw.

C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on wall, alt. c. 400m, 25 Feb. 1998, Erd. 1005.

T. muralis var. *aestiva* Hedw.

C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on wall, alt. c. 400m, 25 Feb. 1998, Erd. 995.

T. princeps De Not.

C11, Aydın: Çine, Şırlan, on stone wall, alt. c. 1400m, 25 Feb. 1998, Erd. 1084.

T. ruraliformis (Besch.) Grout

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 550m, 20 Feb. 2000, Erd. 1431.

T. ruralis (Hedw.) Gaertn., Meyer & Scherb.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on soil, alt. c. 400m, 25 Feb. 1998, Erd. 993.

T. subulata Hedw.

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 550m, 20 Feb. 2000, Erd. 1433.

T. subulata var. *angustata* (Schimp.) Limpr.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on soil, alt. c. 1400m, 11 June 2000, Erd. 1930b.

T. subulata var. *subinermis* (Brid.) Wils.

C11, Aydın: Çine, Tahtacı plateau, on rock, alt. c. 1500m, 11 June 2000, Erd. 1925.

**T. virescens* (De Not.) De Not.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1503.

**Stegonia latifolia* (Schwaegr.) Vent. ex Broth. var. *pilifera* (Brid.) Broth.

C11, Aydın: Kavaklıdere, Tatarcık hill, on soil covering rocks, alt. c. 600m, 3 Feb. 1998, Erd. 921.

Phascum cuspidatum Hedw.

C11, Aydın: Kavaklıdere, Tatarcık hill, on soil covering rocks, alt. c. 600m, 3 Feb. 1998, Erd. 913.

**Barbula convoluta* Hedw.

C11, Aydın: Çine valley, roadside, on rock, alt. c. 250m, 23 Feb. 1998, Erd. 959.

B. unguiculata Hedw.

C11, Aydın: Çine valley, roadside, on rock, alt. c. 250m, 23 Feb. 1998, Erd. 955.

Pseudocrossidium hornschurchianum (Schultz) Zander

C11, Aydın: Çine, Tahtacı plateau, on rock, alt. c. 1500m, 11 June 2000, Erd. 1907.

**Didymodon cordatus* Jur.

C11, Aydın: Çine valley, Roman bridge, on rock, alt. c. 300m, 14 Apr. 2000, Erd. 1619.

Didymodon insulanus (De Not.) M.Hill

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 600m, 20 Feb. 2000, Erd. 1392.

D. rigidulus Hedw.

C11, Aydın: Çine, Şırlan, on stone wall, alt. c. 1400m, 25 Feb. 1998, Erd. 1083.

D. spadiceus (Mitt.) Limpr.

C11, Aydın: Çine, Kavşit village, stream bed, on soil, alt. c. 600m, 25 Feb. 1998, Erd. 1052.

D. tophaceus (Brid.) Lisa

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1526.

D. vinealis (Brid.) Zander

C11, Aydın: Çine, Şırlan, on stone wall, alt. c. 1400m, 25 Feb. 1998, Erd. 1071.

Gymnostomum aeruginosum Sm.

C11, Aydın: Çine valley, Roman bridge, on rock, alt. c. 300m, 14 Apr. 2000, Erd. 1611.

Trichostomum crispulum Bruch

C11, Aydın: Çine valley, Kayırlidere, on rock and soil, alt. c. 300m, 18 May 1999, Erd.1273.

Weisia controversa Hedw.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on soil, alt. c. 400m, 25 Feb. 1998, Erd. 997.

***Weisia controversa** var. **crispata** (Nees & Hornsch.) Nyh.

C11, Aydın: Çine valley, Roman bridge, on soil, alt. c. 300m, 14 Apr. 2000, Erd. 1564.

Pleurochaete squarrosa (Brid.) Lindb.

C11, Aydın: Çine, Kavşit village, stream bed, on soil, alt. c. 600m, 25 Feb. 1998, Erd. 1041.

Tortella nitida (Lindb.) Broth.

C11, Aydın: Çine valley, Kayırlidere, on soil, alt. c. 300m, 18 May 1999, Erd. 1257.

T. tortuosa (Hedw.) Limpr.

C11, Aydın: Kavaklıdere, Tatarcık hill, on soil, alt. c. 600m, 3 Feb. 1998, Erd. 944.

***Timmiella anomala** (B. & S.) Limpr.

C11, Aydın: Çine, Girmene hill, on soil, alt. c. 600m, 20 Feb. 2000, Erd. 1423.

Cinclidotus mucronatus (Brid.) Mach.

C11, Aydın: Çine valley, Kayırlidere, on trunk of *Liquidambar orientalis*, alt. c. 250m, 18 May 1999, Erd. 1255.

C. fontinaloides (Hedw.) P.Beauv.

C11, Aydın: Çine valley, Kayırlidere, on exposed and wet roots of *Liquidambar orientalis*, alt. c. 250m, 18 May 1999, Erd. 1252.

Grimmiaceae Arnott

Grimmia decipiens (Schultz) Lindb.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1513.

G. hartmanii Schimp.

C11, Aydın: Çine valley, roadside, on rock, alt. c. 250m, 23 Feb. 1998, Erd. 951.

G. laevigata (Brid.) Brid.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1497.

G. lisae De Not.

C11, Aydın: Çine valley, Kayırlidere, on rock, alt. c. 300m, 18 May 1999, Erd. 1260.

G. ovalis (Hedw.) Lindb.

C11, Aydın: Çine, Tahtacı plateau, on rock, alt. c. 1500m, 11 June 2000, Erd. 1920.

G. pulvinata (Hedw.) Sw.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, 2nd fountain, on rock, alt. c. 400m, 25 Feb. 1998, Erd. 1009.

G. trichophylla Grev.

C11, Aydın: Kavaklıdere, Tatarcık hill, on rock, alt. c. 600m, 3 Feb. 1998, Erd. 941.

Funariaceae Schwaegr.

***Funaria convexa** Spruce

C11, Aydın: Çine, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1879a.

F. hygrometrica Hedw.

C11, Aydın: Çine, Kavşit village, stream bed, on soil, alt. c. 600m, 25 Feb. 1998, Erd. 1010.

F. muhlenbergii Turn.

C11, Aydın: Kavaklıdere, Tatarcık hill, on soil, alt. c. 600m, 3 Feb. 1998, Erd. 911.

F. pulchella Philib.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, on soil, alt. c. 400m, 25 Feb. 1998, Erd. 987.

Bryaceae Schwaegr.

***Pohlia bulbifera** (Warnst.) Warnst.

C11, Aydın: Çine, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1879b.

**Pohlia nutans* (Hedw.) Lindb. var. *bicolor* (Hoppe & Hornsch.) Hult

C11, Aydın: Çine, Tahtacı plateau, on soil, alt. c. 1500m, 11th June 2000, Erd. 1863a.

Bryum alpinum With.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, on wet soil, alt. c. 400m, 25 Feb. 1998, Erd. 992.

B. argenteum Hedw.

C11, Aydın: Çine, Girmene hill, on soil bank, alt. c. 600m, 20 Feb. 2000, Erd. 1393.

B. bicolor Dicks.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1514.

B. caespiticium Hedw.

C11, Aydın: C11, Aydın: Çine, between Dutluoluk and Kavşit villages, on wet soil, alt. c. 400m, 25 Feb. 1998, Erd. 1011c.

B. cf. canariense Brid.

C11, Aydın: Çine valley, Kayırlıdere, on soil covering rocks, alt. c. 300m, 18 May 1999, Erd. 1253.

B. capillare Hedw.

C11, Aydın: Çine valley, Kayırlıdere, on trunks of *Platanus orientalis*, alt. c. 300m, 18 May 1999, Erd. 1262b.

B. cf. creberrimum Tayl.

C11, Aydın: Çine, Girmene hill, on soil covering rocks, alt. c. 600m, 20 Feb. 2000, Erd. 1406.

**B. gemmiparum* De Not.

C11, Aydın: Çine valley, Kayırlıdere, on rock by streams, alt. c. 300m, 18 May 1999, Erd. 1281.

B. pallescens Schleich. ex Schwaegr.

C11, Aydın: Çine, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1927.

B. pseudotriquetrum (Hedw.) Schwaegr.

C11, Aydın: Çine, Kavşit village, stream bed, on wet soil, alt. c. 600m, 25 Feb. 1998, Erd. 1050.

**B. bimum* (Brid.) Turn.

C11, Aydın: Çine, Tahtacı plateau, on soil, alt. c. 1500m, 11 June 2000, Erd. 1935.

Mniaceae Schwaegr.

Plagiomnium undulatum (Hedw.) T.Kop.

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet soil and rocks, alt. c. 900m, 4 Nov. 1999, Erd. 1350.

Bartramiaceae Schwaegr.

Bartramia ithyphylla Brid.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on soil, alt. c. 1400m, 11 June 2000, Erd. 1930a.

B. pomiformis Hedw.

C11, Aydın: Çine, Şırlan, on soil, alt. c. 1400m, 25 Feb. 1998, Erd. 1085.

B. stricta Brid.

C11, Aydın: Çine, Girmene hill, on soil and rocks, alt. c. 600m, 20 Feb. 2000, Erd. 1432.

Anacolia webbii (Mont.) Schimp.

C11, Aydın: Çine, Şırlan, on soil, alt. c. 1400m, 25 Feb. 1998, Erd. 1069.

**Philonotis caespitosa* Jur.

C11, Aydın: Çine, Kavşit village, stream bed, on wet soil, alt. c. 600m, 25 Feb. 1998, Erd. 1025.

P. fontana (Hedw.) Brid.

C11, Aydın: Çine, Tahtacı plateau, on wet soil, alt. c. 1500m, 11 June 2000, Erd. 1866.

**P. tomentella* Mol.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1528.

Orthotrichaceae Arnott

Zygodon viridissimus (Dicks.) R.Br.

C11, Aydın: Çine, Girmene hill, on trunk of *Pyrus* sp., alt. c. 600m, 20 Feb. 2000, Erd. 1397.

Orthotrichum diaphanum Brid.

C11, Aydın: Çine valley, Roman bridge, on trunk of *Liquidambar orientalis*, alt. c. 300m, 7 Sep. 1999, Erd. 1373f.

O. fastigiatum Bruch ex Brid.

C11, Aydın: Çine, Girmene hill, on trunk of *Pyrus* sp., alt. c. 600m, 20 Feb. 2000, Erd. 1401b.

O. rupestre Schleich. ex Schwaegr.

C11, Aydın: Çine, Girmene hill, on trunk of *Pyrus* sp., alt. c. 600m, 20 Feb. 2000, Erd. 1401a.

O. rupestre var. **franzonianum** (De Not. ex Vent.) Vent.

C11, Aydın: Çine, Tahtacı plateau, on stump, alt. c. 1500m, 11 June 2000, Erd. 1918.

***O. sprucei** Mont.

C11, Aydın: Çine valley, Kayırlidere, on bark of *Liquidambar orientalis*, alt. c. 300m, 18 May 1999, Erd. 1258.

***O. striatum** Hedw.

C11, Aydın: Çine, Tahtacı plateau, on bark, alt. c. 1500m, 11 June 2000, Erd. 1921.

***O. cf. urnigerum** Myr.

C11, Aydın: Çine, Şırlan, on rock, alt. c. 1400m, 25 Feb. 1998, Erd. 1059.

Hedwigiaceae Schimp.

Hedwigia ciliata (Hedw.) P.Beauv.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1505.

Fontinalaceae Schimp.

Fontinalis antipyretica Hedw.

C11, Aydın: Çine, Tahtacı plateau, on rock by stream, alt. c. 1500m, 11 June 2000, Erd. 1921.

Leucodontaceae Schimp.

Leucodon sciuroides (Hedw.) Schwaegr.

C11, Aydın: Çine Gürlendere bridge and vicinity, on trunk of *Platanus orientalis*, alt. c. 750m, 9 Apr. 2000, Erd. 1533.

Antitrichia californica Sull.

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet rocks, alt. c. 900m, 4 Nov. 1999, Erd. 1364.

A. curtispindula (Hedw.) Brid.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on soil, alt. c. 1400m, 11 June 2000, Erd. 1943.

Pterogonium gracile (Hedw.) Sm.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1530.

Neckeraceae Schimp.

Neckera menziesii (Hook.) Steere

C11, Aydın: Çine, Şırlan, Kocahalil garden, on rock, alt. c. 1400m, 11 June 2000, Erd. 1942b.

***Homalia trichomanoides** (Hedw.) B., S. & G.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on rock, alt. c. 1400m, 11 June 2000, Erd. 1942a.

Fabroniaceae Schimp.

Fabronia pusilla Raddi

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1549.

Leskeaceae Schimp.

Pterigynandrum filiforme Hedw.

C11, Aydın: Çine, north of Şırlan, on rock, alt. c. 1400m, 11 June 2000, Erd. 1952.

Thamniaceae Moenk.

***Thamnobryum alopecurum** (Hedw.) Gang.

C11, Aydın: Çine, Şırlan, on wet rocks, alt. c. 1400m, 11 June 2000, Erd. 1074.

Amblystegiaceae (Broth.) Fleisch.

***Amblystegium juratzkanum** Schimp.

C11, Aydın: Bozdoğan, Ballıpınar, Kuzu Bağı, on submerged walls of well, alt. c. 700m, 21 Sep. 2000, Erd. 2080.

Leptodictyum riparium (Hedw.) Warnst.

C11, Aydın: Çine, Kavşit village, stream bed, on wet rock, alt. c. 600m, 25 Feb. 1998, Erd. 1046.

Calliergonella cuspidata (Hedw.) Loesch

C11, Aydın: Çine, Şırlan, on wet soil, alt. c. 1400m, 25 Feb. 1998, Erd. 1066.

Brachytheciaceae Schimp.

Isothecium myurum Brid.

C11, Aydın: Çine, Şırlan, on rock, alt. c. 1400m, 25 Feb. 1998, Erd. 1078.

Scorpiurium sendtneri (Schimp.) Fleisch.

C11, Aydın: Çine valley, Kayırlidere, on rock by streams, alt. c. 300m, 18 May 1999, Erd. 1283.

Homalothecium lutescens (Hedw.) Robins.

C11, Aydın: Çine, Tahtacı plateau, on rock, alt. c. 1500m, 11 June 2000, Erd. 1904.

H. sericeum (Hedw.) B., S.& G.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on rock, alt. c. 1400m, 11 June 2000, Erd. 1964.

Brachythecium rivulare B., S.& G.

C11, Aydın: Çine, Şırlan, on soil, alt. c. 1400m, 25 Feb. 1998, Erd. 1062.

**B. rutabulum* (Hedw.) B., S.& G.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on rock, alt. c. 1400m, 11 June 2000, Erd. 1936.

Pseudoscleropodium purum (Hedw.) Fleisch.

C11, Aydın: Çine Gürlendere bridge and vicinity, on rock, alt. c. 750m, 9 Apr. 2000, Erd. 1522.

**Cirriphyllum piliferum* (Hedw.) Grout

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on rocks, alt. c. 900m, 4 Nov. 1999, Erd. 1347.

**Rhynchostegium confertum* (Dicks.) B., S.& G.

C11, Aydın: Çine, Tahtacı plateau, on wet rock, alt. c. 1500m, 11 June 2000, Erd. 1909.

**Eurhynchium praelongum* (Hedw.) B., S.& G.

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet roots, alt. c. 900m, 4 Nov. 1999, Erd. 1353.

**E. pulchellum* (Hedw.) Jenn.

C11, Aydın: Kavaklıdere, Tatarcık hill, on wet rock, alt. c. 600m, 3 Feb. 1998, Erd. 940.

E. schleicheri (Hedw.) Jur.

C11, Aydın: Çine, Şırlan, Kocahalil garden, on soil covering rock, alt. c. 1400m, 11 June 2000, Erd. 1948.

**E. speciosum* (Brid.) Jur.

C11, Aydın: Bozdoğan, Altıntaş village, Beyderesi Kocaazmak brook, on wet rocks, alt. c. 900m, 4 Nov. 1999, Erd. 1342.

E. swartzii (Turn.) Curn.

C11, Aydın: Çine, Şırlan, on wet rock, alt. c. 1400m, 25 Feb. 1998, Erd. 1072b.

Rhynchostegiella tenella (Dix.) Limpr.

C11, Aydın: Çine, Kavşit village, stream bed, on soil, alt. c. 600m, 25 Feb. 1998, Erd. 1052.

Hypnaceae Schimp.

Hypnum cupressiforme Hedw.

C11, Aydın: Çine, Kavşit village, stream bed, on trunk of *Quercus coccifera*, alt. c. 600m, 25 Feb. 1998, Erd. 1018.

**H. cupressiforme* var. *resupinatum* (Tayl. ex Spruce) Hartm.

C11, Aydın: Çine, Şırlan, on rock, alt. c. 1400m, 25 Feb. 1998, Erd. 1061.

Discussion

One hundred and thirty-three bryophyte species, belonging to 35 families and 69 genera were recorded from the area in the present study. Thirty-five species are new records for square C11. Fifteen species of liverworts, 117 species of mosses and only one species of hornworts were found in the area. Most of the hepatic species were collected from near-stream substrata but *Cephaloziella divaricata* was evident on thin soils covering rock or rock crevices with its short and numerous thread-like minute stems reaching 1 cm. *Jungermannia gracillima* is another relatively minute member of less humid habitats, with closely and slightly obliquely inserted imbricated leaves on a large number of short stems, reaching up to 10mm. One of the remarkable leafy liverworts in the area on trees and rocks is *Frullania dilatata*. Its tuberculate periant and bipinnately branched stems, pitcher-like postical lobes, and the more or less equal length and width of ventral lobes are the diagnostic characters. *Fossombronia pusilla* is easily recognisable in the field by its violet – purple rizoids and generally lobed crisped leaves. Lunar-shaped gemma cups for *Lunularia cruciata*, violet-edged appendages of ventral scales and easily visible pores, centred in a larger areola for *Conocephalum conicum* and goblet-shaped gemma cups for *Marchantia polymorpha* are the main distinctive characters that can be easily observed by a lens in the field. *Phaeoceros laevis*, a unique member of the *Anthocerotopsida* in our study, covers unexposed parts of wet or moist rocks (and also thin soil covering rocks) and is very easily distinguished by bivalved or not bivalved (depending on maturity) cylindrical sporophytes.

Mosses are the dominant element in the bryoflora of the area. The presence and abundance of the species vary greatly, depending on the zones and site conditions.

Boulders, roots and trunks (especially in *Liquidambar orientalis* stands) at the bottom zone of the valley for instance, are dominated by *Cinclidotus mucronatus*, *C. fontinaloides* and *Scorpiurium sendtneri*. These localities are most important for the genus *Cinclidotus* P. Beauv. in south-west Anatolia, harbouring two endemic species, *C. nyholmiae* Çetin and the recently described *C. bistratosus* (Kürschner and Lübenau-Nestle, 2000). Phytosociologically, *Cinclidotus mucronatus* assemblages outline the *Scorpiurio sendtneri-Zygodentetum vulgaris* (Walther, 1975) *cinclidotetosum mucronati* subassociation, described by Kürschner et al. (Kürschner et al., 1998). *Fissidens crassipes*, *Philonotis fontana*, *P. tomentella*, *Bryum alpinum*, *Leptodictyum riparium* and *Eurhynchium pulchellum* are other evident species of moist or wet parts of the bottom zone.

Orthotrichum sprucei was collected on the trunk and well developed lower branches of *Liquidambar orientalis*. Silty material on some of the moss specimens is clear evidence for floods reaching c. 2 m from the base to the upper parts. *Tortula latifolia*, *Bryum capillare*, *Orthotrichum diaphanum*, *Scorpiurium sendtneri*, *Cinclidotus mucronatus* and rarely *Cinclidotus fontinaloides* are characteristic associates of *O. sprucei*. This species can easily be distinguished by its larger (13-24 µm) rounded leaf cells, and well developed costa ending clearly below the broadly obtuse to rounded apex from the related *O. rivulare* and from *O. diaphanum* by the absence of glass-hairs (Erdağ and Kürschner, 2000).

In the middle zone, *Bartramia stricta*, *Homalothecium sericeum*, *Pleurochaete squarrosa*, *Barbula unguiculata*, *Tortella tortuosa* (more occasionally) and *Encalypta vulgaris* are the most commonly encountered species on rocks. Some of these species belong to the *Homalothecio aurei-Pleurochaetetum squarrosae* (Kürschner and Parolly, 1999).

The hill zone and almost all deforested parts of the area consist largely of siliceous sun-exposed rocks. Therefore it was not surprising to observe that the *Grimmietum commutatae-campestris* association (Kürschner and Parolly, 1999), a common community of western Anatolia, covers almost all boulders. Characteristic species of this association are *Grimmia ovalis* (syn. *G. commutata*), *G. laevigata* (syn. *G. campestris*) and *G. lisae* (syns. *G. retracta*, *G. azorica*, *G. subsquarrosa*, *G. trichophylla* var. *brachycarpa*, *G. trichophylla* var. *meridionalis* and *G. hartmanii* ssp. *retracta*).

Pleuridium acuminatum is a species distributed in south-west Turkey; in contrast, another species of the genus (*P. subulatum* (Hedw.) Lindb.) is from the north-west of the country.

Funariaceae are represented by four species in the area: *F. convexa*, *F. hygrometrica*, *F. muhlenbergii* and *F. pulchella*. *F. convexa* can easily be distinguished by its convex to almost plane lid, whereas the lid is mamillate in *F. pulchella* and *F. muhlenbergii*. The lid is also convex in *F. hygrometrica* but the spores are finely papillose and the seta is arcuate when young in this species. Coarsely papillose spores and a straight seta are the differences between *F. convexa* and *F. hygrometrica*. Toothed leaf margins in *F. muhlenbergii* (Crundwell and Nyholm, 1974) and entire or slightly sinuose leaf margins in *F. pulchella* are the diagnostic character for these species. Almost all species of the genus are encountered on basic soil among rocks in the open or in sheltered habitats but *F. hygrometrica* favours moist or wet substrata like fountain walls.

Pohlia species can be distinguished from *Bryum* Hedw. by their long leaf cells. Long leaf cells are also found in *Bryum alpinum* but imbricate leaves (when dry) of the species can help to identify it correctly in the field. *Pohlia nutans* var. *bicolor* is found in Tahtacı high plateau (Erdağ et al., 2001) with *P. bulbifera*, which have trapped air bubbles by leaf primordia on apex of the bulbils in the remoistened herbarium specimen.

Stegonia latifolia var. *pilifera* is a minute member of the family Pottiaceae, having a wide but scattered bipolar distribution (Ochyra and Smith, 1996; Ochyra, 1998). Hitherto, the hair-less phenotype was recorded only once from Erciyas Dağı (central Anatolia) in Turkey (Matouschek, 1905). This species is considered to be an arctic alpine-bipolar taxon at present but our record from alt. c. 600 m reflects its distributional capacity also at lower elevations and in mild climates.

Tahtacı high plateau has some brooks, flowing in the base of earthy fissures. These brooks have an important hygrophytic species diversity. Species such as *Eurhynchium pulchellum*, *Bryum alpinum*, *B. pallescens*, *Fontinalis antipyretica*, *Pohlia nutans*, *P. bulbifera*, *Philonotis fontana*, *Rhynchostegium confertum*, *Lunularia cruciata* and *Conocephalum conicum* occur within a short distance. Similarly, Bozdoğan and the hills surrounding the town are favourable places for bryophyte distribution

because many small brooks and streams, increasing the humidity, are encountered. These sites of the mountain have well conserved forest formations dominated by *Pinus nigra* and *P. brutia*.

The xeric nature of the area causes evident dominance of acrocarpous moss species in accordance with other regions of west Anatolia (Erdağ and Yayıntaş, 1999). Pleurocarpous mosses generally cover rocks or other substrata in more humid habitats. However, *Homalothecium sericeum* and *Hypnum cupressiforme* are common in all kinds of habitats because of their high tolerance to desiccation during the long dry season between May and October. Therefore, it is not a surprise that *Pottiaceae* have a great species richness (36 taxa with a few hygrophytic species).

Grimmietum commutatae-campestris association covers bare boulders on the deforested western and southern slopes of Madran mountain. Local brooks and springs serve as sheltered hygic habitats for many hygrophytic mosses such as *Pohlia* Hedw. spp, *Bryum pseudotriquetrum*, *Plagiomnium undulatum* and *Philonotis* Brid. spp. in the area. At this point, conservation of these kind of "refugia" is very important due to their valuable contributions to total species richness in xeric areas like south-west Anatolia. To lose these sheltered habitats means the loss of almost all hygrophytic species and this means losing up to at least 20% of the total bryophyte species of Madran mountain and adjacent areas. Therefore, as a general strategy, we

should consider these shelters to be a priority in conservation studies.

Industrial activities in developing countries are generally considered to be more important than biological richness and related topics. Perhaps this approach to environment is the most striking in the case of relatively inconspicuous plant groups like bryophytes, which have great importance in the environment at least as a shelter for many organisms (Richardson, 1981 and literature therein).

At the end of dam construction the bottom zone and the middle zone of the valley will be completely lost but the hill zone will exist on the shore of a lake. This allows the possibility of studying the changing moss flora and associations under changing habitat conditions.

The present study is part of the ongoing research on the mosses of the Caria region of south-west Anatolia. Other parts of the area will be described separately in the near future to contribute to the present knowledge on the mosses of west Anatolia.

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