

Contribution to the bryophyte flora of Morocco: terricolous and saxicolous bryophytes of the Jbel Bouhalla

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SUMMARY

The terricolous and saxicolous bryophytes of the Jbel Bouhalla (Rif Cordillera, Morocco) have been studied. This mountainous system, characterized by basic geology, contains the largest and best conserved forest of *Abies pinsapo* subsp. *maroccana* in Northern Africa. The catalogue is composed of 121 taxa, of which 108 are mosses and 13 liverworts. Of these, nine are new to the African continent (*Acaulon mediterraneum*, *Claopodium whippleanum*, *Gymnostomum lanceolatum*, *Hedwigia stellata*, *Orthotrichum cupulatum* var. *baldacci*, *Schistidium brunnescens* subsp. *griseum*, *S. crassipilum*, *Scorpiurium sendtneri*, *Seligeria acutifolia*), *Eurhynchium schleicheri* is new for mainland Africa, and seven are new records for Morocco (*Barbula enderesii*, *Bryum dunense*, *Campyliadelphus chrysophyllus*, *Fissidens dubius*, *Hedwigia ciliata* var. *leucophaea*, *Pleuroidium acuminatum*, *Pseudoleskeella catenulata*).

KEYWORDS: terricolous and saxicolous bryophyte flora, Jbel Bouhalla, Northern Africa, Morocco.

INTRODUCTION

The bryophytes of the Rif Cordillera have been previously studied only in a fragmentary way, as with the rest of Morocco. Very few publications deal with this Cordillera, which enjoys a very specific climate. Jovet-Ast (1958) was the only bryologist to list mosses from the W. Rif, although none of the mosses reported were collected in the Jbel Bouhalla. More recent papers provide some data for this area, two related to epiphytic mosses. Garilleti, Lara & Mazimpaka (1997a) reported *Orthotrichum macrocephalum* Lara, Garilleti & Mazimpaka and *O. ibericum* Lara & Mazimpaka new from the African continent, and Garilleti, Lara & Mazimpaka (1997b) described the new species *O. lewinskyae* Lara, Garilleti & Mazimpaka from the Jbel Bouhalla. Cano *et al.* (1999) in a wider work about a new bryophyte community from S. Spain and Morocco, cited some species from the Jbel Bouhalla.

The Rif Cordillera is a mountainous system running parallel to the Mediterranean coast in Northern Morocco. Its mean altitude is about 1500 m and the higher peaks reach 2000 m. The Jbel Bouhalla, also known as Jbel Lakraâ, is situated in the western part of the Rif, within the province of Chefchaouen. The only way to reach these mountains is through the village of Bab-Taza, along a very poor track. The Jbel Bouhalla is formed by a series of escarpments aligned in a N.–S. direction and

perpendicular to the coast. The maximum height is 2170 m, which is the second highest in the Rif Cordillera after Jbel Tidhirine (2448 m). The relief is very abrupt, with long slopes and several sharp and deep gullies.

Geologically, the Jbel Bouhalla is formed of mesozoic and cenozoic rocks, in which carbonates dominate. According to Sanz de Galdeano (1997), the stratigraphic series of the Jbel Bouhalla is made of dolomites with marl–limestone intrusions, limestones, sometimes with flints, radiolarites and loamy conglomerates.

Due to the intermediate geographic situation of the Rif Cordillera, midway between the Atlantic Ocean in the W. and the Mediterranean Sea in the N. and N.E., its climate is very distinctive. In general, the Rif Cordillera is an area of high precipitation. In the western part of the Rif, clouds from the Straits of Gibraltar produce rainfall when they come up against the high Moroccan mountains. The only quantitative rainfall data for this area refer to other mountainous systems near the Jbel Bouhalla: e.g. the Jbel Bou Hachem (1094 m) situated on the N.E. face of the Bouhalla receives 2168 mm per year and the Jbel Outka (1085 m) on the S.W. face of the Bouhalla experiences 1760 mm per year. According to Benabid (1982), the Jbel Bouhalla receives more precipitation than these other two mountains. As in other Mediterranean climates, there are two rainfall maxima, one in winter and the other in spring. Foggy

days are numerous, which is critical for the existence of the *Abies* forest. In spite of a very pronounced summer drought, air humidity remains high. The average annual temperature at the nearest weather station to the study area (Chefchaouen, 630 m) is 16°C, January being the coldest month (9°C) and August the warmest (22°C). The average annual minimum temperature in the higher parts of the Jbel Bouhalla varies from -3.5 to 4.0°C (Ruiz-Laso, 1986).

The lowest parts of the Jbel Bouhalla that have been studied are occupied by mixed evergreen forests of *Quercus suber* L. and *Q. rotundifolia* Lam., in the so-called thermo- and meso-Mediterranean belts. The last species dominates at about 1000 m in the meso-Mediterranean belt, but it is substituted at greater altitudes by *Q. faginea* Lam. in the more humid parts, and by *Pinus pinaster* Aiton in the drier parts. At about 1500 m the *Quercus* forest disappears and *Abies pinsapo* Boiss. subsp. *maroccana* (Trab.) Emb. & Maire appears, but only above 1600 m, in the supra-Mediterranean belt, does the *Abies* forest become very dense. Some isolated specimens of *P. nigra* Arnold subsp. *mauretanica* (Maire & Peyerimh.) Heywood are present from 1500 to 1700 m, in the supra-Mediterranean belt. At about 1800 m *Cedrus atlantica* Manetti appears and starts to supplant the *Abies* forest, which does not ascend above 1900 m. *Cedrus* forms a pure forest above this altitude, in a zone that is still regarded as part of the supra-Mediterranean belt. In the highest parts of the mountains, trees disappear and they are substituted by a xerophytic formation composed of thorny shrubs.

This paper adds to our knowledge of a very interesting Moroccan mountainous area, which is bryologically almost unknown. The epiphytes being studied by bryologists at the Autonomous University of Madrid will form the subject of a separate publication. This paper focuses on the terricolous and saxicolous bryophytes of the Jbel Bouhalla. These were studied along an altitudinal gradient (Fig. 1) that began at 1050 m above sea level and finished at 1800 m. No bryophytes were found above this altitude. Specimens were collected on two expeditions (March and June 1997). They are deposited at MUB, MO and NY. Table 1 lists the sites sampled, all of which belong to the province of Chefchaouen.

BRYOPHYTE CATALOGUE

The terricolous and saxicolous bryophyte catalogue includes 121 bryophytes: 108 mosses and 13 liverworts. After consulting Dirkse, Bouman & Losada-Lima (1993), Wigginton & Grolle (1996), O'Shea (1999) and Ros, Cano & Guerra (1999), nine are identified as new for the African continent, one is new for the African mainland and seven are new for Morocco. For the nomenclature of most taxa, Corley *et al.* (1981), Corley & Crundwell (1991) and Grolle & Long (2000) were followed, but for the family Pottiaceae and the genus *Schistidium* we have followed Zander (1993) and Blom (1996) respectively, as well as some other recent taxonomical papers mentioned in the text. For each taxon the numbers of the sites where they have been

found are given, followed by the description of the habitat occupied in the study area and the previous reports, if any. When the distribution area of a taxon is extended by a discovery in the Jbel Bouhalla, or if the taxon is very rare in the area, some comments about its known distribution are also included. The new records for the African continent and Morocco are summarized in Table 2.

Mosses

Pogonatum aloides (Hedw.) P.Beauv. 1. Sheltered screes under *Quercus rotundifolia*.

Fissidens dubius P.Beauv. 3, 7, 10. Rock crevices with soil. Known from Europe extending east to Ukraine and Crimea, Macaronesia, N. Africa, Turkey, Caucasus, Himalaya, N.E. and S.E. Asia, N. America, Mexico and Haiti (Hill, Preston & Smith, 1992). In N. Africa has only been cited from Algeria (Ros *et al.*, 1999). New for Morocco.

Fissidens sublimbatus Grout. 3, 8, 9, 10. Sheltered crevices, in screes and on rocks in evergreen *Quercus* and coniferous forests. It was formerly considered to be an endemic of western North America (Arizona, California, Colorado, Nevada, New Mexico, Oklahoma, Texas, Utah, and Wyoming in the United States, Baja California Norte in Mexico, and Alberta in western Canada; Pursell, 1997), but has recently been discovered in Morocco and the Canary Islands (Ros *et al.*, 2001).

Fissidens taxifolius Hedw. 5, 9. Screes and rock hollows with accumulated soil.

Dicranella howei Renaud & Cardot. 1, 2. Screes sheltered by *Quercus rotundifolia* and *Q. suber*.

Dicranella varia (Hedw.) Schimp. 9. Scree at the edge of a path.

Ceratodon purpureus (Hedw.) Brid. 1, 9. Annual grasslands over exposed acid soils. Previously found in the study area by Cano *et al.* (1999).

Pleuroidium acuminatum Lindb. 1, 2. Exposed acid soils and screes under *Quercus rotundifolia* and *Q. suber*. Known from nearly all Europe, Turkey, W. Russia, Macaronesia, Algeria, E. China, N. America (Hill *et al.*, 1992). Its presence in N. Africa was considered doubtful by Ros *et al.* (1999), but it is now confirmed by this new record. New for Morocco.

Distichium capillaceum (Hedw.) Bruch, Schimp. & W.Gümbel 3, 7, 8, 9, 10, 11, 12. Humid and sheltered screes, rock crevices and hollows with soil.

Encalypta streptocarpa Hedw. 3, 7, 8, 9, 10, 11. Crevices, ledges and rock bases, sometimes with soil.

Encalypta vulgaris Hedw. 3, 7, 9. Rock fissures and ledges, also in grasslands.

Tortula canescens Mont. 1, 2. Dry and exposed soils. Also on screes under *Quercus rotundifolia*.

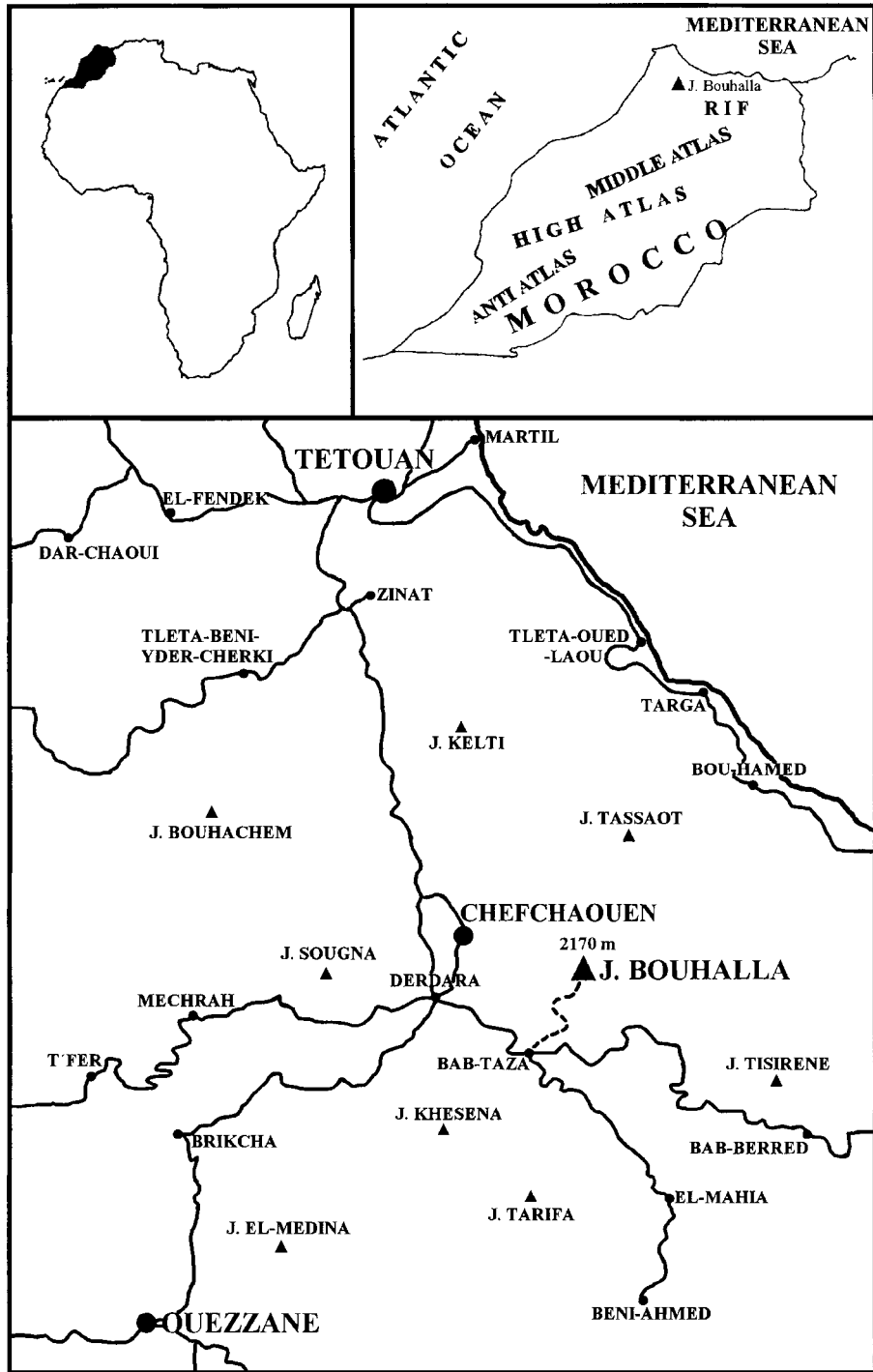


Figure 1. Map of the study area with insets showing its position in Morocco and North Africa. Discontinuous line: altitudinal transect studied.

Tortula muralis Hedw. 3, 4, 6, 9. On exposed rocks and fissures with soil.

Tortula subulata Hedw. var. *subulata*. 2, 5, 9, 11, 12. Soils and rock fissures, partially shady. Var. *subinermis* (Bruch & Schimp.) Wilson. 1, 3, 5, 7, 9, 10. Screens at rock bases and fissures with skeletal soils.

Syntrichia calcicola J.J. Amann. 6, 7, 9. Skeletal and deep soils in *Abies pinsapo* subsp. *maroccana* woods. Also in grasslands.

Syntrichia handelii (Schiffn.) Agnew & Vondr. 6, 9. Rock ledges under *Quercus rotundifolia*.

Syntrichia inermis (Brid.) Bruch. 3, 6, 9. On exposed and sheltered rocks and screes under shrubs.

Syntrichia intermedia Brid. 3, 4, 5, 10. Rocks and fissures with soil.

Syntrichia princeps (De Not.) Mitt. 5. Limestone in *Quercus rotundifolia* wood.

Table 1. Details of the study sites. Forest formation: AM = *Abies pinsapo subsp. maroccana*, CA = *Cedrus atlantica*, PM = *Pinus nigra subsp. mauretanica*, PP = *Pinus pinaster*, QF = *Quercus faginea*, QR = *Q. rotundifolia*, QS = *Q. suber*. Vegetation belt: m-M = meso-Mediterranean, s-M = supra-Mediterranean.

Site number	Altitude in metres above sea level	Geographic coordinates and U.T.M. square	Vegetation belt	Forest formation ¹
1	1050	35°04'34"N, 5°10'45"W (U.T.M.: 30SUD0183).	m-M, subhumid	QS, QR
2	1220	35°05'26"N, 5°09'47"W (U.T.M.: 30SUD0285)	m-M, subhumid	QS, QR
3	1275	35°05'58"N, 5°08'56"W (U.T.M.: 30SUD0385)	m-M, subhumid	QF, QR
4	1300	35°06'20"N, 5°08'48"W (U.T.M.: 30SUD0486)	s-M, subhumid	QF, QR
5	1400	35°06'58"N, 5°08'22"W (U.T.M.: 30SUD0588)	s-M, humid	QF, QR
6	1500	35°07'31"N, 5°08'10"W (U.T.M.: 30SUD0589)	s-M, humid	QF, QR, PP, AM
7	1500	35°07'10"N, 5°08'03"W (U.T.M.: 30SUD0588)	s-M, humid	QR, AM
8	1595	35°08'32"N, 5°08'27"W (U.T.M.: 30SUD0490)	s-M, humid	AM, PM
9	1600	35°08'17"N, 5°08'20"W (U.T.M.: 30SUD059)	s-M, humid	AM, PP
10	1700	35°08'36"N, 5°08'42"W (U.T.M.: 30SUD0491)	s-M, humid	AM, PM
11	1700	35°08'09"N, 5°08'27"W (U.T.M.: 30SUD0490)	s-M, humid	AM
12	1800	35°08'33"N, 5°08'48"W (U.T.M.: 30SUD0491)	s-M, humid	AM, CA

Syntrichia ruralis (Hedw.) F.Weber & D.Mohr. 1, 5, 7, 9, 10, 11, 12. On sheltered and exposed rocks. Also in screes and grasslands.

Syntrichia virescens (De Not.) Ochyra. 11. Sheltered scree under rock.

Table 2. Notable range extensions represented by the recent discoveries in the Jbel Bouhalla.

Taxon	Range extension	Previous distribution in Africa
<i>Acaulon mediterraneum</i>	Africa	–
<i>Barbula enderesii</i>	Morocco	Algeria
<i>Bryum dunense</i>	Morocco	Algeria, Tunisia
<i>Campyladelphus chrysophyllus</i>	Morocco	Chad
<i>Claopodium whippleanum</i>	Africa	–
<i>Eurhynchium schleicheri</i>	Africa mainland	Canary Islands
<i>Fissidens dubius</i>	Morocco	Algeria
<i>Gymnostomum lanceolatum</i>	Africa	–
<i>Hedwigia ciliata</i> var. <i>leucophaea</i>	Morocco	Algeria, Tunisia
<i>Hedwigia stellata</i>	Africa	–
<i>Orthotrichum cupulatum</i> var. <i>baldacci</i>	Africa	–
<i>Pleuridium acuminatum</i>	Morocco	No country cited
<i>Pseudoleskeella catenulata</i>	Morocco	Algeria
<i>Schistidium brunnescens</i> subsp. <i>griseum</i>	Africa	–
<i>Schistidium crassipilum</i>	Africa	–
<i>Scorpiurium sendtneri</i>	Africa	–
<i>Seligeria acutifolia</i>	Africa	–

Aloina aloides (Schultz) Kindb. 6, 11. Dry soils, partially sheltered.

Aloina ambigua (Bruch & Schimp.) Limpr. 6. Scree between rocks.

Acaulon mediterraneum Limpr. 1. Dry and exposed, acid soils. It is known from nearly all European countries and Turkey (Düll, 1984, 1992). New to the African continent.

Barbula convoluta Hedw. 3, 9, 10, 11, 12. Screes, crevices of rocks with skeletal or sandy soils.

Barbula enderesii Garov. 3, 7. Exposed or partially sheltered limestones with soil. It was only known from the European continent, Caucasus and C. Asia (Ignatov & Afonina, 1992). Jelenc (1955) reports this species from Algeria, but Düll (1992) doubted its veracity. Our record confirms its presence in N. Africa. New to Morocco.

Barbula unguiculata Hedw. 7, 11. Ledges of rocks with accumulated soil.

Pseudocrossidium hornschi (Schultz) R.H.Zander. 3. Grassland.

Pseudocrossidium revolutum (Brid.) R.H.Zander. 3, 7, 11. Ledges of rocks with accumulated soil.

Didymodon fallax (Hedw.) R.H.Zander. 3, 4, 8. Rock fissures and sandy soils.

Didymodon tophaceus (Brid.) Lisa. 9, 11. Screes where water seeps, with or without soil.

Didymodon vinealis (Brid.) R.H.Zander. 7, 9. Exposed limestones with soil and screes at the edge of a path. Var. *flaccidus* (Bruch & Schimp.) R.H.Zander. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. Rock fissures, ledges and crevices with soil, sometimes at the base of rocks, usually in sheltered places.

Bryoerythrophyllum recurvirostrum (Hedw.) P.C.Chen. 9, 11. Rock crevices with soil and screes under *Abies pinsapo* subsp. *maroccana*.

Eucladium verticillatum (Brid.) Bruch, Schimp. & W.Gümbel 9. Humid scree at the edge of a path.

Gymnostomum calcareum Nees & Hornsch. 8, 11. Humid screes.

Gymnostomum lanceolatum M.J.Cano, Ros & J.Guerra. 9. Scree at the edge of a path. Until now it was known only from the S.E. of the Iberian Peninsula, in Almeria and Alicante provinces (Cano, Ros & Guerra, 1994). Recently it has been found on the Balearic Islands (Cano *et al.*, 2001), and in Turkey and Croatia (Kučera, 1998). New to the African continent.

Gymnostomum viridulum Brid. 7. Ledge of rock with soil.

Anoetangium aestivum (Hedw.) Mitt. 3. On bare limestone. It is widespread in C. and N. Europe and more rare in equatorial countries and the Southern Hemisphere (Hill *et al.*, 1992). In N. Africa it was known from Morocco (Ros *et al.*, 1999); nevertheless it is very uncommon.

Trichostomum brachydontium Bruch. 1. Scree under *Quercus rotundifolia*.

Trichostomum crispulum Bruch. 6, 7, 8. Exposed rocks with soil and screes.

Weissia controversa Hedw. 1, 2, 8, 12. Small accumulations of earth at the base of rocks and exposed soils.

Weissia fallax Sehm. 5. Skeletal soil in a clearing between bushes.

Weissia longifolia Mitt. 5, 9. Fissures and exposed skeletal soils.

Aschisma carniolicum (F.Weber & D.Mohr) Lindb. 2. Clayey soil in a clearing among *Cistus crispus* L.

Pleurochaete squarrosa (Brid.) Lindb. 3. Grassland.

Tortella tortuosa (Hedw.) Limpr. 3, 4, 5, 6, 7, 9, 10, 11, 12. Fissures and rocks with accumulated soil, usually in sheltered places.

Timmia sp. 1. Exposed soil among *Cistus ladanifer* L. and *C. monspeliensis* L. It was impossible to identify the species because of the absence of sporophytes.

Schistidium brunnescens subsp. *griseum* (Nees & Hornsch.) H.H.Blom. 9. Exposed limestone. Until now it was known only from central, E. and N. Europe and Turkey (Blom, 1996). New to the African continent.

Schistidium crassipilum H.H.Blom. 5, 7, 11. Exposed and bare limestones, sometimes with soil. It is known from Europe, N. America and Asia Minor (Blom, 1996). New to the African continent.

Schistidium singarense (Schiffn.) Laz. 3, 4, 6, 7, 8, 10, 12. In the same habitats as the preceding species. These two are the commonest species of the genus *Schistidium* in the Mediterranean area.

Grimmia laevigata (Brid.) Brid. 2. Partially sheltered limestone.

Grimmia lisae De Not. 1, 2. Bare limestone rock fissures, more or less sheltered.

Grimmia pulvinata (Hedw.) Sm. 3, 5, 6, 7, 10. Exposed limestones.

Grimmia trichophylla Grev. 3, 4, 5, 6, 7, 9, 10, 11. Shaded and exposed limestones.

Seligeria acutifolia Lindb. 3, 4, 9. Sheltered limestones and fissures. It is present in Europe, Caucasus, Turkey, Japan and N. America (Hill, *et al.*, 1992). New to the African continent.

Funaria hygrometrica Hedw. 3. Sandy soil.

Bryum alpinum Huds. ex With. 8. Scree on a dry river bank.

Bryum argenteum Hedw. 1, 9. Soils at the edge of a path. It was previously recorded in the Jbel Bouhalla by Cano *et al.* (1999).

Bryum caespiticium Hedw. 7, 9, 12. Rock bases and screes.

Bryum canariense Brid. 3. Partially sheltered limestone.

Bryum capillare Hedw. 3, 5, 7, 8, 9, 10, 11, 12. Accumulated earth in rock fissures and screes.

Bryum dichotomum Dicks. 1, 2, 3. Sandy soils in clearings between bushes.

Bryum donianum Grev. 5. Rock crevices with soil.

Bryum dunense A.J.E.Sm. & H.Whitehouse. 9. Sandy soil. It is present in Europe and Turkey (Hill, Preston & Smith, 1994). In N. Africa it was known from Algeria and Tunisia (Ros *et al.*, 1999). New for Morocco.

Bryum gemmilucens R.Wilczek & Demaret. 1, 2. Exposed soils.

Bryum pseudotriquetrum (Hedw.) P.Gaertn., B.Mey. & Scherb. 8. Scree on a dry river bank.

Bryum torquescens Bruch ex De Not. 1, 3, 12. Sheltered rocks and screes.

Bartramia pomiformis Hedw. 1. Scree under *Quercus rotundifolia*.

Bartramia stricta Brid. 1. Bare and exposed rocks, and screes sheltered by *Quercus rotundifolia*.

Timmia bavarica Hessel. 5, 9, 11. Bases of rocks with soil and rock fissures. It is found in all the major mountain areas of the

N. Hemisphere (Brassard, 1984). It was previously known from Algeria and Morocco (Ros *et al.*, 1999), but it is a rare species in N. Africa.

Orthotrichum anomalum Hedw. 3, 6. Exposed and shaded limestones.

Orthotrichum cupulatum Brid. 3, 4, 5, 6, 7, 9, 10, 11, 12. More or less sheltered limestones.

Orthotrichum cupulatum var. *baldacci* (Bott. & Venturi) Piccioli. 3, 7. Bare limestones. It is known from the Iberian Peninsula and former Yugoslavia (Düll, 1984). New to the African continent.

Orthotrichum rupestre Schleich. ex Schwägr. 2, 3, 6. Rocks, sometimes sheltered by trees.

Hedwigia ciliata var. *leucophaea* Bruch, Schimp. & W.Gümbel 1. Exposed rock. It is known from Europe, Asia Minor and N. America (Wijk, Margadant & Florschütz, 1964) and China (Redfearn & Wu, 1986). In Africa it was only cited in Algeria and Tunisia. New for Morocco.

Hedwigia stellata Hedenäs. 1. Acid and exposed rock. After the description of the species by Hedenäs (1994) with material from N. Europe, it has been recognized in several areas of Europe (Frahm, 1995; Casas & Sérgio, 1996; Buck & Norris, 1996) and N. America (Buck & Norris, 1996). New to the African continent.

Leucodon sciuroides (Hedw.) Schwägr. 4, 5. Exposed and sheltered rocks, sometimes with soil.

Antitrichia californica Sull. 1, 3, 4, 5, 6, 7. On rocks, usually sheltered and with soil.

Pterogonium gracile (Hedw.) Sm. 1, 3, 4, 5, 6, 7. Rocks with or without soil, sometimes in sheltered places.

Leptodon smithii (Hedw.) F.Weber & D.Mohr. 3, 4, 7, 9, 11. Limestones, more or less sheltered.

Metaneckera menziesii (Drumm.) Steere. 3, 4, 5, 9. Rocks and limestone fissures with or without accumulated soil.

Fabronia pusilla Raddi. 3, 4. Exposed rocks and shady hollow.

Pseudoleskeella catenulata (Brid. ex Schrad.) Kindb. 9. Sheltered rock with protosoil. It is present in the mountains of W., central and N. Europe (Hill *et al.*, 1994). According to Wilson & Norris (1989), the species only grows in Europe and records from outside Europe apparently refer to other taxa, although these authors did not study African specimens. In N. Africa it was known from Algeria. New to Morocco.

Pseudoleskea incurvata (Hedw.) Loeske. 12. Rock ledge with soil.

Thamnobryum alopecurum var. *maderense* (Kindb.) Stech, Ros & Werner. 3, 5. Dry basic rocks in very sheltered places, sometimes with a skeletal soil in a *Quercus rotundifolia* and *Q. faginea* forest, sometimes mixed with *Abies pinsapo* subsp.

maroccana. It is known from the Macaronesian Islands: Azores, Canary Islands (Tenerife) and Madeira (Hedenäs, 1992), and Portugal (Blockeel *et al.*, 2000). It has recently been found in Morocco, in several localities of the Rif Cordillera (Jbel Bouhalla, Jbel Bessoui and Gorges of Ouazzanne) and in Southern Spain, in Cadiz province (Jiménez *et al.*, 2000). Molecular studies carried out by Stech, Ros & Werner (2001) have shown the close genetic similarity of *Thamnobryum alopecurum* and *T. maderense*, which are only distinguishable by small morphological and ecological differences.

Claopodium whippleanum (Sull.) Renauld & Cardot. 1. Humid scree under *Quercus rotundifolia*. It presents a disjunct distribution in Europe and America. It is known from some countries and islands of S.W. Europe and N.W. America (Düll, 1985, 1992). It is new to the African continent.

Cratoneuron filicinum (Hedw.) Spruce. 8. Scree in a dry river bank.

Campyliadelphus chrysophyllus (Brid.) Kanda. 4. Very shaded and sheltered limestone. It is widespread in the Northern Hemisphere, from the Arctic south to N. Africa, Turkey, C. Asia, Japan and Mexico, reaching the tropics in Guatemala and Colombia (Hill *et al.*, 1994). In N. Africa it was only known from Chad (Ros *et al.*, 1999). New to Morocco.

Scorpiurium circinatum (Brid.) M.Fleisch. & Loeske. 3, 4, 10. Vertical and overhanging limestones, sometimes in very shaded conditions.

Scorpiurium deflexifolium (Solms) M.Fleisch. & Loeske. 3. Sheltered limestone. Formerly it was known only from Europe, Macaronesia, E. and S.W. Asia (Düll, 1985). In N. Africa it has been reported from several countries: Algeria, Chad, Morocco and Tunisia (Ros *et al.*, 1999). Nevertheless, it is a rare species in that continent.

Scorpiurium sendtneri (Schimp.) M.Fleisch. 9. Sheltered limestone under *Quercus rotundifolia*. It was previously known from Europe, Macaronesia and S.W. Asia (Düll, 1985). New to the African continent.

Homalothecium aureum (Spruce) H.Rob. 3, 4, 5, 6, 7, 8, 9, 10, 11. Rocks and screes with soil, more or less sheltered.

Homalothecium philippeanum (Spruce) Schimp. 9, 12. Deep and skeletal soils, sometimes also on sheltered rocks.

Homalothecium sericeum (Hedw.) Bruch, Schimp. & W.Gümbel 3, 4, 5, 7, 9, 10, 11, 12. Limestones and rock fissures, sometimes with a thin layer of soil.

Brachythecium bellicum W.R.Buck, J.A.Jiménez, Ros & M.J.Cano. 10, 11. Rock hollow with soil. Until now only known from Morocco (Buck *et al.*, 2001).

Brachythecium dieckei Röhl. 12. Exposed rocks and ledges with soil and also on screes between rocks.

Brachythecium velutinum (Hedw.) Bruch, Schimp. & W.Gümbel 4, 7, 9, 10, 11, 12. Sheltered rocks and screes, more

or less humicolous. Var. *salicinum* (Schimp.) Mönk. 9. Rock crevices with a thin layer of soil.

Scleropodium tourettii (Brid.) L.F. Koch. 1, 3, 7. On very sheltered screes.

Eurhynchium meridionale (Bruch, Schimp. & W.Gümbel) De Not. 3, 4, 5, 7. Bare rocks and fissures with skeletal soil.

Eurhynchium praelongum (Hedw.) Bruch, Schimp. & W.Gümbel 3. On very sheltered limestone rocks.

Eurhynchium schleicheri (R.Hedw.) Milde. 10. Rock fissure with skeletal soil. It is present in Europe, Macaronesia, Turkey and Iran (Hill *et al.*, 1994). New to African mainland.

Eurhynchium striatulum (Spruce) Bruch, Schimp. & W.Gümbel 3, 5. In very sheltered rocks fissures and on bare limestones.

Rhynchostegiella tenella (Dicks.) Limpr. 5. Rock hollow with skeletal soil.

Hypnum cupressiforme Hedw. 5, 10. Sheltered fissures and rocks.

Ctenidium molluscum (Hedw.) Mitt. 5. Partially sheltered limestone.

Liverworts

Targionia hypophylla L. 1, 3. Rock fissures with skeletal soil and sheltered screes.

Reboulia hemisphaerica (L.) Raddi. 3, 4, 5, 9, 10, 11, 12. Rock fissures and hollows with accumulated earth.

Athalamia hyalina (Sommerf.) S.Hatt. 9, 10, 11, 12. Rock fissures and bases with skeletal soil, in dark conditions.

Riccia ciliata Hoffm. 1. Scree under *Quercus rotundifolia*.

Riccia nigrella DC. 1. Dry and exposed soil.

Riccia sorocarpa Bisch. 1. Dry and exposed soil.

Fossombronia sp. 1. On the trunk base of *Quercus rotundifolia*.

Gongylanthus ericetorum (Raddi) Nees. 1. Humid and sheltered scree under *Quercus rotundifolia*.

Cephaloziella divaricata (Sm.) Schiffn. 1. Very humid and shady scree.

Cephaloziella turneri (Hook.) Müll.Frib. 1. Very humid and shady scree.

Radula lindenberiana Gottsche ex C.Hartm. 3, 7. Very sheltered and humid rocks.

Porella platyphylla (L.) Pfeiff. 5, 9, 10, 11, 12. In very sheltered fissures and on bare rocks.

Frullania dilatata (L.) Dumort. 2. On small scree under *Quercus suber*.

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REFERENCES

- Benabid A. 1982. *Études phytoécologique, biogéographique et dynamique des associations et series sylvatiques du Rif occidental (Maroc)*. Doctoral thesis. Université de Droit, d'Économie et des Sciences d'Aix-Marseille.
- Blockeel TL, Bergamini A, Brusa G, Ertz D, Sérgio C, García C, Hedenäs L, Müller F, Nieuwkoop JAW, Sabovljević MS. 2000. New national and regional bryophyte records, 3. *Journal of Bryology* 22: 303–306.
- Blom HH. 1996. A revision of the *Schistidium apocarpum* complex in Norway and Sweden. *Bryophytorum Bibliotheca* 49: 1–333.
- Brassard GR. 1984. The moss genus *Timmia*. 3. Sect. *Timmia*. *Lindbergia* 10: 33–40.
- Buck WR, Norris DH. 1996. *Hedwigia stellata* and *H. detonsa* (Hedwigiaceae) in North America. *Nova Hedwigia* 62: 361–370.
- Buck WR, Jiménez JA, Ros RM, Cano MJ. 2001. *Brachythecium bellicum* sp. nov. from Northern Africa. *Nova Hedwigia* 72: 467–472.
- Cano MJ, Ros RM, Guerra J. 1994. *Gymnostomum lanceolatum* sp. nov. (Pottiaceae, Musci) von der Iberischen Halbinsel. *Nova Hedwigia* 59: 143–146.
- Cano MJ, Ros RM, Guerra J, García-Zamora P. 1999. A new bryophytic community from the mountains of Southern Spain and Morocco: *Tortulo subulatae-Syntrichietum ruralis*. *Cryptogamie, Bryologie* 20: 197–202.
- Cano MJ, Gallego MT, Garilleti R, Juaristi R, Lara F, Martínez-Abaigar J, Mazimpaka V, Roselló JA, Sánchez-Moya MC, Urdiroz A. 2001. Aportaciones al conocimiento de la flora briológica española. Notula XIII: Hepáticas y musgos de Mallorca (Islas Baleares). *Boletín de la Sociedad Española de Briología* 18/19: 103–110.
- Casas C, Sérgio C. 1996. *Hedwigia stellata* Hedenäs en la Península Ibérica. *Orsis* 11: 183–186.
- Corley MFV, Crundwell AC. 1991. Additions and amendments to the mosses of Europe and the Azores. *Journal of Bryology* 16: 337–356.
- Corley MFV, Crundwell AC, Düll R, Hill MO, Smith AJE. 1981. Mosses of Europe and the Azores; an annotated list of species, with synonyms from the recent literature. *Journal of Bryology* 11: 609–689.
- Dirkse GM, Bouman AC, Losada-Lima A. 1993. Bryophytes of the Canary Islands, an annotated checklist. *Cryptogamie, Bryologie et Lichénologie* 14: 1–47.
- Düll R. 1984. Distribution of the European and Macaronesian mosses (Bryophytina). Part I. *Bryologische Beiträge* 4: 1–113.
- Düll R. 1985. Distribution of the European and Macaronesian mosses (Bryophytina). Part II. *Bryologische Beiträge* 5: 110–232.
- Düll R. 1992. Distribution of the European and Macaronesian mosses (Bryophytina). Annotations and progress. *Bryologische Beiträge* 8/9: 1–223.

- Frahm J-P. 1995.** *Hedwigia stellata* Hedenäs in Deutschland. *Bryologische Rundbriefe* **20**: 3.
- Garilleti R, Lara F, Mazimpaka V. 1997a.** *Orthotrichum ibericum* and *O. macrocephalum* new for Northern Africa. *Lindbergia* **22**: 33–35.
- Garilleti R, Lara F, Mazimpaka V. 1997b.** *Orthotrichum lewinskyae* sp. nov. (Orthotrichaceae, Musci), a Moroccan epiphytic moss related to *O. scanicum* Grönv. and *O. holmenii* Lew.-Haap. *Journal of Bryology* **19**: 457–464.
- Grolle R, Long DG. 2000.** An annotated check-list of the Hepaticae and Anthocerotae of Europe and Macaronesia. *Journal of Bryology* **22**: 103–140.
- Hedenäs L. 1992.** Notes on the genus *Thamnobryum* in Macaronesia (excluding the Cape Verde Islands). *Journal of Bryology* **17**: 119–125.
- Hedenäs L. 1994.** The *Hedwigia ciliata* complex in Sweden, with notes on the occurrence of the taxa in Fennoscandia. *Journal of Bryology* **18**: 139–157.
- Hill MO, Preston CD, Smith AJE. 1992.** *Atlas of the bryophytes of Britain and Ireland. Volume 2. Mosses (except Diplolepideae)*. Colchester: Harley Books.
- Hill MO, Preston CD, Smith AJE. 1994.** *Atlas of the bryophytes of Britain and Ireland. Volume 3. Mosses (Diplolepideae)*. Colchester: Harley Books.
- Ignatov MS, Afonina OM. 1992.** Check-list of mosses of the former USSR. *Arctoa* **1**: 1–85.
- Jiménez JA, Ros RM, Guerra J, Cano MJ, Gallego MT. 2000.** *Thamnobryum maderense* (Kindb.) Hedenäs in Spain and Northern Africa. *Nova Hedwigia* **71**: 439–445.
- Jelenc F. 1955.** Muscinées de l'Afrique du Nord (Algérie, Tunisie, Maroc, Sahara). *Société de Géographie et d'Archéologie de la Province d'Oran* **72–76**: 1–152.
- Jovet-Ast S. 1958.** Muscinées du Rif Occidental. *Bulletin de la Société des Sciences Naturelles et Physiques du Maroc* **38**: 183–186.
- Kučera J. 1998.** *Gymnostomum lanceolatum* Cano, Ros & Guerra (Pottiaceae, Musci) also in Turkey and Croatia. *Journal of Bryology* **20**: 515–516.
- O'Shea B. 1999.** Checklist of the mosses of sub-Saharan Africa (version 3, 11/99). *Tropical Bryology Research Reports* **1**: 1–133.
- Pursell RA. 1997.** A comparison of *Fissidens obtusifolius* and *F. sublimbatus*. *Journal of the Hattori Botanical Laboratory* **82**: 203–212.
- Redfearn PL, Wu, PC. 1986.** Catalog of the mosses of China. *Annals of the Missouri Botanical Garden* **73**: 177–208.
- Ros RM, Cano MJ, Guerra J. 1999.** Bryophyte checklist of Northern Africa. *Journal of Bryology* **21**: 207–244.
- Ros RM, Jiménez JA, Cano MJ, Pursell RA, Bruggeman-Nannenga MA, Dirkse GM. 2001.** *Fissidens sublimbatus*, new to Morocco and the Canary Islands. *Bryologist* **104**: 468–470
- Ruiz-Laso A. 1986.** *Geología y Biología de Marruecos en itinerarios didácticos*. Madrid: Instituto Hispano-Árabe de Cultura.
- Sanz de Galdeano C. 1997.** *La zona interna bético-rifeña*. Granada: Universidad de Granada.
- Stech M, Ros RM, Werner O. 2001.** The taxonomic status of *Thamnobryum maderense* (Kindb.) Hedenäs (Bryopsida) as inferred from molecular data. *Nova Hedwigia* **72**: 251–257.
- Wigginton MJ, Grolle R. 1996.** Catalogue of the Hepaticae and Anthocerotae of Sub-Saharan Africa. *Bryophytorum Bibliotheca* **50**: 1–267.
- Wijk R van der, Margadant WD, Florschütz PA. 1964.** Index muscorum, Volume III (Hypnum-O). *Regnum Vegetabile* **33**: 1–529.
- Wilson P, Norris DH. 1989.** *Pseudoleskeella* in North America and Europe. *Bryologist* **92**: 387–396.
- Zander RH. 1993.** Genera of the Pottiaceae: mosses of harsh environments. *Bulletin of the Buffalo Society of Natural Sciences* **32**: 1–378.