

Contribution to the bryophyte flora of Morocco: the Anti-Atlas catalogue

María J. CANO *, Rosa M. ROS, M. Teresa GALLEGO,
Juan A. JIMÉNEZ & Juan GUERRA

*Departamento de Biología Vegetal, Área de Botánica, Facultad de Biología,
Universidad de Murcia, Campus de Espinardo, E-30100 Murcia, Spain*

(Received 10 April 2002, accepted 25 June 2002)

Abstract – The bryophytes of the Anti-Atlas (Morocco) are catalogued. 88 bryophytes (69 mosses and 19 liverworts) are reported from bibliographic and new collections, of which three are new records for Africa (*Didymodon sicculus* M.J. Cano, Ros, García-Zamora & J. Guerra, *Syntrichia minor* (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & Sánchez-Moya and *Tortula mucronifera* W. Frey, Kürschner & Ros), one for the Maghreb (*Hymenostylium hildebrandtii* (Müll. Hal.) R.H. Zander) and one for Morocco (*Weissia condensa* var. *armata* M.J. Cano, Ros & J. Guerra).

Bryophyte flora / Northern Africa / Canary Islands / Morocco / Anti-Atlas

INTRODUCTION

The Anti Atlas is situated in southern Morocco, extending from the Ifni coast to the proximity of Tafilalt (Fig. 1). It is separated from the High Atlas by the Sous Valley and Dadès Wadi. It is generally lower than the High Atlas, although the Jbel Sarhro reaches 2712 m. Geologically, it is formed by Precambrian and Paleozoic materials, which are strongly folded, providing a tabular landscape due to the horizontal position of the strata. Sometimes these materials are covered of Mesozoic and Cenozoic materials (Ruiz-Laso, 1986). Thus, the lithological base of the study area is mainly composed of schists, calcareous rocks, quartzites, basalts and granites.

The northwestern part has a dry Mediterranean climate, with mild temperature due to the influence of the Atlantic, with an average annual rainfall of about 100-300 mm, which increases with height. However, most of the southern and eastern parts of the Anti-Atlas present an arid or Saharan Mediterranean climate, with large differences in temperature between days and nights and an average annual rainfall of less than 150 mm (Charco, 1999).

Despite these conditions, the flora and vegetation of the Anti-Atlas is highly interesting, because of Macaronesian and dry-tropical influence on its western side and Saharian affinities toward the east and south. The vegetation is dominated by *Argania spinosa* Skeels, which, in the west, where the influence of the

* Correspondence and reprints: mcano@um.es

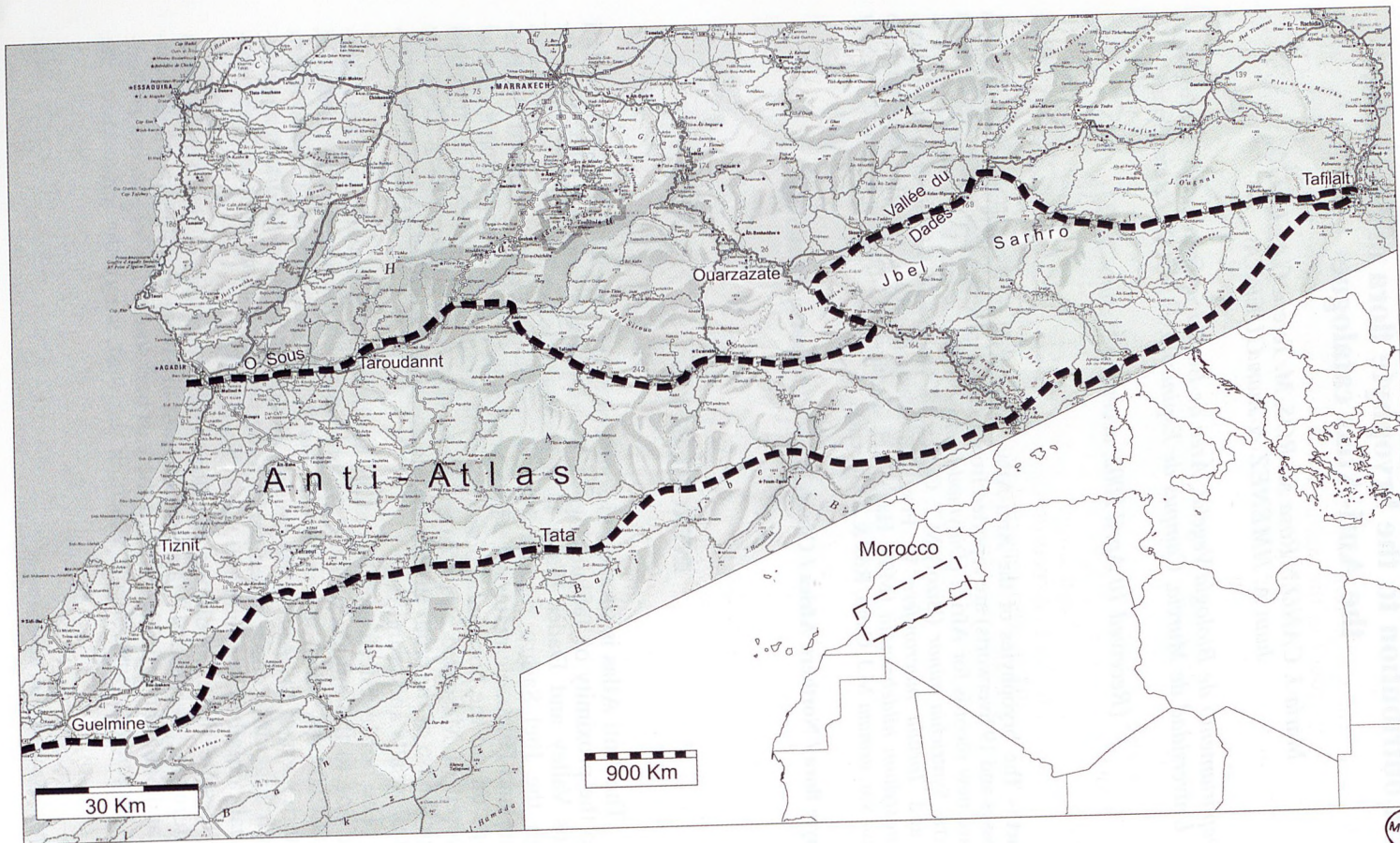


Fig. 1. Geographical situation of the studied area.

Atlantic Ocean is greatest, is associated with some cactiform species of the genus *Euphorbia* (*E. resinifera* Berg, *E. echinus* Hook. f. & Coss.). In more continental conditions, *Acacia gummifera* Willd. appears together with *Ziziphus lotus* (L.) Lam., which is frequent in the small depressions where humidity is retained for a longer time than in surrounding areas. Also of note are the *Quercus rotundifolia* Lam. forest in Jbel Leskt and the relict *Dracaena drago* subsp. *ajgal* Benabid & Cuzin populations in the Jbel Imzi, the latter associated with other rare or endemic species such as *Laurus azorica* (Seub.) Franco, *Olea maroccana* Greuter & Burdet or *Aeonium arboreum* (L.) Webb & Berthel. (Benabid & Cuzin, 1997). Where the influence of the Sahara is strongest, a savannah of *Acacia ehrenbergiana* Hayne and *A. raddiana* Savi appears.

From a bryological point of view, the Anti-Atlas has been neglected. Thus, very few sites have been studied, in which only 16 liverworts and 18 mosses have been reported. The first records about the bryophytes of the Anti-Atlas were those of Werner (1932), who reported two mosses in a wider work on the cryptogamic flora of Morocco. In subsequent contributions, Maire & Werner (1934) mentioned three bryophytes and Gattefossé & Werner (1935) mentioned in additional four mosses and five liverworts. Later, Meylan (1937) described a new species, *Physcomitrium maroccanum* Meyl., from material collected in this area.

Other contributions were made by Jovet-Ast (1955a,b, 1956) who cited eight hepatics, some of them new for the area. Jelenc (1955), in his compiled work of the bryophytes from North Africa, mentioned the presence of some bryophytes from this area and afterward reported two more mosses and hepatics (Jelenc, 1967).

More recently Bischler (1978) mentioned the presence of *Plagiochasma rupestre* (J.R.Forst. & G.Forst.) Steph., and Frahm (1988) cited five bryophytes. Other previous records from the Anti-Atlas were from Jbel Siroua, which is included by some authors in the Anti-Atlas and by others as a part of the High-Atlas. In this study, we have not considered the Jbel Siroua belonging to the Anti-Atlas, because the species of bryophytes which grow in the higher part of this mountain show more affinity with those of the High-Atlas mountains.

In this paper, we report the list of bryophytes collected during two bryological expeditions to the Anti-Atlas that took place in April 2000 by M.J. Cano, J.A. Jiménez & R.M. Ros and in March 2001 by M.J. Cano & J. Muñoz. Also, all the bryophytes cited in the bibliography of this area and some material collected by R.R. Brooks, C. Dunn, J.R. Edmondson & M. Leblanc, which were kindly sent by S.L. Jury (University of Reading), have been included. With this work, we continue with our contributions to deepen on the knowledge of the bryophyte flora

Tab. 1. Main range extensions represented by the recent discoveries in the Anti-Atlas.

<i>Taxon</i>	<i>Range extension</i>	<i>Previous distribution in Africa</i>
<i>Didymodon sicculus</i>	Africa	-
<i>Hymenostylium hildebrandtii</i>	Maghreb	Somalia
<i>Syntrichia minor</i>	Africa	-
<i>Tortula mucronifera</i>	Africa	-
<i>Weissia condensa</i> var. <i>armata</i>	Morocco	Algeria

and vegetation of the main mountain ranges of Morocco (Ros *et al.*, 2000; Jiménez *et al.*, 2002, b).

The catalogue of the study area includes 88 taxa, of which 69 are mosses and 19 liverworts. Based on the checklist to Dirkse *et al.* (1993), O'Shea (1999), Ros *et al.* (1999) and Wigginton (2002), three are new for Africa, one for the Maghreb (Morocco, Algeria and Tunisia), one for Morocco and forty-four for the Anti-Atlas. Also, *Syntrichia minor* (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & Sánchez-Moya is reported for the first time from the Canary Islands. The most significant records are summarized in Table 1.

Of the thirty-four bryophytes reported in the literature, 19 were not found by us. Most of them correspond to liverworts cited by Jovet-Ast, whose identifications we consider reliable. We have not been able to study the old collections, except some of them which were published by Cano *et al.* (2000).

The nomenclature is based on that of Ros *et al.* (1999) except in the case of some taxa that have been subject to more recent changes. For each taxon, the numbers of the localities where they were found (according to Table 2) are given, followed by a brief description of the habitat occupied in the study area and previous reports, if any. In the cases of new records, distribution of the species and additional comments are also included. All the specimens cited are deposited in MUB.

LIST OF BRYOPHYTES FROM THE ANTI-ATLAS

Mosses

Acaulon sp. — Site: 10. — On bare soil in an almond tree crop. This sample presents the same gametophytic characters as *Acaulon fontiquerianum* Casas & Sérgio with its typical inflated ventral costa cells. However, due to the absence of sporophytes, we prefer not to describe this taxon as a new record for the African continent.

Acaulon triquetrum (Spruce) Müll. Hal. — Site: 5. — On soil under *Ziziphus lotus*. New for the Anti-Atlas.

Aloina bifrons (De Not.) Delgad. — Sites: 1, 3, 5. — On bare soils. In Morocco it had only been cited by Gallego *et al.* (1999). New for the Anti-Atlas.

Aloina brevirostris (Hook. & Grev.) Kindb. — Site: 8. — On scree. New for the Anti-Atlas.

Aloina rigida (Hedw.) Limpr. — Sites: 1, 3, 4, 6, 7, 8, 9, 12, 14, 16, 22, 23. — On open soils, in fissures of travertine, screes, and soils accumulated at the bases of calcareous, quartzitic or igneous rocks. Previously, it was cited *sub Aloina stellata* Kindb. by Gattefossé & Werner (1935) from Arba des Aït Baha and Taderrast, valley of oued Massa.

Anacolia webbii (Mont.) Schimp. — Reported by Jelenc (1955) from Jebel Leskt.

Barbula bolleana (Müll. Hal.) Broth. — Site: 1. — On wet rock in a stream. New for the Anti-Atlas.

Barbula unguiculata Hedw. — Site: 1. — Soil accumulated at the edge of an irrigation channel. New for the Anti-Atlas.

Tab. 2. Visited localities during the bryological expeditions to the Anti-Atlas in 2000 and 2001.

Site	Province and locality	Latitude/Longitude	Altitude (m)	Main shrubs and trees
1	Guelmim: Ifrane de l'Anti-Atlas	29°11'N 9°32'W	770	<i>Euphorbia</i> sp. pl., <i>Phoenix dactylifera</i>
2	Tiznit: Mesti, near Sidi Ifni,	29°15'N 10°06'W	400	<i>Euphorbia</i> sp. pl.
3	Tiznit: Sebt-Bou-Naamane	29°28'N 9°50'W	530	<i>Euphorbia</i> sp. pl., <i>Argania spinosa</i>
4	Tiznit: Ait Bāamaran	29°26'N 9°53'W	350	<i>Euphorbia</i> sp. pl., <i>Argania spinosa</i>
5	Tiznit: 10 km S. of Tiznit	29°34'N 9°43'W	390	<i>Ziziphus lotus</i>
6	Tiznit: Tleta-ida-Gougmar	29°31'N 9°20'W	860	<i>Euphorbia</i> sp. pl.
7	Tiznit: Col-du-Kerdous	29°36'N 9°20'W	1200	<i>Argania spinosa</i> and <i>Euphorbia</i> sp. pl.
8	Tiznit: Near Anezi	29°40'N 9°19'W	510	<i>Argania spinosa</i> , <i>Euphorbia</i> sp. pl.
9	Tiznit: 28 km N.W. Anezi, Addar	29°45'N 9°15'W	500	<i>Dracaena drago</i> , <i>Argania spinosa</i> , <i>Chamaerops humilis</i>
10	Tiznit: Aouzert	29°38'N 9°14'W	950	<i>Prunus dulcis</i>
11	Tiznit: Tizi-n-Tagounit	29°47'N 9°05'W	1600	<i>Quercus rotundifolia</i>
12	Tiznit: Jbel Leskt	29°48'N 9°01'W	1850	<i>Quercus rotundifolia</i>
13	Tata: Had-Tahala	29°36'N 9°08'W	1000	<i>Maytenus senegalensis</i>
14	Tata: near Tafraout	29°44'N 8°54'W	1200	<i>Argania spinosa</i>
15	Tata: Tizi Mlil	29°43'N 8°50'W	1650	Subshrubs
16	Tata: Tisgui Ida-Ou-Baloul	29°43'N 8°29'W	975	Subshrubs
17	Tata: Targannt	29°53'N 7°38'W	860	<i>Phoenix dactylifera</i>
18	Tata: 15 km N. of Akka-Irhèn	30°03'N 7°37'W	950	<i>Nerium oleander</i> , <i>Retama</i> sp.
19	Tata: Tisnassemine	30°02'N 7°48'W	1200	<i>Nerium oleander</i> , <i>Retama</i> sp.
20	Taroudannt: Near Igherm	30°03'N 8°27'W	1675	Subshrubs
21	Taroudannt: Igherm	30°04'N 8°27'W	1800	Subshrubs
22	Taroudannt: Agadir-Melloul	30°15'N 7°48'W	1700	<i>Tamarix</i> sp., <i>Populus</i> sp., <i>Nerium oleander</i>
23	Taroudannt: N. of Tamjercht	30°26'N 7°50'W	1540	Subshrubs
24	Ouarzazate: mountain S. of Ambed, 19 km E of Bou Azzer	30°32'N 6°39'W	1400	–
25	Ouarzazate: N side of Jbel Igthem, 25 km E. of Bou Azzer	30°31'N 6°40'W	1600	–
26	Ouarzazate: Jbel Sarho, E. of Tasettift	31°22'N 05°33'W	1260	Subshrubs
27	Ouarzazate: Jbel Sarho, Taourirt n-Irhial	31°19'N 05°36'W	1800	Subshrubs
28	Ouarzazate: Jbel Sarho, Khettart-n-Ikeddarn	31°17'N 05°35'W	1750	<i>Artemisia</i> shrubs
29	Ouarzazate: Erfoud-Tinejdad road, 47 km before Tinejdad	31°31'N 04°36'W	900	Subshrubs

Bartramia stricta Brid. — Sites: 6, 7, 9, 11, 14, 15. — Ledges and soil accumulated at the bases of quartzitic or igneous rocks. Also reported by Jelenc (1955) from Agadir n'Tafert and Jebel Leskt.

Brachythecium velutinum (Hedw.) Schimp. — Sites: 11, 12. — Fissures of quartzitic rocks and soil under *Quercus rotundifolia*. New for the Anti-Atlas.

Bryum argenteum Hedw. — Sites: 3, 5, 6, 8, 9, 10, 11, 12, 13, 27. — Fissures, ledges, scree, soils accumulated at the bases of calcareous, quartzitic and igneous rocks and open soils. New for the Anti-Atlas.

Bryum bicolor Dicks. — Sites: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 20, 21, 22. — Dry soils, ledges, fissures and soils accumulated on calcareous or igneous rocks. Also reported from Sidi Moussa, near Aglou (Gattefossé & Werner, 1935).

Bryum gemmilucens R. Wilczek & Demaret — Site: 10. — Open soil in almond tree crop. New for the Anti-Atlas.

Bryum muehlenbeckii Bruch & Schimp. — Sites: 6, 24. — Scree and wet rocks in stream. In the Northern Africa, this species had only been reported from Jbel Toubkal, High Atlas (Ros *et al.*, 2000). New for the Anti-Atlas.

Bryum radiculosum Brid. — Sites: 1, 16. — Scree and soil accumulated at the edge of an irrigation channel. New for the Anti-Atlas.

Bryum torquescens Bruch ex De Not. — Site: 11. — Soil under *Quercus rotundifolia*. New for the Anti-Atlas.

Crossidium aberrans Holz. & E.B. Bartram — Sites: 1, 11, 12, 13, 14, 15, 16, 18, 19, 20, 26, 28. — Open soils, fissures, screes, ledges and soils accumulated at the bases of calcareous or igneous rocks. New for the Anti-Atlas.

Crossidium crassinerve (De Not.) Jur. — Sites: 3, 8, 13, 16, 18, 22, 28. — Screes, ledges of calcareous or igneous rocks and bare soils. New for the Anti-Atlas.

Crossidium laevipilum Thér. & Trab. — Sites: 1, 2, 3, 5, 8. — Small depressions or open soils and soil accumulated at the bases of calcareous rocks. New for the Anti-Atlas.

Crossidium squamiferum (Viv.) Jur. — Sites: 1, 2, 3, 5, 6, 8, 9, 11, 13, 14, 15, 16, 20, 22, 23, 26. — Fissures, ledges, screes, soils accumulated at the bases of calcareous, quartzitic or igneous rocks and open soils. New for the Anti-Atlas.

Didymodon acutus (Brid.) K. Saito — Reported by Maire & Werner (1934) sub. *Barbula acuta* (Brid.) Brid. from Djebel Inter.

Didymodon australasiae (Hook. & Grev.) R.H. Zander — Sites: 1, 2, 3, 6, 7, 8, 9, 12, 13, 14, 15, 16, 20, 21, 22, 23, 26, 27, 28. — Screes, ledges, and soils accumulated at the bases of calcareous, quartzitic or igneous rocks and open soils. New for the Anti-Atlas.

Didymodon insulanus (De Not.) M.O. Hill — Sites: 11, 12. — Fissures of quartzitic rocks and soil under *Quercus rotundifolia*. New for the Anti-Atlas.

Didymodon rigidulus Hedw. — Sites: 1, 3, 4, 6, 8, 11, 13, 14, 15, 16, 20, 23. — Bare soils, screes, ledge, soils accumulated at the bases of calcareous or igneous rocks or at the edge of an irrigation channel. New for the Anti-Atlas.

Didymodon sicculus M.J. Cano, Ros, García-Zamora & J. Guerra — Sites: 17, 27. — On soil accumulated at the edge of an irrigation channel and ledge of basalt rock. It is similar to *D. luridus* but can be distinguished by its leaves occasionally bistratose, with papillose, 6-14 mm wide upper laminal cells, rectangular basal cells and recurved margins from near the apex to the base. Hitherto, it was only known from southeastern Iberian Peninsula (Cano *et al.*, 1996; Sánchez-Moya & Cano, 1999), Balearic Islands (Cano *et al.*, 2001) and Greece (Blockeel *et al.*, 2002). **New record for Africa.**

Didymodon vinealis (Brid.) R.H. Zander — Sites: 12, 13, 28. — Fissure, scree, ledge of basalt rock and bare soil. New for the Anti-Atlas.

Encalypta rhaptocharpa Schwägr. — Site: 6. — Soil accumulated at the bases of igneous rocks. New for the Anti-Atlas.

Encalypta vulgaris Hedw. — Sites: 6, 12, 15, 26. — Fissures, ledge and soils accumulated at the bases of igneous rocks. New for the Anti-Atlas.

Encalypta vulgaris* var. *mutica Brid. — Reported by Jelenc (1955) sub *Encalypta vulgaris* var. *obtusifolia* (Funck) Husn. from Jebel Sarhro, Amalou n'manssour.

Entosthodon hungaricus (Boros) Loeske — Reported by Meylan (1937) sub *Physcomitrium maroccanum* Meyl. from oued Noun.

Fabronia pusilla Raddi — Site: 12. — Ledge of basalt rock. Also, reported by Werner (1932) from Tizi-n-Tarhatine.

Fissidens curvatus Hornsch. — Site: 9. — Scree on quartzitic rock. New for the Anti-Atlas.

Fissidens crispus Mont. — Reported by Gattefossé & Werner (1935) sub *Fissidens herzogii* from gorges of Taderrast, S. oued Massa.

Fissidens sublimbatus Grout — Site 27. — Crevice of basalt rock. This species has recently been reported from Rif Cordillera and High Atlas in Morocco and Canary Islands (Ros *et al.*, 2001). New for the Anti-Atlas.

Funaria muhlenbergii Turner — Reported by Jelenc (1955) sub *Funaria dentata* var. *mediterranea* (Lindb.) J.J. Amann from Jbel Inter.

Funaria pulchella H.Philib. — Reported by Frahm (1988) between Touroy and Achouria, along the Tinerhir-Tafilalt road.

Gigaspermum mouretti Corb. — Reported by Frahm (1988) from W. Anti-Atlas by Tafroute.

Grimmia anodon Bruch & Schimp. — Sites: 21, 28. — Fissures of travertine and basalt rocks. New for the Anti-Atlas.

Grimmia alpestris (F. Weber & D. Mohr) Schleich. ex Hornsch.— Reported by Jelenc (1955) from Jebel Sarhro: Amalou n'manssour.

Grimmia laevigata (Brid.) Brid. — Sites: 6, 7, 11, 12, 13, 15, 21.— Exposed quartzitic or igneous rocks. Also reported from Taliouine, Tizi n'Taratine sub *Grimmia campestris* Burch. ex Hook. (Werner, 1932).

Grimmia orbicularis Bruch ex Wilson — Sites: 20, 22, 23, 26, 28.— Soil accumulated on basalt rock, limestone and fissures of travertine. New for the Anti-Atlas.

Grimmia ovalis (Hedw.) Lindb. — Sites: 7, 11, 12, 15, 21.— Exposed quartzitic or igneous rocks. New for the Anti-Atlas.

Grimmia pulvinata (Hedw.) Sm. — Sites: 2, 11, 12, 26, 28. — Ledges of basalt rock or quartzitic rocks. New for the Anti-Atlas.

***Gymnostomum* sp.** — Jelenc (1955) reported *Hyophylla perpusilla* Thér. & Trab. from Ait el Hadj. We have not been able to study this record. However, according to Cano *et al.* (2000), the type material of *Hyophylla perpusilla* corresponds to a species of *Gymnostomum* (*G. lanceolatum* M.J. Cano, Ros & J. Guerra or *G. mosis* (Lorentz) Jur. & Milde) with bistratose margined leaves.

Gymnostomum viridulum Brid. — Sites: 1, 8, 11, 14, 16, 27. — Screes, ledge of igneous rocks and soil accumulated at the edge of an irrigation channel. Also reported from S of Agadir along road S509 2-3 km S. of Ait Baha, Tafraoute and between Touroy and Achouria, along the road Tinerhir-Tafilalt sub *Gymnostomum luisieri* (Sérgio) Sérgio ex Crundw. (Frahm, 1988).

Hymenostylium hildebrandtii (Müll. Hal.) R.H. Zander (Fig. 2). — Site: 27. — Ledge of basalt rock. It can be distinguished from other species of

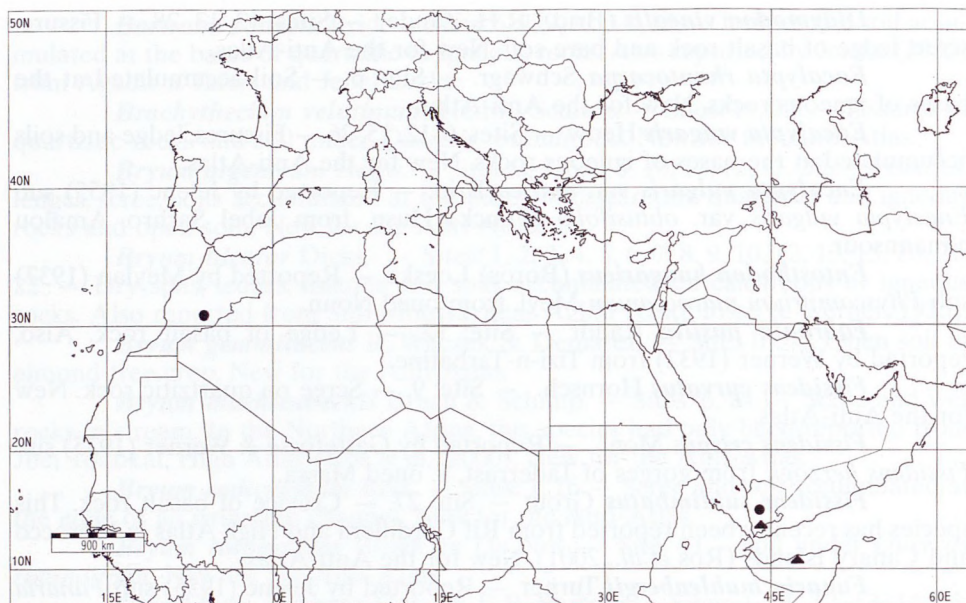


Fig 2. Distribution of *Hymenostylium hildebrandtii* (Müll.Hal.) R.H. Zander based on literature records (▲) and studied material (●).

Hymenostylium by its lingulate to short-lanceolate or spatulate leaves and obtuse or acute apex (Müller, 1876). According to Kürschner (1998), it is a paleotropical species known only from Somalia and Yemen. In these localities, the species grows mainly in xero-tropical habitats influenced by the summer monsoons, together with other tropical species such as *Pleurochaete malacophylla* (Mül. Hal) Broth., *Lejeunea aethiopica* E.W. Jones, *Tortula porphyreoneura* (Müll. Hal) C.C. Towns., etc. In the Jebel Sarhro, the tropical influence is less, growing in association with more xerophytic species such as *Didymodon australasiae*, *Pottia starckeana* (Hedw.) Müll. Hal., *Targionia hypophylla* L. and *Tortula atrovirens* (Sm.) Lindb. With this record, the distribution area of *H. hildebrandtii* is extended to the north-western part of Africa. New record for the Maghreb.

Orthotrichum rupestre Schleich. ex Schwägr. — Site: 12. — On quartzitic rock. New for the Anti-Atlas.

Pleurochaete squarrosa (Brid.) Lindb. — Sites: 2, 6, 9, 11, 12, 13, 15. — Ledges and soil accumulated at bases of calcareous and basalt rocks. New for the Anti-Atlas.

Pottia starckeana (Hedw.) Müll. Hal. — Sites: 1, 27, 28. — Soil accumulated at the edge of an irrigation channel and ledges of basalt rock. New for the Anti-Atlas.

***Pottia starckeana* agg.** (Hedw.) Müll. Hal. — Site: 12. — On bare soil.

Pseudocrossidium hornschurchianum (Schultz) R.H. Zander — Sites: 6, 9, 13. — Screes and soil at the base of igneous or quartzitic rocks. New for the Anti-Atlas.

Pterygoneurum ovatum (Hedw.) Dixon — Sites: 5, 23. — Small depression in open soil and fissures of travertine. New for the Anti-Atlas.

Schistidium flaccidum (De Not.) Ochyra — Site: 11. — Ledge of basalt rock. New for the Anti-Atlas.

Scleropodium touretii (Brid.) L.F. Koch — Site: 11. — Ledge of basalt rock. Also, reported by Jelenc (1955) sub *Scleropodium illecebrum* Schimp. from Jebel Leskt .

Syntrichia calcicola J.J. Amann — Sites: 21, 22. — Soil accumulated on igneous rock and ledge of limestone. New for the Anti-Atlas.

Syntrichia caninervis Mitt. — Sites: 21, 23.— On igneous rock and fissures of travertine. This species has recently been reported from Morocco (Gallego *et al.*, in press). New for the Anti-Atlas.

Syntrichia caninervis var. *gypsophila* (J.J. Amann ex G. Roth) Ochyra — Site: 3. — On bare soil. This taxon has recently been reported from Morocco (Gallego *et al.*, in press).

Syntrichia fragilis (Taylor) Ochyra — Site: 25. — Soil under shade of basalt cliff. New for the Anti-Atlas.

Syntrichia minor (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & Sánchez-Moya. (Fig. 3) — Sites: 11, 15. — Soil on granitic or basalt rock. It is close to *Syntrichia virescens* (De Not.) Ochyra, but can mainly be distinguished by the type of papillosity on the laminal leaf cells (1 pedicellate and branched papillae per cell, which is 12-17 μm in length, in *S. minor* and 2-4(5) bifurcate papillae, whose length does not exceed 5 μm in *S. virescens*). Previously, it was reported from Lebanon, Cyprus and Spain (Gallego *et al.*, 2000) and recently from Greece (Blockeel *et al.*, 2002). Also, we report this species from the Canary Islands [La Palma, Caldera de Taburiente, Mirador de los Andenes, 28°46'N 17°52'W, 2350 m., 2 Aug 2000, M.J. Cano s.n.]. **New record for Africa.**

Syntrichia papillosissima (Copp.) Loeske — Site: 12. — On quartzitic rocks. New for the Anti-Atlas.

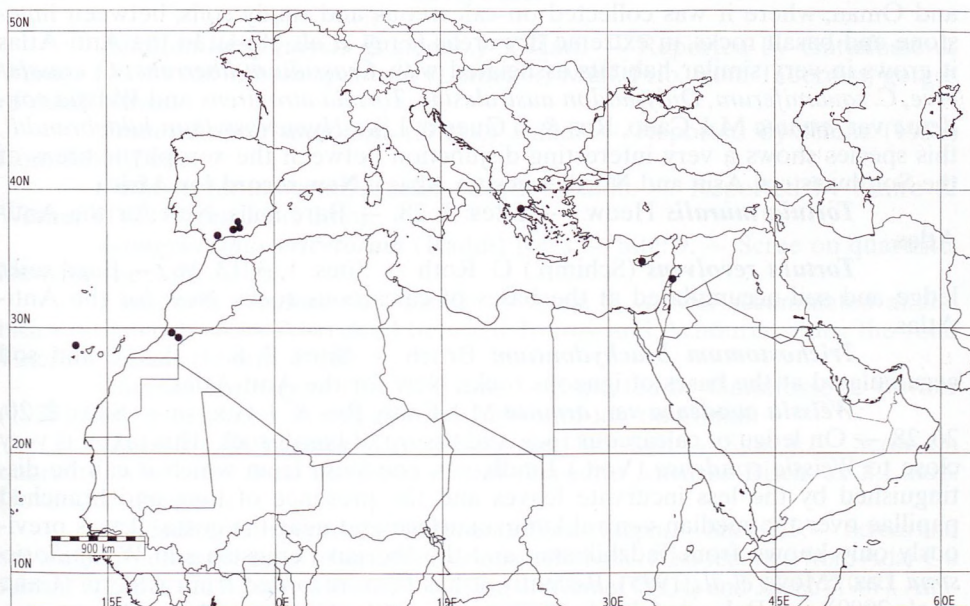


Fig. 3. Distribution of *Syntrichia minor* (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & Sanchez-Moya.

Syntrichia princeps (De Not.) Mitt. — Sites: 11, 12. — Soil under *Quercus rotundifolia*. New for the Anti-Atlas.

Syntrichia ruralis (Hedw.) F. Weber & D. Mohr — Reported by Jelenc (1967) from Agadir n'Tigfert (Agadir n'Tiferch?) sub *Tortula ruralis* (Hedw.) P. Gaertn., B. Mey. & Scherb.

Scorpiurium deflexifolium (Solms) M. Fleisch. & Loeske — Site: 6. — Soil accumulated at the bases of igneous rocks. New for the Anti-Atlas.

Tortula atrovirens (Sm.) Lindb. — Sites: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 21, 22, 23, 26, 27, 28, 29. — Bare soils, fissures, screes, ledges and soils at the base of calcareous, quartzitic or igneous rocks. Also reported from Jebel Ighern (Jelenc, 1955). In the study area, we have found some samples buried in soil, showing leaves with supracostal filaments, 2(3) cells high (sites 3, 5 and 8). This form has been described as *Crossidium davidai* Catches. (Cano *et al.*, 1993; Dirkse & Bouman, 1995; Stern, 1995), but we think that, at least for the material from Morocco, it is only a modification of *T. atrovirens* in very dry conditions.

Tortula cuneifolia (With.) Turner — Sites: 6, 9, 11, 12. — Bare soil, scree and soil at the bases of quartzite and basalt rocks. Also reported by Gattefossé & Werner (1935) from Arba des Aït Baha.

Tortula inermis (Brid.) Mont. — Sites: 11, 12, 15, 21, 22, 26, 28. — Ledges, fissures or soil accumulated on calcareous or igneous rocks. Also reported from Jbel Sarhro, Tizi n Tazazerte by Jelenc (1967).

Tortula mucronifera W. Frey, Kürschner & Ros (Fig. 4) — Sites: 26, 28. — Ledges and fissure of basalt rock. It is easily characterized by its ovate-elliptic to linguulate-spathulate leaves, with revolute margins, mucronate apex, costa thickened ventrally by a row of 3-4 elongated, swollen, papillose cells and a short peristome of 32 filiform, irregular by broken, not twisted teeth. Although the material from Morocco has no sporophyte, we have been able to identify the species on the basis of its gametophytic characters. It was only known from Saudi Arabia, Yemen and Oman, where it was collected on calcareous and sandy soils, between limestone and basalt rocks, in extreme dry areas (Frey *et al.*, 1994). In the Anti-Atlas it grows in very similar habitats associated with *Crossidium aberrans*, *C. crassinerve*, *C. squamiferum*, *Didymodon australasiae*, *Tortula atrovirens* and *Weissia condensa* var. *armata* M.J. Cano, Ros & J. Guerra. Like *Hymenostylium hildebrandtii*, this species shows a very interesting disjunction between the xerophytic areas of the Southwestern Asia and Northernwestern Africa. **New record for Africa.**

Tortula muralis Hedw. — Sites: 3, 28. — Bare soils. New for the Anti-Atlas.

Tortula revolvens (Schimp.) G. Roth — Sites: 1, 3, 13, 16. — Bare soils, ledge and soil accumulated at the bases of calcareous rocks. New for the Anti-Atlas.

Trichostomum brachydontium Bruch — Sites: 7, 8. — Scree and soil accumulated at the bases of igneous rocks. New for the Anti-Atlas.

Weissia condensa var. *armata* M.J. Cano, Ros & J. Guerra — Sites: 2, 20, 26, 28. — On ledge of calcareous rock and fissure of basalt rock. This taxon is very close to *Weissia condensa* (Voit.) Lindb. var. *condensa* from which it can be distinguished by the less incurvate leaves and the presence of long and branched papillae over the median ventral lamina surface and near the costa. It was previously only known from Tadzhikistan and the Iberian Peninsula sub *W. papillosissima* Laz. (Moya *et al.*, 1995). Recently, it has been recorded from Algeria (Cano *et al.*, 2000) and Balearic Islands (Cano *et al.*, 2001). New record for Morocco.

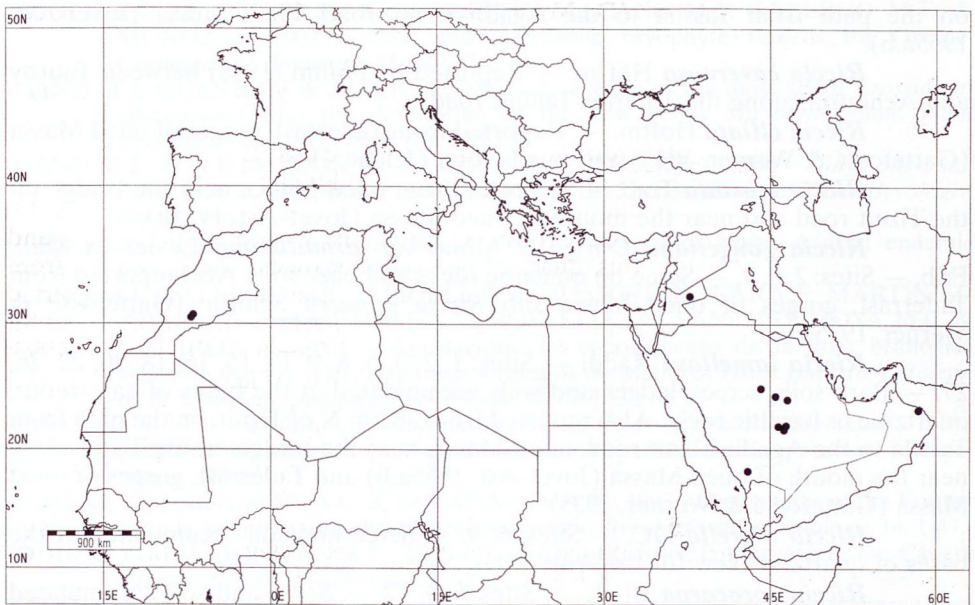


Fig. 4. Distribution of *Tortula mucronifera* W. Frey, Kürschner & Ros.

Liverworts

Athalamia spathysii (Lindenb.) S. Hatt. — Reported by Gattefossé & Werner (1935) sub *Clevea spathysii* (Lindenb.) Müll. Frib. from Taderrast, gorges of oued Massa.

Fossombronia angulosa (Dicks.) Raddi — Reported by Jelenc (1955) from Jebel Leskt.

Fossombronia wondraczekii (Corda) Lindb. — Reported by Maire & Werner (1934) from Jebel Inter.

Gongylanthus ericetorum (Raddi) Nees — Site: 9. — Scree on quartzite. New for the Anti-Atlas.

Lunularia cruciata (L.) Lindb. — Sites: 6. — Soil accumulated at the bases of igneous rocks. Also cited between Touroy and Achouria, along the road Tinerhir-Tafilalt (Frahm, 1988).

Mannia androgyna (L.) A. Evans — Reported by Gattefossé & Werner (1935) from Jebel Leskt, Arbas des Aït Baha and Ida ou Gnidif.

Oxymitra incrassata (Brot.) Sérgio & Sim-Sim — Site: 9. — Scree on quartzite. Also cited from oued Massa sub *Oxymitra paleacea* Bisch. ex J. Lindb. (Jovet-Ast, 1955a,b).

Plagiochasma rupestre (J.R. Forst. & G. Forst.) Steph. — Sites: 2, 9. — Screes and soil accumulated at the bases of limestone or quartzitic rocks. Also reported from Adar Ou Amane sub *Aytonia rupestre* J.R.Forst. by Maire & Werner (1934) and Jelenc (1967), Anti-Atlas (Bischler, 1978) and Tafroute (Frahm, 1988).

Riccia atromarginata Levier — Sites: 1, 2, 3, 5, 16. — Bare soils, scree and soil accumulated at the bases of limestone rocks. Also cited 38 km N. of Tiznit,

on the path from Tassila to the Agadir-Tiznit road, oued Massa (Jovet-Ast, 1955a,b).

Riccia cavernosa Hoffm. — Reported by Frahm (1988) between Touroy and Achouria, along the Tinerhir-Tafilalt road.

Riccia ciliata Hoffm. — Reported from Taderrast, gorges of oued Massa (Gattefossé & Werner, 1935) and oued Noun (Jelenc, 1955).

Riccia crustata Trab. — Reported from oued Massa, near the bridge on the Tiznit road and near the mouth of oued Massa (Jovet-Ast, 1955b).

Riccia gougetiana Durieu & Mont. var. ***armatissima*** Levier ex Müll. Frib. — Sites: 2, 8, 9. — Scree on quartzitic rocks and bare soils. Also reported from Taderrast, gorges of oued Massa *sub Riccia erinacea* Schiffn. (Gattefossé & Werner, 1935).

Riccia lamellosa Raddi — Sites: 1, 2, 3, 5, 8, 9, 13, 15, 16, 18, 20, 22, 26, 27. — Bare soils, screes, ledges and soils accumulated at the bases of calcareous, quartzitic or basaltic rocks. Also reported from 38 km N of Tiznit, on the path from Tassila to the Agadir-Tiznit road, oued Massa, near the bridge on the Tiznit road, near the mouth of oued Massa (Jovet-Ast, 1955a,b) and Taderrast, gorges of oued Massa (Gattefossé & Werner, 1935).

Riccia nigrella DC. — Sites: 6, 9. — Scree and soil accumulated at the bases of quartzite. New for the Anti-Atlas.

Riccia sorocarpa Bisch. — Sites: 6, 9, 12. — Scree and soil accumulated at the bases of quartzitic rocks. Also reported on the path from Tassila to the Agadir-Tiznit road, oued Massa, near the bridge on the Tiznit road (Jovet-Ast, 1955a,b), Taderrast, gorges of oued Massa (Gattefossé & Werner, 1935) and Jebel Inter (Maire & Werner, 1934).

Riccia trabutiana Steph. — Site: 1. — Soil accumulated at the bases of calcareous rocks. Also reported by Jovet-Ast (1955a) *sub Riccia atromarginata* var. *glabra* Levier ex Müll. Frib. on the path from Tassila to the Agadir-Tiznit road and near the mouth of oued Massa.

Riccia trichocarpa Howe — Reported from oued Massa, near the bridge on the Tiznit road (Jovet-Ast, 1955b).

Targionia hypophylla L. — Sites: 1, 2, 6, 7, 8, 9, 11, 12, 13, 14, 15, 27. — Screes, ledges or soils accumulated at the bases of calcareous, quartzitic or igneous rocks. Also reported from Adrar Ou Amane (Maire & Werner, 1934; Jelenc, 1967) and oued Massa, near the bridge on the Tiznit road *sub Targionia lorbeeriana* Müll. Frib. (Jovet-Ast, 1955a, 1956).

Acknowledgements. We are grateful to S.L. Jury (University of Reading) for sending his Moroccan collections and H. Kürschner for the gift of one specimen for comparison of *Hymenostylium hildebrandtii* from Yemen. Also, we thank J. Muñoz by his help in the field. This research was carried out with financial aid from the National Geographic Society (Grant 6708-00).

REFERENCES

- BENABID A. & CUZIN F., 1997 — Populations de dragonnier (*Dracaena draco* L. subsp. *ajgal* Benabid et Cuzin) au Maroc: valeurs taxinomique, biogéographique et phytosociologique. *Comptes Rendus de l'Académie des Sciences, Série 3, Sciences de la Vie* 320: 267-277.
- BISCHLER H., 1978 — *Plagiochasma* Lehm. et Lindenb. II. Les taxa européens et africains. *Revue Bryologique et Lichénologique* 44: 323-300.

- BLOCKEEL T.L., ROS R.M., SABOVLJEVIĆ M., CANO M.J., GALLEGO M.T., & MUÑOZ J., 2002 – New and interesting bryophyte records for Greece. *Cryptogamie, Bryologie* 23: 149-155.
- CANO M.J., GUERRA J. & ROS R.M., 1993 – A revision of the moss genus *Crossidium* (Pottiaceae) with the description of the new genus *Microcrossidium*. *Plant Systematics and Evolution* 188: 213-235.
- CANO M.J., ROS R.M., GARCÍA-ZAMORA P. & GUERRA J., 1996 – *Didymodon sicculus* sp. nov. (Bryopsida, Pottiaceae) from the Iberian Peninsula. *The Bryologist* 99: 401-406.
- CANO M.J., ROS R.M. & GUERRA J., 2000 – Identity of North African endemic bryophytes I. *Journal of Bryology* 22: 269-272.
- CANO M.J., GALLEGO M.T., GARILLETI R., JUARISTI R., LARA F., MARTÍNEZ-ABAIGAR J., MAZIMPAKA V., ROSELLÓ J.A., SÁNCHEZ-MOYA M.C. & URDÍROZ 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.
- CHARCO J., 1999 – *El bosque mediterráneo en el norte de África. Biodiversidad y lucha contra la desertificación*. Madrid. Agencia Española de Cooperación Internacional, 370 p.
- DIRKSE G.M., BOUMAN A.C. & LOSADA-LIMA A., 1993 – Bryophytes of the Canary Islands, an annotated checklist. *Cryptogamie, Bryologie et Lichénologie* 14: 1-47.
- DIRKSE G.M. & BOUMAN A.C., 1995 – *Crossidium* (Musci, Pottiaceae) in the Canary Islands (Spain). *Lindbergia* 20: 12-25.
- FRAHM J.P., 1988 – Bemerkenswerte Laubmoosfunde aus Nordafrika. *Cryptogamie, Bryologie et Lichénologie* 9: 231-234.
- FREY W., KÜRSCHNER H., ROS R.M., GUERRA J. & CANO M.J., 1994 – *Tortula mucronifera* (Pottiaceae, Musci), a new xerophytic species of the Arabian Peninsula and Jordan. *Nova Hedwigia* 59: 345-351.
- GALLEGO M.T., CANO M.J., ROS R.M. & GUERRA J., 1999 – The genus *Aloina* (Pottiaceae, Musci) in the Mediterranean Region and neighbouring areas. *Nova Hedwigia*: 69: 173-194.
- GALLEGO M.T., GUERRA J., CANO M.J., ROS R.M. & SÁNCHEZ-MOYA M.C., 2000 – The status and distribution of *Syntrichia virescens* var. *minor* (Bizot) Ochrya. *The Bryologist* 103: 375-378.
- GATTEFOSSÉ J. & WERNER R.G., 1935 – Contribution à la Flore Cryptogamique du Maroc. Fascicule XI. *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord* 26: 72-84.
- GALLEGO M.T., CANO M.J., ROS R.M. & GUERRA J., in press – New taxonomic data on a Circum-Tethyan group of *Syntrichia* (Pottiaceae, Bryophyta): the *S. caninervis* complex. *Systematic Botany*.
- JELENC F., 1955 – *Muscinées de l'Afrique du Nord (Algérie, Tunisie, Maroc, Sahara)*. Oran, L. Fouque, 152p. [extrait de *Bulletin de la Société de Géographie et d'Archéologie de la Province d'Oran* 1949-1953, tomes 72-76]
- JELENC F., 1967 – Muscinées de l'Afrique du Nord (Supplément). *Revue Bryologique et Lichénologique* 35: 186-215.
- JIMÉNEZ J.A., ROS R.M., CANO M.J. & GUERRA J., 2002a – Vegetación briofítica terrícola y saxícola de del Jbel Bouhalla (Cordillera del Rif, Marruecos). *Phytocoenologia* 32: 3-28.
- JIMÉNEZ J.A., ROS R.M., CANO M.J. & GUERRA J., 2002b – Contribution to the bryophyte flora of Morocco: terricolous and saxicolous bryophytes of the Jbel Bouhalla. *Journal of Bryology* 24: 243-246.
- JOVET-AST S., 1955a – *Riccia atomarginata* Lev. et sa variété *glabra* Lev. au Maroc. *Revue Bryologique et Lichénologique* 24: 240-247.
- JOVET-AST S., 1955b – Hépatiques marocaines-I. *Bulletin de la Société des Sciences Naturelles du Maroc* 35: 265-282.
- JOVET-AST S., 1956 – Hépatiques Marocaines-II. *Bulletin de la Société des Sciences Naturelles du Maroc* 36: 43-60.

- KÜRSCHNER H., 1998 – *Hymenostylium hildebrandtii* (C. Müll.) Zander (Pottiaceae, Musci), and further new and interesting records to the moss flora of Yemen and Socotra. *Studies in Arabian bryophytes* 22. *Nova Hedwigia* 67: 457-467.
- MAIRE R. & WERNER R.G., 1934 – Contribution à la Flore Cryptogamique du Maroc. Fascicule IV. *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord* 25: 40-60.
- MEYLAN C., 1937 – Note sur une nouvelle espèce de *Physcomitrium*. *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord* 28: 42-427.
- MOYA J.J., ROS R.M., GUERRA J. & CANO M.J., 1995 – *Weissia papillosissima* Laz. (Pottiaceae, Musci), a species new to the European Bryophyte Flora. *Journal of Bryology* 18: 493-498.
- MÜLLER, C., 1876 – Musci Hildebrandtiani, in Archipelago Comorensi et in Somalia litoris Africani anno 1875 ab I.M. Hildebrandt lecti. *Linnaea* 40: 225-300.
- O'SHEA B.J., 1999 – Checklist of the mosses of sub-Saharan Africa (version 3, 11/99). *Tropical Bryology Research Reports* 1: 1-133.
- ROS R.M., CANO M.J. & GUERRA J., 1999 – Bryophyte checklist of Northern Africa. *Journal of Bryology* 21: 207-244.
- ROS R.M., CANO M.J., MUÑOZ J. & GUERRA J., 2000 – Contribution to the bryophyte flora of Morocco: the Jbel Toubkal. *Journal of Bryology* 22: 283-289.
- ROS R.M., JIMÉNEZ J.J., CANO M.J., PURSELL R.A., BRÜGGEMAN-NANNENGA M.A. & DIRKSE G.M., 2001 – *Fissidens sublimbatus*, new to Morocco and the Canary Island. *The Bryologist* 104: 468-470.
- RUIZ-LASO A., 1986 – *Geología y Biología de Marruecos en itinerarios didácticos*. Madrid. Instituto Hispano-Árabe de Cultura, 159 p.
- SÁNCHEZ-MOYA M.C. & CANO M.J., 1999 – Adiciones a la flora briofítica del sudeste de España. La sierra minera de La Unión (Murcia). *Boletín de la Sociedad Española de Briología* 14: 9-12.
- STERN R.C., 1995 – *Crossidium davidai* in the Canary Islands. *Journal of Bryology* 18: 621-622.
- WERNER R.G., 1932 – Contribution à la Flore Cryptogamique du Maroc. Fascicule VIII. *Revue Bryologique et Lichénologique* 5: 210-228.
- WIGGINTON M.J., 2002 – Checklist and distribution of the liverworts and hornworts of sub-Saharan Africa, including the East African Islands (version 1, 2/02). *Tropical Bryology Research Reports* 3: 1-88.