A new bryophytic community from the mountains of southern Spain and Morocco:
*Tortula subulatae-Syntrichietum ruralis*

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**Abstract** — *Tortula subulatae-Syntrichietum ruralis* is proposed as a new bryophytic association from high mountain grasslands of southern Spain and Morocco. This new community is described and characterized. © ADAC / Elsevier, Paris

bryophyte vegetation / SE Spain / Morocco / Mediterranean region

**Resumen** — Se propone una nueva asociación briofítica, *Tortula subulatae-Syntrichietum ruralis*, de pastizales de alta montaña del sur de España y Marruecos. La nueva comunidad es descrita y caracterizada. © ADAC / Elsevier, Paris

vegetación briofítica / SE España / Marruecos / región Mediterránea

**INTRODUCTION**

Although the terricolous vegetation from southeastern Spain is relatively well-known (e.g. Ros & Guerra, 1987; Cano et al., 1997; García-Zamora, 1997), very little has been published on acrophilous communities. This is especially true of those which occur in the oro-Mediterranean belt, since this termotype is not very extensive in the study area.

A vegetation transect made in Sierra de Filabres in Almería province (2,168 m), revealed a community in orophilous pastures which was characterized floristically by *Syntrichia ruralis* (Hedw.) F. Weber & D. Mohr (which does not include *Syntrichia calcicola* J.J. Amann species), *S. ruralis* var. *arenicola* (Braithw.) J.J. Amann, *Tortula subulata* Hedw., *Tortula subulata* var. *subinermis* (Bruch & Schimp.) Wilson and frequently by *Encalypta vulgaris* Hedw., *Pseudocrossidium hornschuchianum* (Schultz) R.H. Zander, *Didymodon Hedw.* sp. pl. and *Pterygoneurum ovatum* (Hedw.) Dixon, in addition to other annual taxa. The same floristic composition has been observed in other provinces of southern Spain, such as, Alicante, Granada Jaén and Murcia, where the community grows in the same ecotypes, and in the Rif, High Atlas and Middle Atlas of Morocco. With this paper, we provide new data about the bryophytic vegetation of Northern Africa, since, to date, only the paper of Ros et al. (1990) has been published.
Tab. 1. *Tortula subulatae-Syntrichium ruralis* ass. nov.

<table>
<thead>
<tr>
<th>Relevé number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of relevé (dm²)</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td>25</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cover value (%)</td>
<td>50</td>
<td>30</td>
<td>60</td>
<td>70</td>
<td>85</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>Inclination (°)</td>
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<td>0</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exposure</td>
<td>-</td>
<td>-</td>
<td>N</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of species</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Altitude (m)</td>
<td>18.9</td>
<td>16</td>
<td>21.6</td>
<td>24</td>
<td>10</td>
<td>16</td>
<td>21</td>
</tr>
</tbody>
</table>

Characteristic species of association (*Tortula subulatae-Syntrichium ruralis*)

*Syntrichium ruralis* (including var. arenicola) | 3 | 1 | 1 | 2 | 4 | 3 | 1 |
*Tortula subulata* (including var. subinermis) | 1 | - | 1 | 1 | - | - | 2 |

Characteristic species of alliance (*Grimaldion fragrans*)

*Encalypta vulgaris* | - | - | - | - | - | - | - |
*Pterygoneurum ovatum* | - | - | 1 | - | - | 1 | + |
*Pseudocrossidium hornschuchianum* | - | - | - | - | + | - | - |
*Pleurochaete squarrosa* | - | - | - | - | - | - | - |
*Didymodon virensis* | - | - | - | - | - | - | - |
*Phascum cuspidatum* (included var. retortifolium) | - | - | - | - | - | - | - |
*Potnia lanceolata* | - | - | - | - | - | - | - |

*Didymodon lirius* in 17 and + in 19; *Didymodon insulanus* 3 in 19.

Characteristic species of order and class (*Barbuletales anguiculatae, Barbuleteae anguiculatae*)

*Bryum bicolor* | - | - | 3 | - | + | 2 | 3 |
*Bryum torquescens* | - | - | + | - | + | - | 1 |
*Homalothecium aureum* | - | - | - | - | - | - | - |
*Bryum duneense* | - | - | - | - | - | - | - |
*Didymodon acutus* | - | - | - | - | 1 | - | - |

*Bryum canariense* in 9; *Weisia sp.* + in 10; *Didymodon rigidulus* 1 in 11 and 1 in 13; *Riccia tomescuei* 1 in 12; *Barbulav convoluta* 3 in 13 and 1 in 18; *Barbula anguiculata* 1 in 16 and 1 in 17; *Didymodon fallax* 1 in 16 and 1 in 17; *Potnia braunii* + in 16 and 2 in 17; *Didymodon australis* + in 19; *Tortula atrovirens* + in 19.

Other species:

*Ceratosgon purpureus* | 1 | 3 | - | + | - | - | - |
*Bryum argenteum* | - | 1 | - | 1 | - | 2 | + |
*Bryum sp.* | 1 | 1 | - | 3 | - | - | - |

*Syntrichia intermedia* in 9; *Bryum alpinum* 1 in 14; *Funaria hygrometrica* 1 in 14; *Pohlia sp.* + in 16.

Relevés origin: 1: Morocco, Middle Atlas, Jebel Bou Iblane, mountain refuge of Tafert, 33°19’N 4°09’W; 2: Morocco, Rif, Jebel Bouhallia, 35°08’N 5°08’W; 3, 7, 8: Spain, Almezeta, Sierra de Filabres, Catar Alto (Cérguel), W39329; 4: Morocco, High Atlas, 5 km before Oukaimeden, 31°14’N 7°49’W; 5: Spain, Alicante, Puerto de Benifallim (Benifallim), Y12680; 6: Spain, Granada, Puente del Pinar (Puebla de Don Fadrique), W14551; 9 and 17: Spain, Murcia, Sierra de los Alamos, Cenajo del Agua Cerada (Moratalla), W188829; 10: Morocco, Middle Atlas, Jebel Tazeka, 34°03’N 4°09’W; 11: Morocco, High Atlas, Oukaimeden, 31°12’N 7°51’W.

**METHODOLOGY**

The bryophyte vegetation was studied using the plant sociology methods of *Braun-Blanquet* (1979). Only the cover-abundance index was used. The sociability index
Tab. I (suite)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 4 | 4 | 4 | 4 | 9 | 25 | 16 | 16 | 9 | 4 | 4 | 25 | 30 | 30 | 60 | 60 | 90 | 80 | 60 | 60 |
| 30 | 20 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 5 | 0 | 20 | 15 | 30 | NW | N | N | - | - | - | N | E | - | E | N | N |
| 6 | 6 | 6 | 6 | 8 | 8 | 8 | 9 | 9 | 10 | 11 | 20 | 25.5 | 17 | 13 | 17 | 12 | 17 | 10 | 13 | 11 |

1: + | 2: 1 | 1: 1 | 1: 2 | 1: 3 | + | 2 | 1 | V |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 4 | 4 | 4 | 4 | 9 | 25 | 16 | 16 | 9 | 4 | 4 | 25 | 30 | 30 | 60 | 60 | 90 | 80 | 60 | 60 |
| 30 | 20 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 5 | 0 | 20 | 15 | 30 | NW | N | N | - | - | - | N | E | - | E | N | N |
| 6 | 6 | 6 | 6 | 8 | 8 | 8 | 9 | 9 | 10 | 11 | 20 | 25.5 | 17 | 13 | 17 | 12 | 17 | 10 | 13 | 11 |

1: + | 2: 1 | 1: 1 | 1: 2 | 1: 3 | + | 2 | 1 | V |

12: Spain, Jaén, Sierra de Segura, near Cañada de las Fuentes (Peñal de Becerro), WH2911; 13: Spain, Jaén, Sierra de Cazorla, near Cañada de las Fuentes (Peñal de Becerro), WH2087; 14: Spain, Almería, Sierra de Filabres, barranco de Mogatón (Bacares), WG44125; 15: Spain, Almería, Sierra de Martín, near rastro mastic (Aguas YH1694; 16: Spain, Jaén, Sierra de Segura, arroyo de los Cortales (Santiago de la Espada), WH2705; 17: Spain, Murcia, Sierra de Moratalaz, Pantalón de la Vieja (Moratalaz), WH7923; 18: Spain, Almería, Sierra de Filabres, Cerro de Santiago (Olula de Castro), WG4511.

was not taken into account because of the protonematous moss growth. Cover-abundance was estimated according to the following scales: +: <1 %; 1: 1–10 %; 2: 10–25 %; 3: 25–50 %; 4: 50–75 %; 5: 75–100 %.
The nomenclature followed for the communities was that of Marstaller (1993), for mosses and liverworts, that of Corley et al. (1981), Corley & Crundwell (1991) and Grollie (1983) except in the case of Synrichia Brid. genus, for which Zander (1993) was followed.

DESCRIPTION OF THE COMMUNITY

*Tortulo subulatae-Synrichietum ruralis ass. nov.*

**Syntype:** Tab. 1, holosyntype: Relevé 8.

This new community occurs in stony grasslands of high mountain zones, which are frequently nitrified, exposed and sunny. The community is terricolous, xerophilous and photophilous and grows in both acidic and basic soils. In the studied area, it appears in the supra- and oro-Mediterranean belts, with dry ombrotypes, from 1000 m in Alicante and Murcia to 2550 m in some localities of the High Atlas in Morocco.

The relatively high coverage that the association shows in some cases, with a mean value of 62.4%, is of particular note. Characteristic species usually grow in clearings of Poetes vulgaris Godoy & Rivas-Martínez in Rivas-Martínez 1978, almost always in the domain of shrubs of Erechimetum anthyllidum Quézel 1951. The community comprises a great number of colonist taxa. This life strategy is shown by the characteristic species of the association, Synrichia ruralis (including var. arenicola) (V) and Tortula subulata (including var. subinermis) (II). Other colonist species characteristic of the alliance, order and class are B. bicolor Dicks. (III), Pseudocrossidium horncschuchianum (II), Bryum torquescens Bruch & Schimp. (II) and different species of the genus Didymodon (D. vinealis (Brd.) R.H. Zander (II), D. luridus Hornsch. ex Spreng. (I), D. fallax (Hedw.) R.H. Zander (I), etc.). Moreover, some perennial species, e.g. Pleurochaeta squarrosa (Brd.) Lindb. (II) and short-lived shuttle species such as Encalypta vulgaris (II) and Pierogyneum ovatum (II) are present. The high frequency of colonist species can be attributed to the climatic conditions to which the community is exposed, with snow covering the area during a great part of the year. At the end of spring the community can be rich in annual shuttle species such as Phascum cuspidatum Hedw. (I) and Pottia bryoides (Dicks.) Mitt. (I) as the snow melts and temperatures increase.

The new community can grow in basic and acidic soils. In the latter case, acidophile species such as Ceratodon purpureus (Hedw.) Brd. (relevés 1, 2, 4, 10–12 and 14) and Bryum alpinum With. (relevé 14) are usually present. The presence of Bryum argenteum Hedw., Phascum cuspidatum s. l. and in some cases Funaria hygrometrica Hedw., suggests relatively high levels of nitrification in the soils occupied by this association.

An analysis of the chorological elements of the species in the community described shows that the most frequent elements are the temperate (37.5%), followed by Mediterranean (including submediterranean) (31.3%) and oceanic-Mediterranean (including suboceanic-submediterranean, submediterranean-oceanic, oceanic-submediterranean) (25%). The lowest percentages are the subboreal (3.1%) and cuoceanic-subtropical (3.1%). The chorological nomenclature are taken from Düll (1983, 1984, 1985).

The community’s most appropriate syntaxonomic position seems to be in the *Grumatio fragrans* Smarda & Hadac 1944 alliance, belonging to *Barbuleata ungulactae* Hübshman 1960 order and *Barbuleata ungulactae* Mohan 1978 class. Another association of this alliance to which it could be related is *Trichostomo-Didymodon vinealis* Privitera & Puglisi 1989 because of the abundance of species
belonging to *Didymodon* and *Pseudocrossidium* Williams genera. However this community's climatic optimum is the thermo- and meso-Mediterranean belt (Privitera & Puglisi, 1989). An association with a very similar floristic composition, *Pleurochaeto-Tortuletum ruralis* Brullo, Lo Giudice & Privitera 1991 included in the allanza *Homalothecio-Pleurochaetum squarrosoae* (Ros & Guerra, 1987) Marstaller 1993 alliance, has been described. This association is known from Greece and Turkey (Brullo et al., 1991), Sardinia (Privitera et al., 1996) and Sicily (Privitera & Puglisi, 1996) and occurs from 600 to 1 100 m, and exceptionally up to 1 700 m, as in Mt. Etna (Sicily). Although, the thermophilous species, *Pleurochaete squarrosoa*, is very frequent in the above-described community, it is relatively rare in the community described here. Furthermore, this species is only present in the relevés, both Spanish and Moroccan, taken below 1 300 m.

In southern Spain, this community can merge with two associations: *Homalothecio-Pleurochaetetum squarrosoae* Ros & Guerra 1987 in basic soils and *Homalothecio-Scleropodium touretii inèd.* in neutral or acidic soils. Both communities grow in deep soils and have a more mesophilous character than *Tortulo-Syntrichietum ruralis*. Moreover, their altitudinal range is lower. They rarely appear above 2 000 m.

Another association included in the *Grimaldion fragransi* Smarda & Hadac alliance is *Trichostomo-Molinietum aloitidis* Guerra & Varo 1981, which presents the same level of xerophily as the new community. However, the genus *Syntrichia* is not usually represented in its floristic composition and its altitudinal range is always lower, being frequent in the thermo- and meso-Mediterranean belts and only occasionally occurring in the supra-Mediterranean belt.

At present, this new community is only known from the orophilous areas of southern Spain (Alicante, Almería, Granada, Jaén and Murcia) and Morocco (Rif, Middle Atlas and High Atlas) (Fig. 1).

![Fig. 1. Distribution of the *Tortulo subulatae-Syntrichietum ruralis* association.](image-url)
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REFERENCES


