

The epiphytic bryoflora of the Jbel Bouhalla (Rif, Morocco), including a new variety of moss, *Orthotrichum speciosum* var. *brevisetum*

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SUMMARY

The epiphytic bryoflora of Jbel Bouhalla, a mountain sited in the Rif range (northern Morocco), is catalogued, resulting in a list of 48 taxa (45 mosses and 3 liverworts). One new variety, *Orthotrichum speciosum* var. *brevisetum*, is described, and some new records are reported: *Orthotrichum shawii* and *O. pallens* are new to northern Africa, while *Habrodon perpusillus* and *O. speciosum* var. *speciosum* are new to Morocco.

KEYWORDS: Bryophyte flora, epiphytes, chorology, northern Africa, Morocco, Rif, *Orthotrichum speciosum* var. *brevisetum*.

INTRODUCTION

Despite its biogeographical interest, the Moroccan bryophyte flora has been little studied. The first reports were published by Ball (1878), but the majority of the collections were made by French phanerogamists after the First World War, when botanists were allowed to explore the Moroccan territory. Louis Trabut (1853–1929) was one of the first bryologists to visit northern Africa. He mostly worked in Algeria, but also published on the Moroccan flora (Trabut, 1941). During the 1950s, this bryoflora was intensively studied by Jelenc and Jovet-Ast (Jelenc, 1953, 1955, 1967; Jovet-Ast, 1956a, b, 1958). Since then, the study of Moroccan bryophytes was interrupted until the 1990s, when several reports were published by Spanish bryologists (Ros, Jiménez & Guerra, 1990; Garilleti, Lara & Mazimpaka, 1997a, b; Cano *et al.*, 1999, 2002; Mazimpaka, Lara & Garilleti, 1999; Jiménez *et al.*, 2000; Buck *et al.*, 2001). Some of the latest studies have focused on the terricolous and saxicolous bryophytes of the Jbel Bouhalla (Jiménez *et al.*, 2002a, b), and this paper intends to complete the bryophyte catalogue of that mountain, providing a survey of the epiphytic taxa.

The Rif range is the northernmost cordillera of Morocco and runs parallel to the Mediterranean coast, from Gibraltar Strait in the west to Muluya River in the east. Jbel Bouhalla lies at the west of the principal chain, in U.T.M. grid squares 30SUD08 and 30SUD09, near the towns of Bab Taza and Chefchaouene (Fig. 1). It is formed by a series

of abrupt escarpments aligned in a north–south direction, with a maximum altitude of 2170 m. Geologically, it belongs to a calcareous deposit from the Jurassic period with limestone intrusions. The whole Cordillera is subject to a mild Mediterranean climate (subhumid Mediterranean climate; after Emberger, 1939), owing to the influence of the Atlantic Ocean. The mountains surrounding the study area receive high precipitation: 1760 mm yr⁻¹ for Jbel Outka (on the south-west of Jbel Bouhalla) and 2168 mm yr⁻¹ for Jbel Bou Hachem, on its north-east.

The high diversity of environments in the Jbel Bouhalla favours the development of several types of vegetation, both vascular and bryophytic. The lowest parts, from 1000 to 1200 m, are covered by *Quercus suber* L. woods and their substitution stages, which are dominated by *Arbutus unedo* L., *Erica arborea* L. and *Crataegus monogyna* Jacq. Above these plant formations, woods of *Quercus ilex* ssp. *ballota* (Desf.) Samp. appear, where *Juniperus oxycedrus* L. and *Quercus coccifera* L. also grow. As humidity increases with altitude, *Quercus ilex* ssp. *ballota* is progressively substituted by *Quercus faginea* Lam., which forms a mixed mass with *Acer opalus* ssp. *granatense* (Boiss.) Font Quer & Rothm., *Viburnum tinus* L. and *Crataegus laciniata* Curia. The Spanish fir (*Abies maroccana* Trabut) appears at 1300 m and forms woods above 1400 m. At 1600 m this species grows together with *Pinus pinaster* Aiton, *P. nigra* ssp. *mauretanica* (Mayre & Peyerimh) Heywood, *Taxus baccata* L. and *Cedrus atlantica* (Endl.) Carrière. Pure cedar wood constitutes the uppermost forest in Jbel Bouhalla.

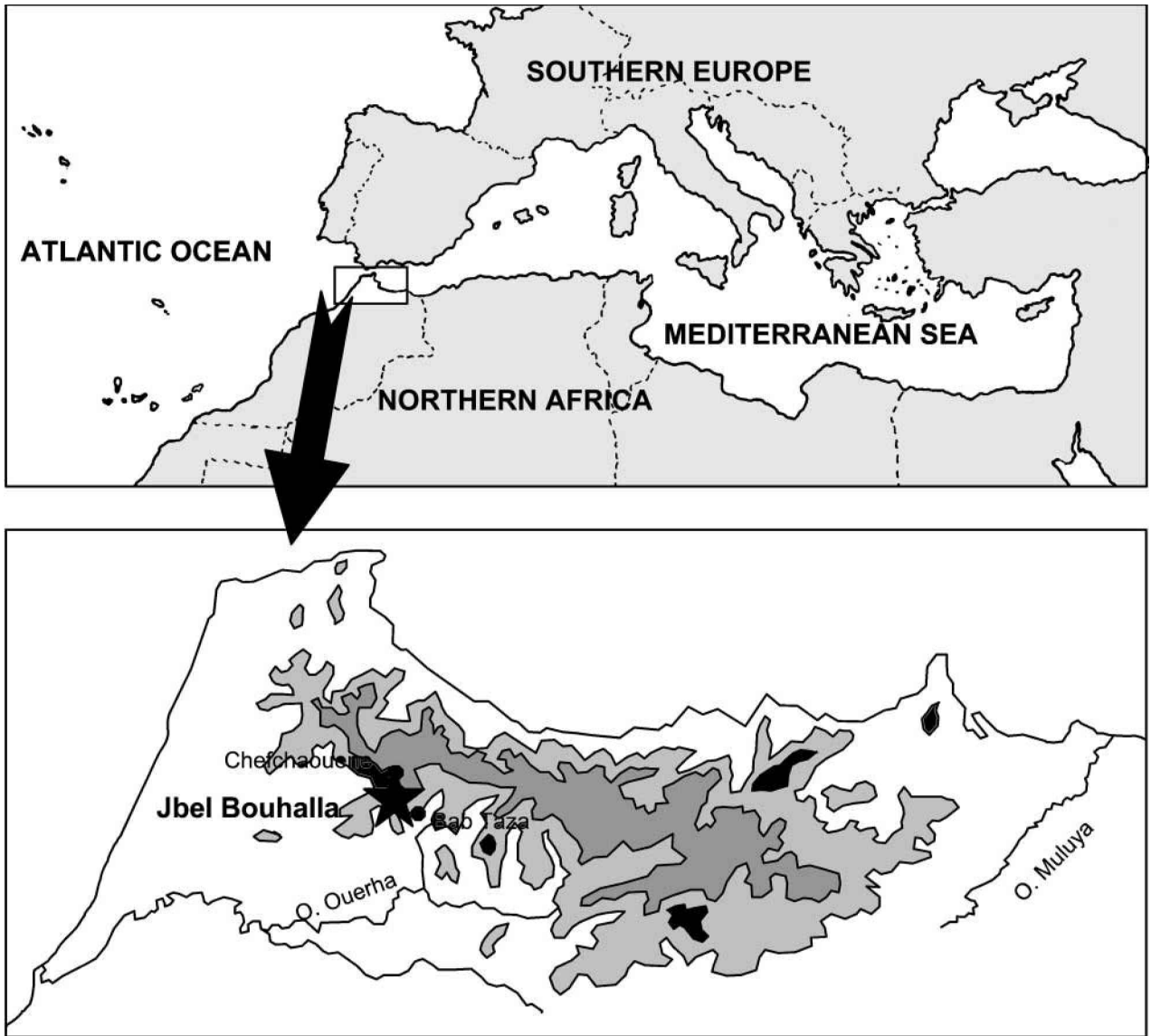


Figure 1. Localization of the study area.

METHODOLOGY

The study area was explored in the course of three expeditions, in March 1994 and March and June 1997. Prospecting was carried out along an altitudinal gradient from 1000 to 2000 m, and samples were taken from all the different phorophytes of each wood, on bases, trunks and branches with different orientations and ages. Details of the sampled localities are summarized in Table 1.

Species abundance in the different plant formations of the study area has been expressed using the Index of Ecological Significance (IES, Lara & Mazimpaka, 1998). For easier comprehension, the values of this index, shown in Table 2, have been delimited in frequency classes as follows: very rare (<10), rare (11–50), moderately abundant (51–125), abundant (126–200) and very abundant (>200).

Additionally, the correlation of taxa with epiphytic habitats has been studied on the basis of local occurrence on

different substrata (Table 3). Classes based on the groups established by Mazimpaka & Lara (1995) were defined as follows: customary epiphytes, which include strict epiphytes and facultative epiphytes preferentially found on bark; cortico-saxicolous, which include facultative epiphytes that colonize both bark and rock in the same way; indifferent, for taxa that occur similarly on bark, rock and soil; and preferentially not corticolous, for bryophytes that occasionally appear on bark but are more common on other substrata.

BRYOPHYTE CATALOGUE

The bryophytes found in Jbel Bouhalla are presented in alphabetical order in the following list. The nomenclature is based on Ros, Cano & Guerra (1999), with the exceptions of the genera *Didymodon* Hedw. (Corley *et al.*, 1981),

Table 1. Description of the sampling localities.

Site	Altitude (m)	U.T.M. grid	Forest type
1	1050	30SUD0183	Degraded <i>Quercus suber</i> forest with south exposition
2	1100	30SUD0284	Degraded <i>Quercus suber</i> forest with north exposition
3	1220	30SUD0285	<i>Quercus ilex</i> ssp. <i>ballota</i> wood with <i>Q. suber</i> and <i>Juniperus oxycedrus</i> . North-eastern exposition
4	1250	30SUD0385	<i>Quercus ilex</i> ssp. <i>ballota</i> and <i>Q. faginea</i> mixed wood
5	1300	30SUD0486	<i>Quercus ilex</i> ssp. <i>ballota</i> and <i>Q. faginea</i> mixed wood, with <i>Abies maroccana</i>
6	1400	30SUD0588	<i>Quercus ilex</i> ssp. <i>ballota</i> and <i>Q. faginea</i> mixed wood, with <i>Abies maroccana</i> (more abundant)
7	1500	30SUD0588	<i>Abies maroccana</i> forest, with <i>Q. ilex</i> ssp. <i>ballota</i> . Northern slope.
8	1500	30SUD0589	<i>Quercus ilex</i> ssp. <i>ballota</i> and <i>Q. faginea</i> mixed wood, with <i>Abies maroccana</i> and <i>Pinus pinaster</i>
9	1595	30SUD0489	<i>Abies maroccana</i> forest
10	1600	30SUD0590	<i>Quercus ilex</i> ssp. <i>ballota</i> forest in north–south valley
11	1600	30SUD0590	<i>Abies maroccana</i> forest
12	1700	30SUD0490	<i>Abies maroccana</i> forest
13	1700	30SUD0491	<i>Abies maroccana</i> forest with <i>Pinus nigra</i> and <i>Cedrus atlantica</i>

Schistidium Bruch & Schimp. (Blom, 1996), *Orthotrichum* Hedw. (Cortini & Lara, 2001) and *Syntrichia* Brid. (Gallego, 2002). For each taxon, the sites where it has been recorded are given (the locality numbers appear in Table 1), as well as its reproductive state (F when fertile and Fr when sporophytes were present) and a description of the habitat occupied in the study area. Distribution, altitudinal preferences and other interesting data are given where appropriate. Chorological novelties are marked with*.

Marchantiophyta

Frullania dilatata (L.) Dumort. — 1, 3, 4^{Fr}, 5, 6^{Fr}, 7^{Fr}, 12. In all woodland types, on bases and trunks of different phorophytes.

Porella platyphylla (L.) Pleiff. — 6, 10, 11. On trunks of *Acer* and *Abies*, between 1400 and 1600 m.

Radula cf. *lindenberiana* Gottsche ex Hartm. — 4, 5. On bases of *Quercus faginea* and *Q. ilex* ssp. *ballota*, between 1200 and 1300 m. As the studied specimens were all sterile, they have been provisionally attributed to this species, which is the only one that has been recorded in the study area (Jiménez *et al.*, 2002b).

Bryophyta

Antitrichia californica Sull. — 1, 2^{Fr}, 3, 4^{Fr}, 5^{Fr}, 6^{Fr}, 7^{Fr}. In all woodland types, on bases and trunks of different phorophytes.

Brachythecium dieckeii Roll. — 2. On base of *Abies maroccana*.

Brachythecium velutinum (Hedw.) Schimp. — 2, 4, 5, 6, 7. On *Quercus suber*, *Q. ilex* ssp. *ballota* and *Q. faginea*, generally on bases. Not found above 1500 m.

Brachythecium velutinum (Hedw.) Schimp. var. *salicinum* (Schimp.) Mönk. — 4, 5. On bases of *Quercus ilex* ssp. *ballota*, between 1200 and 1300 m.

Ceratodon purpureus (Hedw.) Brid. — 1. On base and trunk of *Quercus suber*.

**Dicranoweisia cirrata* (Hedw.) Lindb. — 1^{Fr}. On base of *Quercus suber*. Previously known in Morocco from the Middle Atlas (Jelenc, 1953, 1967), new to the Rif Cordillera.

Didymodon insulanus (De Not.) M.O.Hill — 7. On base of *Abies maroccana*.

Eurhynchium praelongum (Hedw.) Schimp. — 3. On base of *Juniperus oxycedrus*.

Fabronia pusilla Raddi — 2, 3, 4. In *Quercus suber* and *Q. ilex* ssp. *faginea* woods, on bases of *Q. suber*, *Juniperus oxycedrus* and *Q. ilex* ssp. *ballota*. Not found above 1250 m.

Grimmia pulvinata (Hedw.) Sm. — 4. On base of *Quercus ilex* ssp. *ballota*.

Grimmia trichophylla Grev. — 2, 7. On bases of *Quercus suber* and trunk of *Q. faginea*.

**Habrodon perpusillus* (De Not.) Lindb. — 4, 5, 6, 7. On bases and trunks of *Quercus ilex* ssp. *ballota*, *Q. faginea* and *Abies maroccana*. Not found above 1500 m. This submediterranean taxon widely distributed in Europe and known from Africa and Asia (Düll, 1985), has not been previously reported from Morocco.

Homalothecium aureum (Spruce) H. Rob. — 2, 4, 5, 7. On bases of *Quercus suber*, *Q. ilex* ssp. *ballota* and *Q. faginea*, not found above 1500 m.

Homalothecium sericeum (Hedw.) Schimp. — 2, 4, 5, 6, 7, 11, 12. In all woodland types, on bases and trunks of different phorophytes.

Hypnum cupressiforme Hedw. — 2, 5, 6, 7. On *Quercus suber*, *Q. ilex* ssp. *ballota*, *Q. faginea* and *Abies maroccana*, especially on bases. Not present in the *Quercus ilex* ssp. *ballota* wood, nor above 1500 m.

**Isothecium alopecuroides* (Lam. ex Dubois) Isov. — 6. On base of *Quercus ilex* ssp. *ballota* at 1400 m. Previously recorded in Morocco from the High Atlas (Jelenc, 1953), new to the Rif Cordillera.

Isothecium myosuroides Brid. — 5. On base of *Quercus ilex* ssp. *ballota*.

Leptodon smithii (Hedw.) F. Weber & D. Mohr — 5. On bases of *Quercus ilex* ssp. *ballota* and *Q. faginea*.

Leucodon sciuroides (Hedw.) Schwägr. — 2, 7^{Fr}, 12. On bases of *Quercus suber* and *Acer opalus* ssp. *granatense* and trunks of *Abies maroccana* and *Q. ilex* ssp. *ballota*.

Table 2. Average IES values of recorded species in different altitudinal ranges in Jbel Bouhalla. Bold type indicates the highest IES value for each taxon.

Species	Altitude (m)				
	1200	1300	1400	1600	1800
<i>Antitrichia californica</i>	64	65	171	78	0
<i>Brachythecium dieckei</i>	10	0	0	0	0
<i>Brachythecium velutinum</i>	3	8	5	7	0
<i>Brachythecium velutinum</i> var. <i>salicinum</i>	0	1	3	0	0
<i>Ceratodon purpureus</i>	9	0	0	0	0
<i>Dicranoweisia cirrata</i>	7	0	0	0	0
<i>Didymodon insulanus</i>	0	0	0	1	0
<i>Eurhynchium praelongum</i>	0	5	0	0	0
<i>Fabronia pusilla</i>	3	11	0	0	0
<i>Frullania dilatata</i>	16	8	17	41	2
<i>Grimmia pulvinata</i>	0	3	0	0	0
<i>Grimmia trichophylla</i>	10	0	0	2	0
<i>Habrodon perpusillus</i>	0	4	19	14	0
<i>Homalothecium aureum</i>	10	8	10	7	0
<i>Homalothecium sericeum</i>	21	49	28	48	9
<i>Hypnum cupressiforme</i>	24	0	7	20	0
<i>Isothecium alopecuroides</i>	0	0	0	4	0
<i>Isothecium myosuroides</i>	0	0	3	0	0
<i>Leptodon smithii</i>	0	0	17	0	0
<i>Leucodon sciuroides</i>	2	0	0	5	2
<i>Leucodon sciuroides</i> var. <i>morensis</i>	0	0	7	17	0
<i>Metaneckera menziesii</i>	0	0	38	28	0
<i>Orthotrichum acuminatum</i>	43	4	26	10	23
<i>Orthotrichum affine</i>	22	4	24	10	31
<i>Orthotrichum cupulatum</i>	0	0	0	4	0
<i>Orthotrichum ibericum</i>	0	8	3	0	7
<i>Orthotrichum lyellii</i>	176	259	221	181	155
<i>Orthotrichum pallens</i>	0	0	2	0	1
<i>Orthotrichum rupestre</i>	29	24	12	32	41
<i>Orthotrichum scanicum</i>	3	5	0	6	30
<i>Orthotrichum schimperi</i>	2	0	0	0	0
<i>Orthotrichum shawii</i>	0	0	10	3	0
<i>Orthotrichum speciosum</i> var. <i>speciosum</i>	0	0	7	0	6
<i>Orthotrichum speciosum</i> var. <i>brevisetum</i>	3	1	3	45	148
<i>Orthotrichum striatum</i>	9	143	133	97	112
<i>Orthotrichum tenellum</i>	12	0	3	2	0
<i>Porella platyphylla</i>	0	0	0	1	2
<i>Pterigynandrum filiforme</i>	2	0	0	55	115
<i>Pterogonium gracile</i>	31	0	14	4	0
<i>Radula</i> cf. <i>lindenbergiana</i>	0	0	5	0	0
<i>Schistidium crassipilum</i>	0	0	0	9	0
<i>Scleropodium touretii</i>	19	0	0	0	0
<i>Syntrichia laevipila</i>	21	3	0	0	0
<i>Syntrichia montana</i>	0	0	0	1	0
<i>Syntrichia princeps</i>	0	0	7	0	0
<i>Tortella tortuosa</i>	0	0	0	11	0
<i>Weissia controversa</i>	7	1	0	0	0
<i>Zygodon rupestris</i>	0	0	7	4	0

Leucodon sciuroides (Hedw.) Schwägr. var. *morensis* (Schwägr.) De Not. — 5, 6, 7. On bases and trunks of *Quercus ilex* ssp. *ballota*, *Juniperus oxycedrus* and *Abies maroccana*. Found between 1300 and 1500 m.

Metaneckera menziesii (Drumm.) Steere — 5, 6, 7. On bases and trunks of *Quercus ilex* ssp. *ballota*, bases of *Q. faginea* and trunks of *Acer opalus* ssp. *granatense*. Only found in the middle slope, between 1275 and 1415 m.

**Orthotrichum acuminatum* H.Philib. — 1^{Fr}, 2^{Fr}, 4^{Fr}, 7^{Fr}, 8^{Fr}, 9^{Fr}, 10^{Fr}, 11^{Fr}, 12, 13^{Fr}. In all woodland types, on bases

and trunks of different phorophytes. Previously recorded in Morocco from the Middle Atlas (Jelenc, 1953, 1967; Lara, 1995), this taxon is new to the Rif cordillera.

**Orthotrichum affine* Schrad. ex Brid. — 1^{Fr}, 3^{Fr}, 4^{Fr}, 7^{Fr}, 8^{Fr}, 10^{Fr}, 11^{Fr}, 13^{Fr}. In all woodland types, on bases and trunks of different phorophytes. This species was previously known in Morocco only from the Middle Atlas (Jelenc, 1953, 1967). New to the Rif Cordillera.

Orthotrichum cupulatum Hoffm. ex Brid. — 7^{Fr}. On trunk of *Quercus faginea*.

Table 3. Species affinity for the epiphytic habitats in the Mediterranean Region.

Species	Affinity for epiphytic habitats
<i>Antitrichia californica</i>	Cortico-saxicolous
<i>Brachythecium dieckei</i>	Indifferent
<i>Brachythecium velutinum</i>	Indifferent
<i>Brachythecium velutinum</i> var. <i>salicinum</i>	Indifferent
<i>Ceratodon purpureus</i>	Preferentially not corticolous
<i>Dicranoweisia cirrata</i>	Customary epiphyte
<i>Didymodon insulanus</i>	Preferentially not corticolous
<i>Eurhynchium praelongum</i>	Preferentially not corticolous
<i>Fabronia pusilla</i>	Customary epiphyte
<i>Frullania dilatata</i>	Customary epiphyte
<i>Grimmia pulvinata</i>	Preferentially not corticolous
<i>Grimmia trichophylla</i>	Preferentially not corticolous
<i>Habrodon perpusillus</i>	Customary epiphyte
<i>Homalothecium aureum</i>	Preferentially not corticolous
<i>Homalothecium sericeum</i>	Indifferent
<i>Hypnum cupressiforme</i>	Indifferent
<i>Isothecium alopecuroides</i>	Indifferent
<i>Isothecium myosuroides</i>	Cortico-saxicolous
<i>Leptodon smithii</i>	Cortico-saxicolous
<i>Leucodon sciuroides</i>	Customary epiphyte
<i>Leucodon sciuroides</i> var. <i>morensis</i>	Customary epiphyte
<i>Metaneckera menziesii</i>	Cortico-saxicolous
<i>Orthotrichum acuminatum</i>	Customary epiphyte
<i>Orthotrichum affine</i>	Customary epiphyte
<i>Orthotrichum cupulatum</i>	Preferentially not corticolous
<i>Orthotrichum ibericum</i>	Customary epiphyte
<i>Orthotrichum lyellii</i>	Customary epiphyte
<i>Orthotrichum pallens</i>	Customary epiphyte
<i>Orthotrichum rupestre</i>	Cortico-saxicolous
<i>Orthotrichum scanicum</i>	Customary epiphyte
<i>Orthotrichum schimperi</i>	Customary epiphyte
<i>Orthotrichum shawii</i>	Customary epiphyte
<i>Orthotrichum speciosum</i> var. <i>speciosum</i>	Customary epiphyte
<i>Orthotrichum speciosum</i> var. <i>brevisetum</i>	Customary epiphyte
<i>Orthotrichum striatum</i>	Customary epiphyte
<i>Orthotrichum tenellum</i>	Customary epiphyte
<i>Porella platyphylla</i>	Cortico-saxicolous
<i>Pterigandrum filiforme</i>	Cortico-saxicolous
<i>Pterogonium gracile</i>	Cortico-saxicolous
<i>Radula</i> cf. <i>lindenbergiana</i>	Cortico-saxicolous
<i>Schistidium crassipilum</i>	Preferentially not corticolous
<i>Scleropodium tourettii</i>	Preferentially not corticolous
<i>Syntrichia laevipila</i>	Customary epiphyte
<i>Syntrichia montana</i>	Preferentially not corticolous
<i>Syntrichia princeps</i>	Indifferent
<i>Tortella tortuosa</i>	Preferentially not corticolous
<i>Weissia controversa</i>	Preferentially not corticolous
<i>Zygodon rupestris</i>	Customary epiphyte

Orthotrichum ibericum F.Lara & Mazimpaka — 4^{Fr}, 11^{Fr}. On various phorophytes, preferentially on bases and trunks of *Quercus ilex* ssp. *ballota*. This species is known from the Iberian Peninsula and Jbel Bouhalla (Garilleti *et al.*, 1997a). A small population of this Mediterranean species has also been found in Belgium (Heylen & Walraevens, 2001). Nevertheless, its narrow range suggests an endangered status (Garilleti *et al.*, 2002).

Orthotrichum lyellii Hook. & Taylor — 1^{Fr}, 2^{Fr}, 3^{Fr}, 4^{Fr}, 5^{Fr}, 6^{Fr}, 7^{Fr}, 8^{Fr}, 9^{Fr}, 10^{Fr}, 11^{Fr}, 12^{Fr}, 13^{Fr}. In all woodland types, on bases and trunks of different phorophytes.

****Orthotrichum pallens*** Bruch ex Brid. — 4^{Fr}, 10^{Fr}. On trunks of *Quercus ilex* ssp. *ballota* and *Abies maroccana*, in woods of *Quercus ilex* ssp. *ballota* with *Q. faginea* and of *A. maroccana*. This subboreal species is widely distributed in Europe, north and central America as well as northern and south-western Asia (Düll, 1985; Lewinsky, 1993). Nevertheless, this is the first report for northern Africa.

Orthotrichum rupestre Schleich. ex Schwägr. — 1^{Fr}, 2^{Fr}, 3^{Fr}, 4^{Fr}, 5^{Fr}, 7^{Fr}, 10^{Fr}, 11^{Fr}, 12^{Fr}. In all woodland types, on bases and trunks of different phorophytes.

Orthotrichum scanicum Grönvall — 1^{Fr}, 4^{Fr}, 6^{Fr}, 7^{Fr}, 8^{Fr}, 9^{Fr}, 10^{Fr}, 11^{Fr}, 12^{Fr}, 13^{Fr}. (*Orthotrichum lewinskyae* F. Lara, Garilleti & Mazimpaka **syn. nov.**). In all woodland types, on bases, branches and trunks of different phorophytes. Previously reported from Bouhalla and Tazzeka mountains as *O. lewinskyae* (Garilleti *et al.*, 1997b). Study of new materials from Morocco and Spain has confirmed the conclusions of Sotiaux, Sotiaux & Pierrot (1998) and van der Pluijm (pers. comm.) in that characters of *Orthotrichum lewinskyae* lie within the variability range of *O. scanicum*.

**Orthotrichum schimperi* Hammar — 2^{Fr}. Found at the lowest altitudes on branches of *Quercus ilex* ssp. *ballota*. This species was previously known in Morocco from the Middle Atlas (Jelenc, 1953). New to the Rif Cordillera.

**Orthotrichum shawii* Wilson — 5^{Fr}, 6^{Fr}. Only found in the middle slope, on trunks of *Acer opalus* ssp. *granatense* and *Viburnum lantana* L., and branches of *Quercus ilex* ssp. *ballota*. This submediterranean montane species is known from Europe (Mazimpaka *et al.*, 2000; Lara *et al.*, 2003) and can be considered as endangered in the western Mediterranean countries (Garilleti *et al.*, 2002). New to northern Africa.

**Orthotrichum speciosum* Nees var. *speciosum* — 4^{Fr}, 10^{Fr}, 11^{Fr}. In mixed woods of *Quercus ilex* ssp. *ballota* and *Q. faginea*, and in those of *Abies maroccana*, on trunks and bases of *Q. faginea*, *Q. ilex* ssp. *ballota*, *A. maroccana* and *Acer opalus* ssp. *granatense*. This species is widely distributed in arctic, temperate and alpine zones of the northern Hemisphere (Lewinsky, 1993). In northern Africa it has been reported from Algeria (Ros *et al.*, 1999). New to Morocco.

**Orthotrichum speciosum* Nees var. *brevisetum* F. Lara, Garilleti & Mazimpaka, var. *nova* (Figs. 2 & 3) — 2^{Fr}, 4^{Fr}, 5^{Fr}, 6^{Fr}, 7^{Fr}, 8^{Fr}, 9^{Fr}, 10^{Fr}, 11^{Fr}, 12^{Fr}, 13^{Fr}. Especially abundant in woods above 1600 m, on bases, trunks and branches of *Quercus ilex* ssp. *ballota*, *Abies maroccana* and *Acer opalus* ssp. *granatense*. Also growing at lower altitudes, on trunks of *Quercus suber* and *Q. ilex* ssp. *ballota* and bases of *Q. faginea*.

Orthotrichum striatum Hedw. — 1^{Fr}, 3^{Fr}, 4^{Fr}, 5^{Fr}, 6^{Fr}, 7^{Fr}, 8^{Fr}, 9^{Fr}, 10^{Fr}, 11^{Fr}, 12^{Fr}, 13^{Fr}. In all woodland types, on bases and trunks of different phorophytes. This species is widely distributed in the Mediterranean Region. Nevertheless, there is only one previous report in the Rif Cordillera (Jelenc, 1967).

**Orthotrichum tenellum* Bruch ex Brid. — 1^{Fr}, 2^{Fr}, 4^{Fr}, 7^{Fr}. On bases and trunks of *Quercus suber*, *Q. ilex* ssp. *ballota* and *Q. faginea*, not found above 1350 m. This species was only known in Morocco from the Middle Atlas (Jelenc, 1953). New to the Rif Cordillera.

Pterigynandrum filiforme Hedw. — 2, 6, 7, 10, 11, 12, 13. On bases and trunks of *Quercus suber*, *Q. ilex* ssp. *ballota*, *Q. faginea*, *Abies maroccana* and *Acer opalus* ssp. *granatense*, especially above 1400 m.

Pterogonium gracile (Hedw.) Sm. — 2, 4, 7. On bases and trunks of *Quercus suber*, *Q. ilex* ssp. *ballota*, *Q. faginea* and *Abies maroccana*.

Schistidium crassipilum H.H. Blom — 7^{Fr}. On trunks of *Quercus faginea* and base of *Abies maroccana*, between 1475 and 1525 m.

Scleropodium tourettii (Brid.) L.F. Koch — 2. In the *Quercus suber* wood, on bases of various phorophytes, especially on *Q. suber*.

Syntrichia laevipila Brid. — 1^{Fr}, 2^{Fr}, 3^{Fr}. On bases and trunks of *Quercus suber*.

Syntrichia montana Nees — 7. On base of *Quercus ilex* ssp. *ballota*.

Syntrichia princeps (De Not.) Mitt. — 5^{Fr}. On trunk of *Quercus suber*.

Tortella tortuosa (Hedw.) Limpr. — 7. On bases of *Quercus ilex* ssp. *ballota* and *Abies maroccana*.

Weissia controversa Hedw. — 1^{Fr}. On base of *Quercus suber*.

Zygodon rupestris Schimp. ex Lorentz — 5, 7. Only found in the middle slope, on trunks of *Quercus ilex* ssp. *ballota* and *Juniperus oxycedrus* and base of *Q. faginea*.

DISCUSSION

The woods of Jbel Bouhalla feature an epiphytic bryophyte flora composed of 48 taxa, of which three (6%) are liverworts and 45 (94%) are mosses. The liverworts belong to three families and the mosses to 12, according, respectively, to Crandall-Stotler & Stotler (2000) and Buck & Goffinet (2000). The Orthotrichaceae is not only the best represented family, but it has also enriched the bryoflora with a new variety.

Orthotrichum speciosum Nees var. *brevisetum* F. Lara, Garilleti & Mazimpaka, var. *nova* (Fig. 2).

Plantae usque ad 2 cm altae, pulvinos compactos formantes; setae capsulis breviores; capsulae immersae ad emergentes, dimidio ad omnino sulcatae 8 costisque munitae; calyptrae abundantibus pilis tectae, juventute conoideae et late conicae maturitate.

TYPE: MOROCCO: RIF, Bab-Taza, Jbel Bouhalla. Fir wood in north-south valley, 1600 m altitude. 30SUD0590. Epiphyte on *Abies maroccana* Trabut, *Albertos*, *Cano*, *Coy*, *Mazimpaka* & *Ros*, 16 June 1997 (MA-Musci, holotypus; isotypus in BCB, MUB, NY and BM).

Plants olive green, to 2 cm tall, in compact tufts up to 5 cm in diameter. *Leaves* erect to flexuose when dry, patent when moist, (2.5)3.0–4.0(4.9) mm long, lanceolate to ovate-lanceolate, sharply acute to acuminate with apices often twisted, margins strongly recurved to near apex; median and upper cells shortly ovate to irregularly rounded, very thick-walled, 13–25(30) × 10–15 µm, papillose, with 1 (–2) tall and sharp papillae sometimes forked; basal cells shortly to longly rectangular, thick-walled and often sinuose, epapillose. Gonioautoicous. *Sporophytes* usually numerous in mature plants, 1–2 per perichaetium. *Seta* 1.00–1.60 mm long, capsule immersed to emergent, cylindrical, 1.50–2.25 mm long, generally clearly sulcate, rarely lightly so when dry and empty; stomata phaneropore, in the middle and lower

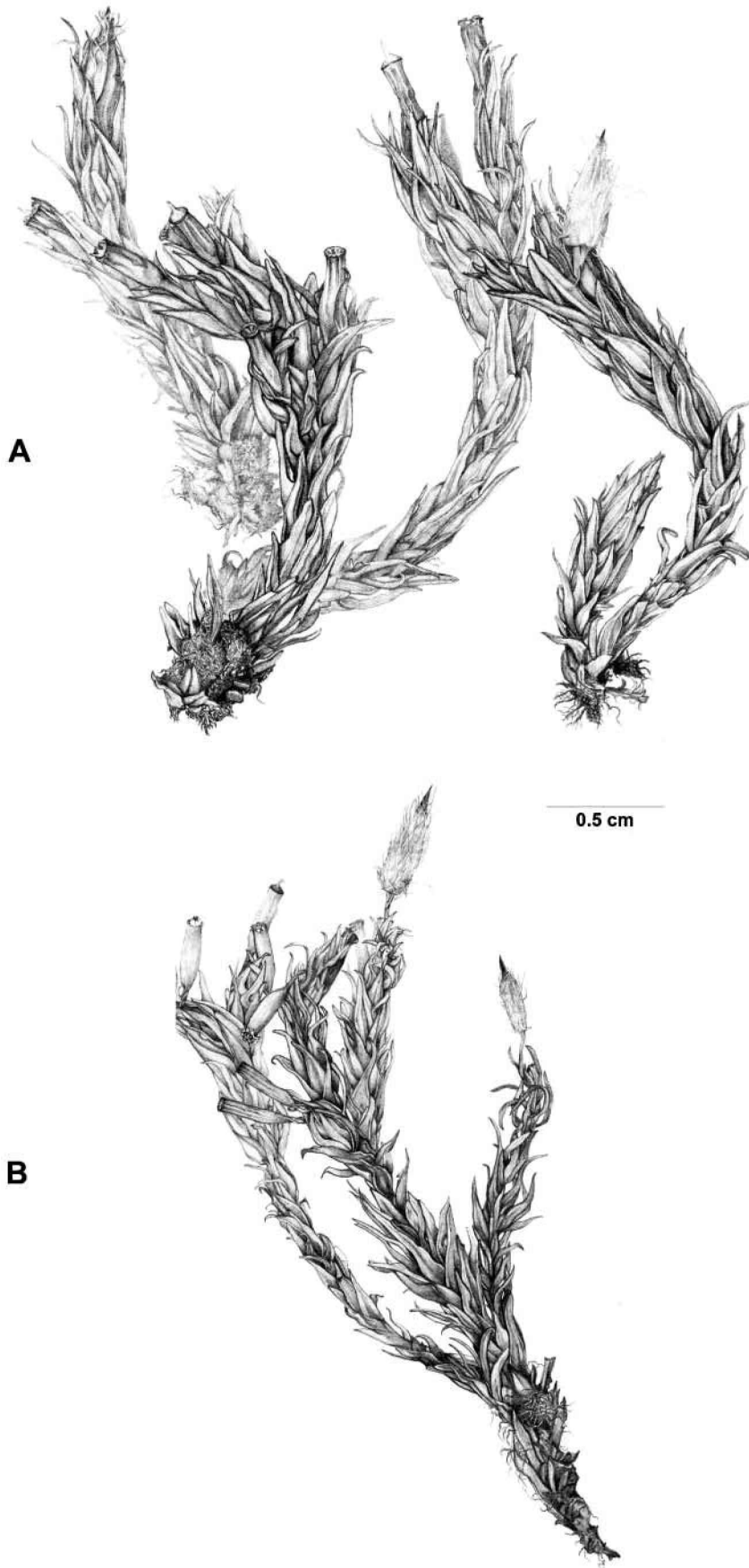


Figure 2. Habit of the two varieties of *Orthotrichum speciosum*. A. *O. speciosum* var. *brevisetum*. B. *O. speciosum* var. *speciosum*.

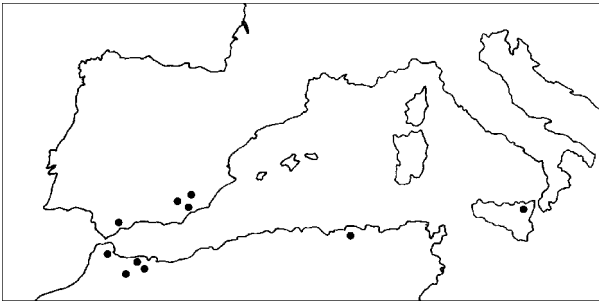


Figure 3. Known distribution of *Orthotrichum speciosum* var. *brevisetum*.

part of the capsule. *Peristome* double; exostome of eight pairs of teeth, homogeneously recurved when dry (only the apex touching the capsule), densely papillose on both sides; endostome formed by eight stout segments, very papillose on inner surface, uniseriate or partially biseriate. *Calyptra* with numerous long, yellow-greenish and strongly papillose hairs, both straight and curved hairs present; calyptra lanceolate and not narrowly fusiform when young, conical when mature, lacking hairs with discoloured tips. *Spores* 12–22 μm .

SELECTED PARATYPES: SPAIN: ALBACETE, Calar del Río Mundo, Riópar, near Camping, 900 m, 30SWH5160, corticolous on *Ulmus pumila* L.; *Albertos et al.*, 1–XI-1993 (authors' herb.). JAÉN, Sierra de Segura, near Los Negros camp, ca 1300 m, 30SWH3537, corticolous on *Quercus* \times *welwitschii* Samp.; *Garilleti & Lara*, 24-I-1998 (authors' herb.). MÁLAGA, Ronda, Sierra de las Nieves, Cortijo de la Nava, SW slope, ca 1100 m, 30SUF1660, corticolous on *Quercus ilex* L.; *Albertos & Garilleti*, 14-I-1996 (authors' herb.). MURCIA, Sierra de Carrascoy, rambla de Roy (Alhama de Murcia), ca 900 m, 30SWG5190, corticolous on *Quercus ilex* ssp. *ballota* (Desf.) Samp.; *Cano & Ros*, 2-VI-1996 (MUB6593). **ITALY:** SICILY, Nebrodi, provincial road 168, km 3.700, ca 1300 m, corticolous on *Prunus lusitanica* L.; *Lo Giudice*, 20-IX-2001 (authors' herb.). **MOROCCO:** CHEFCHAOUENE, Jbel Bouhalla, fir wood in northern slope, 1475 to 1520 m, 30SUD0589, corticolous on *Quercus ilex* ssp. *ballota* (Desf.) Samp.; *Cano et al.*, 17-III-1997 (authors' herb.). CHEFCHAOUENE, Jbel Bouhalla, clear fir-wood, 1700 m, 30SUD0491, corticolous on *Abies maroccana* Trabut; *Albertos et al.*, 16-VI-1997 (authors' herb.). AL HOCEIMA, Jbel Bou Bessoui, fountain, 1600 m, 30SUD5367, corticolous on *Salix pedicellata* Desf.; *Cano et al.*, 16-III-1997 (authors' herb.). AL HOCEIMA, Jbel Tidirhine, road from Ketama to Tatlaketama, past Azila, 1810 m, 30SUD6259, corticolous on *Salix atrocinerea* Brot.; *Albertos et al.*, 17-VI-1997 (authors' herb.). TAZA, ascent to Jbel Tazeka from Bab Bou Idir, cedar wood, 1700 m, 30SUC9172, corticolous on *Cedrus atlantica* (Endl.) Carrière; *Albertos et al.*, 21-VI-1997 (authors' herb.). MEKNES, Azrou, Gouraud's cedar wood, 1750 m, 30STC9901, corticolous on *Quercus canariensis* Willd.; *Albertos et al.*, 2-IV-1994 (authors' herb.). **ALGERIA:** JIJEL, Djebel Tababor; *Cosson et Reboul*, 1880 [ut *Orthotrichumaetnense*, mixed with *O. rupestre*] (TR-Venturi).

The differentiation of the new variety is based on characteristics of the seta, capsule and the calyptra. Seta length in *O. speciosum* var. *speciosum* is variable even in a single individual, but characteristically, all or most of the sporophytes in a tuft have setae which are longer than the capsules (ratio seta/capsule = (0.92–)1.00–1.52). In *O. speciosum* var. *brevisetum*, the setae are shorter, rarely equal to or longer than the capsules (ratio seta/capsule = 0.72–0.85(–0.97)); the tufts are characteristic due to the presence of numerous sporophytes, all immersed or emergent, and to the compact habit, with relatively short plants but large leaves. As Vitt & Darigo (1997) state, the normal habit of *O. speciosum* var. *speciosum* consists of large, loosely tufted plants, generally with fully exerted capsules. The furrows of the capsules are also variable in the type variety. In fact, the capsules vary from nearly smooth to deeply furrowed in the upper half, although most commonly they are lightly ribbed in the upper third. In the var. *brevisetum*, the capsules are generally deeply ribbed to the middle or even to the neck, although occasionally some are less sulcate. Capsules of *O. speciosum* var. *brevisetum* may appear very similar to those of *O. affine* Brid. The teeth revolute but not adpressed to the capsule wall when dry, the strong endostomial segments and the densely hairy calyptrae allow the new variety to be distinguished even in the field. Finally, the calyptrae of the two varieties of *O. speciosum* show some differences. The young calyptrae of the var. *speciosum* are characteristic because of their narrow fusiform shape, with numerous yellowish hairs; when mature, they become conical with a lanceolate silhouette, with the gilded hairs discoloured at the tip. In the var. *brevisetum*, the calyptrae always have a wide base: they are widely fusiform or conical when young and perfectly conic with a triangular outline when mature; their hairs remain yellow-greenish, without observed discoloured hair tips. Despite these differences, segregation at varietal level seems to be the most appropriate, since some samples from southern Europe are difficult to attribute to either of the two taxa, especially in the absence of calyptrae.

Both varieties of *O. speciosum* present basically allopatric ranges (Lara & Mazimpaka, 2001). The var. *speciosum* is widely distributed in the Holarctic, but becomes rare in the European Mediterranean Region, where it is relegated to mountains with little summer drought. It occurs sporadically and sparsely in southern Spain and northern Africa. On the contrary, the var. *brevisetum* has its optimum occurrence in the Mediterranean region, growing in areas that are subject to a long summer drought, but often with significant annual precipitation. It is abundant in montane woods in Morocco and southern Spain, and has been also detected in Algeria and Sicily (Fig. 3). Because of its narrow range and dependence on well developed Mediterranean woods, this variety could be considered to be endangered (Garilleti *et al.*, 2002).

Moss families representation in the epiphytic habitat

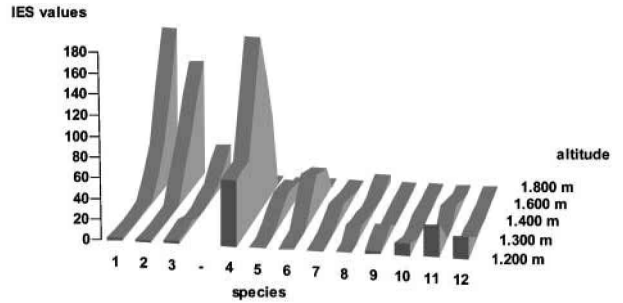
Orthotrichaceae (14 taxa of *Orthotrichum* genus, 1 of *Zygodon*) contributes with more than 85% of the species

that are customary epiphytes, which agrees with its importance in the epiphytic communities all along the Mediterranean basin (Lara, Garilleti & Mazimpaka, 1994; Lara & Mazimpaka, 2001). Other families mostly represented are Brachytheciaceae (9 taxa) and Pottiaceae (6 taxa), that have also been shown to be among the best represented on soil (Jiménez *et al.*, 2002b). Under appropriate conditions, members of these families colonize tree bark (Söderström, 1993; Lara, 1995), although they are mostly found on old trees and are more common on tree bases than on trunks, as Mazimpaka & Lara (1995) showed in central Spain. Similarly, members of the family Grimmiaceae grow both on rock and bark but are preferentially saxicolous. However, when environmental conditions are optimal for their development they occur on bark, as the conditions on this substratum can be similar to those on rocks (Vitt, 1981). In Jbel Bouhalla, these species usually grow on bases in the most humid woods and are usually scarce (Table 2). As for the remaining families, representation is mostly limited to the members that are cortico-saxicolous or customary epiphytes in the Mediterranean Region.

Epiphyte distribution along altitudinal transect

The analysis of species abundance (expressed by the IES values) has revealed two types of distribution along the altitudinal gradient: some bryophytes remain constant while others show preferences for a limited altitudinal range (Table 2). The species that are found in all altitudinal stages are *Frullania dilatata*, *Homalothecium sericeum*, *Orthotrichum acuminatum*, *O. affine*, *O. lyellii*, *O. rupestre*, *O. speciosum* var. *brevisetum* and *O. striatum*. Although represented in the whole transect, their importance in bryophyte communities varies with altitude. *Orthotrichum lyellii* is the species that dominates trunk bryophyte communities all along the transect. The other species show some tendencies: *Orthotrichum acuminatum* is more abundant in the lowest stage, *Frullania dilatata* and *Homalothecium sericeum* prefer the middle slope and *Orthotrichum speciosum* var. *brevisetum* is drastically increased at the highest mountain stage. Finally, *Orthotrichum striatum* is abundant in all the stages but in the lowest one, while *Orthotrichum rupestre* is very scarce in the highest stage.

Other species prefer or are clearly restricted to a specific altitudinal range (Table 2, Fig. 4). *Pterogonium gracile* is specially abundant in *Quercus suber* woods, where it is important in the epiphytic communities. *Syntrichia laevipila*, *Scleropodium tourettii* and *Orthotrichum tenellum* are also restricted to basal stages, although their lower IES values indicate less importance in the communities. *Metaneckera menziesii*, *Fabronia pusilla*, *Habrodon perpusillus*, *Antitrichia californica*, *Leptodon smithii*, *Orthotrichum speciosum* var. *speciosum*, *O. ibericum* and *O. shawii* prefer to grow on the middle slopes (1300–1600 m), while *Pterigynandrum filiforme* and *Orthotrichum scanicum* have their optimum development at the highest altitudes.



SPECIES SHOWING PREFERENCES FOR A SPECIFIC ALTITUDINAL STRATUM

1	<i>Orthotrichum speciosum</i> var. <i>brevisetum</i>
2	<i>Pterigynandrum filiforme</i>
3	<i>Orthotrichum scanicum</i>
4	<i>Antitrichia californica</i>
5	<i>Habrodon perpusillus</i>
6	<i>Metaneckera menziesii</i>
7	<i>Orthotrichum shawii</i>
8	<i>Orthotrichum ibericum</i>
9	<i>Fabronia pusilla</i>
10	<i>Orthotrichum tenellum</i>
11	<i>Pterogonium gracile</i>
12	<i>Syntrichia laevipila</i>

Figure 4. Representation of the abundance of selected epiphytic species along an altitudinal transect in Jbel Bouhalla.

It can be inferred that the studied altitudinal gradient presents changes in the bioclimatic conditions that are enough, not only for forest substitution, but also to cause differences in epiphytic bryophyte distribution.

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TAXONOMIC ADDITIONS AND CHANGES: *Orthotrichum speciosum* var. *brevisetum* F.Lara, Garilleti & Mazimpaka, var. nova, *Orthotrichum scanicum* Grönvall (syn. *O. lewinskyae* F.Lara, Garilleti & Mazimpaka).

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