

A contribution to the knowledge of bryophytes from Sierra de Gredos (central Spain) including a reevaluation of their national conservation status

Modesto LUCEÑO^a, Carlos CERREJÓN^a, Samuel GUERRA-CÁRDENAS^a,
José Ignacio MÁRQUEZ-CORRO^a, Víctor PINEDA-LABELLA^a,
Santiago MARTÍN-BRAVO^a, Marta INFANTE^b & Jesús MUÑOZ^{c*}

^aUniversidad Pablo de Olavide, ctra. de Utrera km 1, 41013 Sevilla, Spain

^bMuseo de Ciencias Naturales de Álava, Fundadora de las Siervas de Jesús,
24. 01001 Vitoria, Spain

^cReal Jardín Botánico (CSIC), Plaza de Murillo 2, 28014 Madrid, Spain

Abstract – Despite the significant increase of bryological studies in Spain during the last decades, some regions remain poorly studied. This is the case of Sierra de Gredos mountain range, in the Iberian Central System, which we visited in several collecting expeditions, with focus in the insufficiently explored high mountain areas. As a result, we highlight 28 taxa either by their importance in bryological conservation or because those populations are the first evidence of the taxa in the Iberian Central System. It is remarkable the presence of *Kiaeria falcata*, never collected previously in the Iberian Peninsula although reported in error based on *K. starkei* specimens, and *Polytrichastrum sexangulare*, known so far in the Iberian Peninsula only from the Pyrenees. Likewise, we highlight the new populations of *Andreaea nivalis*, *Anthoceros caucasicus*, *Kiaeria blyttii*, *Meesia triquetra*, and *Polytrichum longisetum*. The first one is reported fertile for the first time in Spain. In addition, we found 13 species listed in different threat categories whose number of populations and/or Area of Occupancy (AOO) is inconsistent with the category to that they have been assigned in Spain. Thus, four endangered species proved to be relatively common in the Central System; consequently, we propose to withdraw these species from the list of threatened bryophytes in Spain. This study highlights the urgent need to deepen into the taxonomic and chorological research of Spanish bryological biodiversity to set a solid basis on which an adequate and efficient conservation management may be performed. Finally, taxonomic and ecological comments are indicated for some species.

Central System / chorology / endangered species / hornworts / Iberian Peninsula / IUCN threat categories / liverworts / mosses

INTRODUCTION

The Iberian Central System runs for almost 600 km in the center of the Iberian Peninsula, and can be roughly divided in five sectors: 1) Somosierra-Ayllón, 2) Sierra de Guadarrama, 3) Sierra de Gredos, 4) Las Quilamas, Tamames, Francia,

* Corresponding author: jmunoz@rjb.csic.es

Gata, and La Malcata mountain ranges, and 5) Serra da Estrela. Sierra de Guadarrama and Sierra de Gredos are connected by Sierra de Malagón and Sierra del Quintanar.

The Central System has its highest elevations (Almanzor, 2592 m) in the Sierra de Gredos, which spreads NE-SW along *ca.* 140 km from the western limit of Sierra de Malagón to Béjar town. North to south, Sierra de Gredos includes three groups of mountain ranges: the northernmost range of Sierra de Ávila; the middle massif composed by Sierra de la Paramera, La Serrota and Sierra de Villafranca; and the southernmost group, which summits separate the Duero and Tajo basins. The latter is traditionally divided into three massifs: the Macizo Oriental (between the SW limit of Madrid province and Puerto del Pico pass), the Macizo Central, between Puerto del Pico and Puerto de Tornavacas passes), and the Macizo Occidental (between Tornavacas pass and Béjar town). In a restricted sense, the Macizo Central is commonly known as Gredos, and the Macizo Occidental as Sierra de Béjar. Finally, the small Sierra de San Vicente rises south of the Tiétar river (Fig. 1).

Sierra de Gredos is included in the Mediterranean Region, and although the summits of the Macizo Occidental, closer to the Atlantic Ocean, show high precipitation and humidity (> 3600 mm/ year, cf. Luceño & Vargas, 1991), precipitation is not uniformly distributed throughout the year. Most rainfall occurs from October to May, with remarkably dry and hot summers, although some snow beds of the Macizo Central and Macizo Occidental usually withstand the summer in climatological standard years (personal observations).

The vegetation of the uppermost areas includes many boreal-alpine taxa, but it is otherwise typical of Mediterranean high mountains (Luceño *et al.*, 2016a). There is a strong contrast between N and S slopes, the latter being strongly insolated even during the winter. Sierra de Gredos shows a complex orography producing a rich mosaic of microhabitats allowing the presence of organisms adapted to the



Fig. 1. Study area showing the main mountain ranges in Sierra de Gredos (inseted in the upper part is the map of the Iberian Peninsula indicating the situation of Sierra de Gredos in the Iberian Central System).

freezing conditions in the high elevations and to the nearly subtropical environments of some gorges in the southern slopes occupied by *Prunus lusitanica* L. formations (Luceño & Vargas, 1991; Luceño *et al.*, 2016a).

Regarding the status conservation of Gredos bryophytes, Garilleti & Albertos (2012) include 14 taxa in different threat categories. Unlike vascular plants, of which several regional floras and checklists have been published (Rivas Martínez, 1963; Sánchez Mata, 1989; Luceño & Vargas, 1991; Sardinero, 2004; Luceño *et al.*, 2016a), publications on bryophytes have been limited to small lists resulting from isolated collection campaigns (Casas, 1988; Elías, 1988a, 1988b; Arias *et al.*, 1989; Elías, 1989a, 1989b, 1989c; Elías *et al.*, 2006; Luceño *et al.*, 2016b) or studies of specific habitats (Lara & Mazimpaka, 1994; Albertos *et al.*, 1997). The extensive work Flora Briofítica Ibérica (Guerra *et al.*, 2006, 2010, 2014; Brugués *et al.*, 2007a; Brugués & Guerra, 2015) has entailed an important advancement in the knowledge of mosses of the Iberian Peninsula, helping the task of completing the knowledge gaps in regions such as Sierra de Gredos mountain range.

The aims of the present article are: i) to present the most important novelties for the bryoflora of the Sierra de Gredos mountain range, and ii) to reevaluate the conservation status at the national level of the taxa included in Garilleti & Albertos (2012), and specifically the species *Kiaeria falcata* following IUCN criteria.

MATERIALS AND METHODS

Twenty four collection campaigns were carried out across Sierra de Gredos mountain range in the last four years (2013-2016); and a previous one made in 1999. All collected samples were deposited in the bryological herbarium of Universidad Pablo de Olavide (UPOS) and one of them (*Lejeunea lamacerina* (Steph.) Schiffn.) in the Museo de Ciencias Naturales de Álava (VIT). For moss nomenclature, Ros *et al.* (2013) were followed, except for two *Andreaea* species (*A. crassifolia* Luisier and *A. heinemannii* Hampe & Müll. Hal.) and *Pohlia bolanderi* var. *seriata* A.J. Shaw, for which Dirkse & Losada-Lima (2010) and Guerra (2010), respectively, were considered. For liverworts and hornworts, Söderström *et al.* (2016) was followed.

The description of the locations where the specimens were collected follows the next order: Spanish province written in capital letters, mountain chain or massif written in bold, specific location, geographical coordinates, elevation in meters above sea level, habitat, collecting date, collectors, and herbarium accession number.

Comments on taxa are mainly chorological and/or relatives to their conservation biology, although for some species some taxonomic, ecological or reproductive biology comments are added. With a few exceptions, the order of presentation is as follows: i) distribution, ecology and abundance in Gredos, ii) distribution in the Iberian Peninsula, iii) chorological importance of the finding, iv) morphological and taxonomic comments, and v) conservation status in Spain if included in the Red List of Threatened Bryophytes of Spain (Brugués & González-Mancebo, 2012).

For the evaluation of the conservation status at Spanish level, the methodology of Garilleti & Albertos (2012) was followed, using criteria, categories and guidelines from IUCN (2012, 2014), but taking into account the peculiarities of its application to these group of plants, especially those derived from their small size

Table 1. Summary of the proposed changes in the IUCN categories for Spain of the mosses, liverworts and hornworts studied in this work with respect to those formerly proposed in Garillete & Albertos (2012). **national Spanish novelty; *novelty for a Spanish region or province; ^{cf}presence confirmed in the Sierra de Gredos

	Former category	Proposed category
Mosses		
<i>Andreaea crassifolia</i> *	VU D2	LC
<i>Andreaea heinemannii</i>	VU D2	LC
<i>Andreaea nivalis</i> *	VU D2	EN B2a,b(ii,iv,v)
<i>Hydrohypnum molle</i> *	VU D2	DD
<i>Kiaeria falcata</i> **	–	CR
<i>Meesia triquetra</i>	CR B2ab(i,ii,iii,iv)	EN B2ab(i,ii,iii,iv)
<i>Plagiothecium platyphyllum</i> *	VU D2	LC
<i>Pohlia bolanderi</i>	VU D2	LC
<i>Pohlia wahlenbergii</i> *	NT	LC
<i>Polytrichastrum sexangulare</i> *	VU D2	LC
<i>Polytrichum longisetum</i> ^{cf}	CR B2ab(iii);D	CR D
Liverworts		
<i>Fuscocephaloziopsis pleniceps</i> *	VU D2	LC
<i>Jungermannia pumila</i> *	NT	LC
Hornworts		
<i>Anthoceros caucasicus</i> *	CR B2ab(iii,iv)	EN B2ab(iii,v) (only applicable to peninsular Spain)

and difficulties in the delimitation of individuals (Hallingbäck *et al.*, 1998; Garillete & Albertos, 2012). Reference works for previously assigned conservation categories were Garillete & Albertos (2012), which contains the Red List of Threatened Bryophytes of Spain (Brugués & González-Mancebo, 2012), and also González-Mancebo *et al.* (2012) for the Red List of Bryophytes of the Canary Islands. Table 1 presents a summary of the proposed changes in IUCN categories for Spain.

RESULTS AND DISCUSSION

Mosses

Andreaea crassifolia Luisier

ÁVILA: **Macizo Central**, Alto de la Centenera, 40° 17' 18.29"N / 5° 3' 40.87"W, 1346 m, dry granitic rocks, 27-03-2014, *Pineda Labella 188VPL14*, UPOS-100989. *Ibidem*, Arenas de San Pedro, Cabeza del Cambrional, 40° 13' 18.08"N / 5° 10' 41.01"W, 1390 m, exposed granitic rock, 08-04-2014, *García Muñoz s.n.*, UPOS-100514. *Ibidem*, El Arenal, pathway to La Cabrilla pass, 40° 16' 54.34"N / 5° 5' 34.25"W, 1297 m, dry granitic rocks, 26-03-2014, *Pineda Labella 107VPL14*, UPOS-100913. *Ibidem*, Bohoyo gorge, 40° 17' 50.98"N / 5° 25' 48.04"W, 1270 m, dry and meteorized granites, 19/04/2014, *Cerrejón 260CCL14*, UPOS-101361. *Ibidem*, Navamediana gorge, 40° 18' 40"N / 5° 24' 24.87"W, 1240 m, dry granitic blocks, 12-05-2014, *Cerrejón 337CCL14*, UPOS-101718. *Ibidem*, Navalonguilla,

Berrocal del Horcajo, 40° 15' 54"N / 5° 31' 29.10"W, 1343 m, dry and broken granites, 23-02-2014, *García Muñoz s.n.*, UPOS-100494. *Ibidem*, Parador Nacional de Gredos, at the beginning of El Arenal pass pathway, 40° 21' 8.77"N / 5° 6' 3.38"W, 1565 m, artificial and exposed granite wall, 22-01-2016, *Cerrejón 1CCL16*, UPOS-103277. **Macizo Occidental**, El Tremedal, 40° 20' 39.55"N / 5° 36' 12.46"W, 1272 m, exposed and very meteorized granitic rock, 02-10-2015, *Guerra Cárdenas 9SGC15*, UPOS-102385. **Macizo Oriental**, Hoyocasero, La Cordillera, 40° 23' 14.2"N / 4° 59' 58.7"W, 1461 m, exposed granitic blocks, 18-04-2014, *Cerrejón 229CCL14*, UPOS-101330. *Ibidem*, Puerto del Pico pass, pathway to El Torozo, 40° 19' 19.63"N / 5° 0' 36.61"W, 1433 m, exposed granitic rock, 30-03-2014, *Pineda Labella 279VPL14*, UPOS-101065. *Ibidem*, western slopes of Pedro Bernardo pass, 40° 14' 58.78"N / 4° 58' 6.86"W, 1247 m, dry granitic rocks, 16-04-2014, *Cerrejón 119CCL14*, UPOS-101287. *Ibidem*, Villarejo del Valle, El Sidrillo forest track, Rioseco stream, 40° 18' 20.71"N / 4° 59' 28.27"W, 1182 m, dry granitic rocks, 16-04-2014, *Cerrejón 90CCL14*, UPOS-101258. CÁCERES: **Macizo Central**, Guijo de Santa Bárbara, Jaranda gorge, 40° 9' 48.77"N / 5° 39' 10.71"W, 878 m, dry granitic rocks, 14-05-2014, *Cerrejón 447CCL14*, UPOS-101818. **Macizo Occidental**, La Garganta, 40° 19' 55.32"N / 5° 47' 36.49"W, 1310 m, south facing exposed granitic block, 09-12-2013, *Pineda Labella 247VPL13*, UPOS-100876. *Ibidem*, Valle del Jerte, Beceda gorge, 40° 16' 51.52"N / 5° 42' 32.18"W, 1565 m, dry granitic rock, 18-03-2014, *García Muñoz s.n.*, UPOS-102148. SALAMANCA: **Macizo Occidental**, Candelario, La Garganta road, 40° 20' 39.63"N / 5° 46' 18.14"W, 1255 m, north facing exposed granitic block, 09-12-2013, *Pineda Labella 229VPL13*, UPOS-100853.

This is a very common species in the lower and middle levels of the Pyrenean Oak (*Quercus pirenaica* Willd.) stage of the Sierra de Gredos mountain range, between 875 and 1565 m. It preferably grows on sunny and exposed highly weathered granite. The known Iberian distribution of this species so far covers the northern half of Portugal, where it has been abundantly collected, the western sections of the Central System (from the Macizo Occidental of Gredos to Serra da Estrela) and the Montes de León (Cros & Sérgio, 2007; Cros *et al.*, 2016a). Additionally, it grows in the Canary Islands (Dirkse & Losada-Lima, 2010) and in some locations of California (Murray, pers. comm.).

Andreaea crassifolia has been frequently treated as *A. heinemannii* subsp. *crassifolia* (e.g., Sérgio, 2004; Cros & Sérgio, 2007); however, Dirkse & Losada-Lima (2010) stated that based on morphological traits it should be treated at specific rank. In our opinion, there are enough reasons to consider these taxa as two different species, in the light of morphological, ecological (Sérgio, 2004; Cros & Sérgio, 2007; Dirkse & Losada-Lima, 2010), and molecular phylogenetic differences (Luceño *et al.*, in prep.).

This species was classified as "Vulnerable" in Spain (VU D2). The application of this category is based on a small Area of Occupancy (AOO), considered to be less than 20 km², or a number of localities equal or less than five, with a reasonable possibility of being affected by a future threat (IUCN, 2012). The numerous locations found during our collection campaigns in the Central System widely exceed both thresholds, so the species should be excluded from the list of threatened bryophytes of Spain and be considered as "Least Concern" (LC).

Andreaea heinemannii Hampe & Müll. Hal.

ÁVILA: **Sierra de La Paramera**, Zapatero peak, 40° 29' 32.3"N / 4° 52' 6.8"W, 2109, granitic walls with temporary water runoff, 02-09-2015, *García Muñoz s.n.*, UPOS-102310. **Sierra de Villafranca**, Peña Negra mountain pass, 40° 25' 9.88"N / 5° 18' 6.34"W, 1915 m, shady and dry granitic block, 31-03-2015, *Luceño 93ML15*, UPOS-102147. *Ibidem*, 40° 25' 24.89"N / 5° 17' 58.70"W, 1909 m, dry granitic rock, 12-05-2014, *Cerrejón 367CCL14*, UPOS-101743. **Macizo Central**, Apretura de la Mira, 40° 15' 20.20"N / 5° 10' 18.88"W, 1716 m, west facing exposed granitic wall, 23-01-2016, *Cerrejón 63CCL16*,

UPOS-103276. *Ibidem*, La Covacha peak, 40° 13' 1.26"N / 5° 36' 4.57"W, 2331 m, shady granitic rocks with temporary water runoff, 25-10-2015, *Pineda Labella 112VPL15*, UPOS-102658. *Ibidem*, Circo de Gredos, Laguna Grande drainage, 40° 15' 24.89"N / 5° 16' 31.51"W, 1910 m, north facing granitic walls, 03-10-2015, *Guerra Cárdenas 13SGC15*, UPOS-102380. *Ibidem*, Circo de la Laguna del Barco, 40° 13' 30.60"N / 5° 36' 17.77"W, 1825 m, shady granitic walls with water runoff, 24-10-2015, *Pineda Labella 71VPL15*, UPOS-102655. *Ibidem*, between Cuadrada lake and La Covacha peak, 40° 13' 8.19"N / 5° 36' 9.75"W, 2205 m, stony places where the snow remains for a long time, 25-10-2015, *Pineda Labella 96VPL15bis*, UPOS-102657. *Ibidem*, Circo de El Cancho, 40° 11' 51.08"N / 5° 31' 15.71"W, 2158 m, wet and shady crevices on granitic rocks where the snow remains for a long time, 10-07-2016, *Luceño 344ML16*, UPOS-103341. *Ibidem*, Cuervo gorge, 40° 19' 2.62"N / 5° 6' 31.48"W, 1660 m, north facing exposed granitic rock, near a stream, 22-01-2016, *Cerrejón 22CCL16*, UPOS-103272. *Ibidem*, La Plataforma, 40° 16' 16.50"N / 5° 14' 8.27"W, 1886 m, wet north facing granitic rock, 15-04-2014, *Cerrejón 37CCL14*, UPOS-101146. *Ibidem*, Cuadrada lake, 40° 13' 20.12"N / 5° 36' 3.83"W, 2143 m, shady granitic walls with water runoff, 25-10-2015, *Pineda Labella 89VPL15*, UPOS-102656. *Ibidem*, Nogal del Barranco, 40° 14' 58.66"N / 5° 10' 11.11"W, 1518 m, dry granitic rock, 02-01-2015, *Luceño 63ML15*, UPOS-101652. *Ibidem* 40° 15' 20.20"N / 5° 10' 18.88"W, 1716 m, west facing granitic walls, 25-01-2016, *Cerrejón 63CCL16*, UPOS-103276. *Ibidem*, Risco Negro, 40° 15' 42.29"N / 5° 16' 55.07"W, 2112 m, north facing granitic walls, 03-10-2015, *Guerra Cárdenas 23SGC15*, UPOS-102382. **Macizo Occidental**, Circo del Trampal, 40° 18' 31.10"N / 5° 43' 25.18"W, 2210 m, north-east facing granitic fissures, 04-08-2015, *Luceño 819ML15*, UPOS-102317.

This species is common in the Macizo Central and Macizo Occidental of Gredos, as well as in Sierra de la Paramera, between 1518 and 2331 m altitude, always on shady rocks generally facing north, and frequently accompanied by *A. alpestris* (Thed.) Schimp., *A. rothii* F. Weber & D. Mohr subsp. *rothii* or *A. rupestris* Hedw., depending on the altitude. As the previous species, *A. heinemannii* is a rare species in the Iberian Peninsula (see distribution map in Cros *et al.*, 2016b). In the province of Ávila it was only collected in a couple of localities in Sierra de Villafranca (Lloret *et al.*, 1997).

Like *A. crassifolia*, it has received the status of VU (D2) in Spain based on a small AOO and reduced number of localities, which are no longer applicable criteria in view of the number of localities herein reported (see above for *A. crassifolia*). Thus, it should be considered as LC, as discussed above for *A. crassifolia*.

Andreea nivalis Hook.

NOTE: fertile individuals are marked with an asterisk (*).

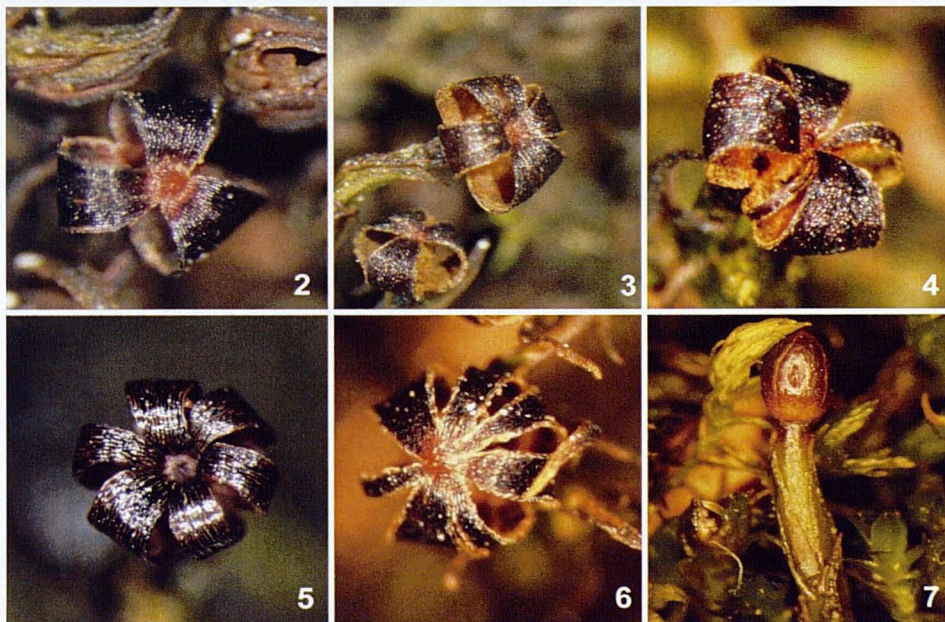
ÁVILA: **Macizo Central**, base of La Covacha*, 40° 13' 0.51"N / 5° 36' 4.79"W, 2345 m, shady granitic rocks with temporary water runoff, 25/10/2015, *Pineda Labella 120VPL15*, UPOS-102538. *Ibidem*, Circo de El Cancho, 40° 11' 51.08"N / 5° 31' 15.71"W, 2158 m, wet and shady crevices on granitic rocks where the snow remains for a long time, 10-07-2016, *Luceño 340ML16*, UPOS-103342. *Ibidem*, headwaters of the Navamediana gorge, 40° 16' 20.16"N / 5° 19' 14.16"W, 2313 m, granites with runoff from melting snow, 05-10-2014, *Luceño 340ML14*, UPOS-102009. *Ibidem*, Canal del Güetre*, 40° 15' 29.26"N / 5° 18' 4.90"W, 2351 m, 14-07-2015, *Luceño 581ML15*, UPOS-102586. *Ibidem*, north face of Riscos del Güetre*, 40° 15' 36.1"N / 5° 18' 18.5"W, 2360 m, granites with runoff from melting snow, 21-08-2014, *García Muñoz s.n.*, UPOS-102059. *Ibidem*, Circo de Gredos, pathway to Bermeja pass, 40° 14' 38.49"N / 5° 17' 39.58"W, 2370 m, granites with runoff from melting snow, 11-08-2014, *Luceño 147ML14*, UPOS-101438. *Ibidem*, Circo del Güetre*, 40° 15' 32.49"N / 5° 18' 1.30"W, 2350 m, granites with runoff from melting snow, 17-08-2014, *Luceño 182ML14*, UPOS-101476. *Ibidem*, Cantos Coloraos pass*, 40° 16' 10.96"N / 5° 19' 5.17"W, 2365 m, fissures, blocks and bare soil near a snowbed, 05-10-2014, *Luceño 358ML14*, UPOS-102028. **Macizo Occidental**, Circo de Hoyo Malillo, 40° 17' 41.11"N /

5° 44' 4.47"W, 2308 m, north facing granitic rocks with temporary runoff, 05-10-2013, *Cerrejón 38CCL13*, UPOS-100557. *Ibidem*, Circo del Trampal, 40° 18' 25.66"N / 5° 43' 41.23"W, 2297 m, wet and shady granitic corbels, 21-08-2013, *Luceño s.n.*, UPOS-100007.

SALAMANCA: **Macizo Occidental**, Circo del Trampal*, 40° 18' 24.17"N / 5° 43' 46.04"W, 2323 m, granites and corbels with temporary runoff from melting snow, 04-08-2015, *Luceño 797ML15*, UPOS-102591.

Andreaea nivalis is an arctic-alpine species (Murray, 1988) scattered, although locally change for "abundant" at Gredos high elevations, with four well delimited populations groups: 1) Picos de Gredos, between Circo de Gredos and the headwaters of the Navamediana gorge, 2) Circo de El Cancho, between Picos de Gredos and Sierra del Barco, 3) Sierra del Barco, and 4) Macizo Occidental (Hoyo Malillo and Circo del Trampal). It grows on shaded rocks with running water from melting snow in areas of late-lying snow and snow beds, always above 2190 m. In the remainder of the Iberian Peninsula, its presence has been only confirmed in the Pyrenees and the Cantabrian Range (Cros & Sérgio, 2007). The only previously known locality of the Central System of this species was published by Elías (1988a). The locality in Salamanca is a provincial novelty.

In most of the newly reported localities, fertile individuals were found with well-developed sporophytes. Male and female cushions of this dioicous species frequently grow close to each other, and even intermingled. This is the first time that *A. nivalis* fertile individuals have been found in the Iberian Peninsula. As it has been already described (Murray, 1988), the capsules are usually opened by four to six valves, although those from Sierra de Gredos present between three and seven valves (Figs 2-7).



Figs 2-7. Capsules of *Andreaea nivalis* from Sierra de Gredos showing 3-7 valves (2 from UPOS-101476; 3, 4, 7 from UPOS-102028; 5, 6 from UPOS-102586).

This species has received the category of VU (D2) in Spain. The discovery of these populations implies that criterion D2 is no longer applicable, since both the number of localities and the AOO exceed the IUCN threshold (IUCN, 2012). However, the threshold for AOO in the criterion B2 is probably not exceeded in EN category. If it is assumed that the distribution is fragmented (subcriterion a) and that the observed climate warming and fluctuations in precipitations are probably reducing the effective number of localities and individuals (subcriterion b) of this ecologically highly specialized species, it could be considered as EN B2a,b(ii,iv,v) in Spain.

Dichodontium pellucidum (Hedw.) Schimp.

ÁVILA: **Macizo Central**, headwaters of Los Conventos gorge, 40° 16' 9.05"N / 5° 11' 8.52"W, 2100 m, shady moist crannies, 19-08-2014, *Luceño 274ML14*, UPOS-101566.

This finding is a remarkable novelty for the Central System. The Iberian distribution of this species includes the Pyrenees, the Cantabrian Range, the Central System, the Catalan Coastal Range and Sierra Nevada Mountains, as well as a single locality in northern Portugal (Brugués & Ruiz, 2015a).

Heterocladium dimorphum (Brid.) Schimp.

ÁVILA: **Macizo Central**, pathway to Cinco Lagunas pass, 40° 15' 37.50"N / 5° 18' 27.21"W, 2250 m, wet fissures in snow beds, 05-10-2014, *Luceño 390ML14*, UPOS-102058.

This arctic-alpine species (Smith, 2004) was known in the Iberian Peninsula from Pyrenees, Cantabrian Range as well as from isolated localities in the Catalan Coastal Range and a population from the easternmost Central System (Garilleti & Albertos, 2012; Brugués & Ruiz, 2016a, 2016b); therefore, our finding represent the second locality known for the Central System and the southernmost Iberian population, since the presence of this species in Sierra Nevada Mountains (Casares Gil, 1914, 1915; Casas *et al.*, 2006) was considered doubtful by Rams *et al.* (2014).

Hygrohypnum molle (Hedw.) Loeske

ÁVILA: **Macizo Central**, Circo del Güetre, 40° 15' 32.49"N / 5° 18' 1.30"W, 2350 m, streams and granitic rocks with melting snow runoff, 17-08-2014, *Luceño 188ML14*, UPOS-101483. *Ibidem*, pathway to Güetre pass, 40° 15' 29.26"N / 5° 18' 4.90"W, 2351 m, 14-07-2015, *Luceño 580ML15*, UPOS-102249.

This species, with boreal-montane preferences (Smith, 2004), is here newly reported for the Central System. In the Iberian Peninsula it was known from Pyrenees, Sierra Nevada Mountains (where it is scarce, cf. Cros *et al.*; 2014; Rams *et al.*, 2014) and a single locality in the Cantabrian range (Oliván *et al.*, 2007). *Hygrohypnum molle* was assigned the status of VU (D2) in Spain, although in our opinion it does not fulfill the criteria, since it is known from at least eight localities in Spain and the AOO is larger than 20 km². Both the number of localities and the AOO are below the thresholds of the criterion B2 to classify the species as VU, although this categorization is not formally possible at present due to the lack of information to evaluate subcriteria b and c, which correspond to a continuing decline or extreme fluctuations in the Extent of Occurrence (EOO), AOO, area, extent and/or quality of habitat, number of locations and number of mature individuals (IUCN, 2012, 2014). Therefore, we consider that this species should be classified as "Data Deficient" (DD), at least until more data allow a more accurate conservation status assessment.

Kiaeria blyttii (Bruch & Schimp.) Broth.

ÁVILA: **Macizo Central**, Plataforma de Gredos, 40° 16' 22.11"N / 5° 14' 0.30"W, 1800 m, granitic shady nooks with north exposure, near the pass, 29-07-2015, *Luceño 621ML15*, UPOS-102290. *Ibidem*, Cuervo gorge, 40° 18' 40.00"N / 5° 5' 50.95"W, 1824 m, wide fissure in a granite block, 02-08-2015, *Luceño 723ML15*, UPOS-102561. **Macizo Occidental**, Circo de Peña Negra, 40° 21' 2.61"N / 5° 40' 40.59"W, 2027 m, granitic rocky area, 06-08-2015, *Luceño 862ML15*, UPOS-102563.

This taxon was considered as lacking from Spain until recently, although it was known from a Portuguese locality in the Serra da Estrela (Casas *et al.*, 2006). Later, during the revision of the genus for Flora Briofítica Ibérica (Brugués & Ruiz, 2015b), it was cited from Arbás lake (Asturias, Cantabrian Range) and from Romedo Inferior Lake (Lérida, central Pyrenees). *Kiaeria blyttii* grows on exposed or shady sites, in crevices of bedrock slabs and boulder faces in fell fields, usually in subalpine environments, and shows no affinity for areas of late-lying snow and snow beds, as do show *K. falcata* (Hedw.) I. Hagen and *K. starkei* (F. Weber & D. Mohr) I. Hagen (Smith, 2004; Miller, 2009).

It is very difficult, if not impossible, to identify sterile individuals of *Kiaeria*, since the vegetative characters are highly plastic (Brugués & Ruiz, 2015b). The study of fertile specimens has allowed us to detect numerous individuals morphologically intermediate between *K. starkei* and *K. blyttii*, not only at transitional altitudes between the optimal for both species, but also in the ecological territory of *K. starkei*. These forms show both intermediate vegetative traits (slightly crispate leaves when dry with variably papillose apex, upper third cells of the leaves square or shortly rectangular, etc.) and sexual traits; they widely vary in the position of the antheridia that, sometimes, appear above very short branches, slightly but not immediately below the perichaetium; this was already pointed out by Miller (2009), who, working on subalpine to alpine tundra environments, stressed that branch growth after fertilization alters the initial spatial relationship, and makes this character difficult to use in practice to separate *Kiaeria* specimens. A genetic study to elucidate whether the individuals listed below are the result of introgressive processes is required:

ÁVILA: **Macizo Central**, Pozas gorge, 40° 16' 3.16"N / 5° 14' 49.59"W, 1920 m, shady cool granitic block, 27-06-2015, *Luceño 395ML15*, UPOS-102552. *Ibidem*, Circo del Güetre, 40° 15' 29.07"N / 5° 18' 7.39"W, 2378 m, very shady crevices through which streams from melting snow flow, 14-07-2015, *Luceño 576ML15*, UPOS-102559. *Ibidem*, Cinco Lagunas, Cabrones lake, 40° 16' 5.23"N / 5° 18' 4.43"W, 2110 m, granites with temporary runoff, 17-08-2014, *Luceño 207ML14*, UPOS-101497. *Ibidem*, pathway to Bermeja pass, 40° 14' 39"N / 5° 17' 39"W, 2300 m, granites with runoff from melting snow, 11-08-2014, *Luceño 169ML14*, UPOS-101459. *Ibidem*, headwaters of the Navamediana gorge, 40° 16' 52.2"N / 5° 19' 42.6"W, 2226 m, corbels of wet rocks facing north, 05-10-2014, *Luceño 331ML14*, UPOS-102000. *Ibidem*, north slope of western Meapoco, 40° 16' 20.20"N / 5° 19' 14.20"W, 2313 m, granites with runoff from melting snow, 05-10-2014, *Luceño 342ML14*, UPOS-102150.

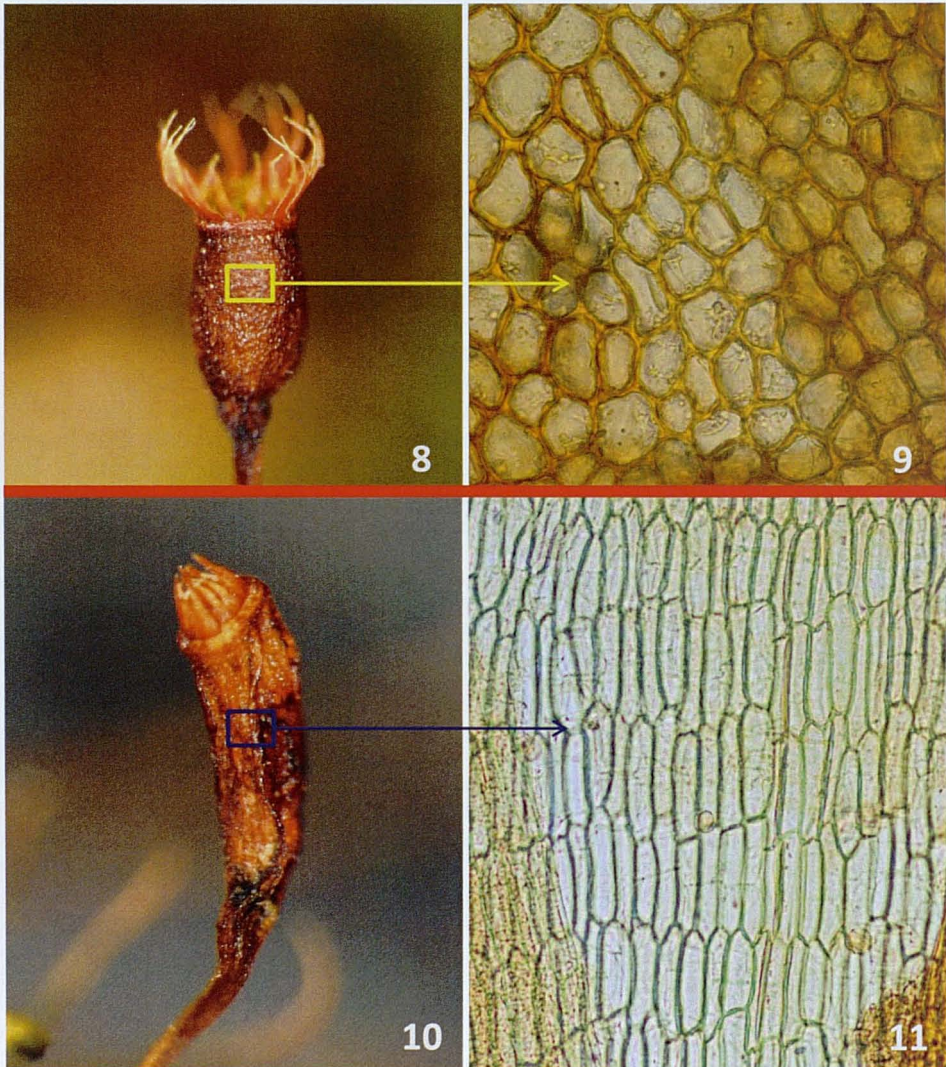
Such apparently intermediate individuals are also known in France, Massif Central, where *Kiaeria blyttii* is locally abundant (Vincent Hugonnot, pers. comm.).

Kiaeria falcata (Hedw.) I. Hagen

ÁVILA: **Macizo Central**, Circo del Güetre, 40° 15' 32.49"N / 5° 18' 1.30"W, 2350 m, streams and granitic rocks with water runoff from snow melt, 17-08-2014, *Luceño 192ML14*, UPOS-101485. *Ibidem*, 13-07-2015, *Luceño 565ML15*, UPOS-102243.

This is the first confirmed observation of this arctic-alpine species (Smith, 2004) in the Iberian Peninsula. The closest known populations are in the Alps,

ca. 1100 km away (Maier, 1997), which represents a remarkable disjunction. The presence of this species in the Iberian Peninsula was first reported by Casas *et al.* (2006), although it was subsequently discarded after the reexamination of the voucher by Brugués & Ruiz (2012). Sterile individuals are impossible to distinguish from *K. starkei*, but are easily separable when sporophytes are present: dry and mature capsules in *K. falcata* are smooth or slightly wrinkled, straight, ovoid or shortly cylindrical, presenting exothecial cells mostly isodiametric with thick walls, while in *K. starkei* dry capsules are sharply striated, usually somewhat curved, long-cylindrical, with rectangular exothecial cells and thinner walls (Figs 8-11).



Figs 8-11. Differences between the capsules of *Kiaeria falcata* (8, 9 from UPOS-101485) and *K. starkei* (10, 11 from UPOS-102246).

Although further surveys in similar habitats near the Circo del Güetre are required, only a single population with three cushions of this species was detected, which would be equivalent to three individuals according to criteria in Garilleti & Albertos (2012). Therefore, we propose the highest threat category to this species in Spain, "Critically endangered" (CR), based on criterion D.

Lescuraea radicata (Mitt.) Mönk.

ÁVILA: **Macizo Central**, headwaters of the Navamediana gorge, 40° 16' 52.17"N / 5° 19' 42.62"W, 2226 m, wet north facing rocky corbels, 5-10-2014, *Luceño 330ML14*, UPOS-101999. *Ibidem*, Risco Negro, 40° 15' 43.12"N / 5° 16' 59.07"W, 2115 m, granites with temporary water runoff, 03-10-2015, *Guerra Cárdenas 65SGC15*, UPOS-102778.

The only known population so far in the Central System corresponds to an old voucher collected in Sierra de Guadarrama, from where it has not been collected again (Brugués & Ruiz, 2015c). Its presence has been also confirmed from Pyrenees and Central System (Casas *et al.*, 2006; Brugués & Ruiz, 2015c); the report from Sierra Nevada Mountains (Allorge & Allorge, 1946), was considered doubtful by Rams *et al.* (2014), but its presence has been confirmed by Brugués (pers. comm.) based on the specimen GDAC 28182 collected in the Puntal de la Caldera, at 3100 m.

Lescuraea saxicola (Schimp.) Molendo

ÁVILA: **Macizo Central**, Circo Central, pathway to Bermeja pass, 40° 14' 36.44"N / 5° 26' 56.55"W, 2240 m, rocks and crannies with melting snow runoff, 11-08-2014, *Luceño 135ML14*, UPOS-101426. *Ibidem*, 40° 14' 39.00"N / 5° 17' 39.00"W, 2300 m, *Luceño 167ML14*, UPOS-101457. *Ibidem*, Circo del Güetre, 40° 15' 32.49"N / 5° 18' 1.30"W, 2350 m, streams and granitic rocks with melting snow runoff, 17-08-2014, *Luceño 198ML14*, UPOS-101490. *Ibidem*, pathway to Güetre pass, 40° 15' 29.26"N / 5° 18' 4.90"W, 2351 m, granitic wall with melting snow runoff, 14-07-2015, *Luceño 594ML15*, UPOS-102813. *Ibidem*, headwaters of the Navamediana gorge, 40° 16' 20.16"N / 5° 19' 14.16"W, 2313 m, granites with melting snow runoff, 05-10-2014, *Luceño 347ML14bis*, UPOS-102018. *Ibidem*, Cantos Coloraos pass, 40° 16' 10.96"N / 5° 19' 5.17"W, 2365 m, fissures, blocks and bare soil near a snowbed, 05-10-2014, *Luceño 356ML14*, UPOS-102026. *Ibidem*, pathway to Cinco Lagunas pass, between 40° 15' 35.40"N / 5° 18' 31.94"W and 40° 15' 37.50"N / 5° 18' 27.21"W, 2300-2250 m, wet fissures with long-term snow cover, 05-10-2014, *Luceño 375ML14*, UPOS-102045. **Macizo Occidental**, Circo de Hoyo Malillo, 40° 17' 54.29"N / 5° 43' 56.87"W, 2330 m, wet granites, 05-10-2013, *Cerrejón 24CCL13*, UPOS-100543. *Ibidem*, Circo del Trampal, 40° 18' 25.65"N / 5° 43' 41.23"W, 2297 m, shady granites with seasonal water runoff, 21-08-2013, *Luceño s.n.*, UPOS-100213.

SALAMANCA: **Macizo Occidental**, El Canchalón, 40° 20' 39.33"N / 5° 41' 48.84"W, 2156 m, shady granitic block, 30-07-2015, *Luceño 652ML15*, UPOS-102291.

A similar species, *L. mutabilis* (Brid.) Lindb., was cited from Circo del Trampal (Elías, 1989b); however, all the materials studied from that locality correspond to *L. saxicola*, as expected taking into account the epiphytic preferences of *L. mutabilis*, which also rarely reaches the upper stages of the Iberian mountains (Casas *et al.*, 2006). *Lescuraea saxicola* was previously known only from the Pyrenees and two isolated populations wide apart, one in the Catalan Coastal Range and another in the Cantabrian Range (Casas *et al.*, 2006); the information in Ruíz & Brugués (2015) from Ávila province is based on the specimens given in this paper.

Meesia triquetra (L. ex Jolycl.) Ångstr.

ÁVILA: **Sierra de Villafranca**, Peña Negra mountain pass, 40° 25' 46.04"N / 5° 15' 51.56"W, 1946 m, mire, 29-07-2015, *Luceño 616ML15*, UPOS-102268. *Ibidem*, 40° 25' 21.47"N / 5° 17' 38.72"W, 1905 m, mire, 31-07-2015, *Luceño 671ML15*, UPOS-102841. **La Serrota**,

Alberche river spring, 40° 24' 39.69"N / 5° 13' 26.99"W, 1730 m, mire, 31-07-2015, *Luceño 679ML15*, UPOS-102952. **Macizo Central**, Parador Nacional de Gredos, 40° 21' 15.91"N / 5° 5' 47.60"W, 1580 m, mire, 31-07-2015, *Luceño 684ML15*, UPOS-102286.

This peatland species is very rare in the Iberian Peninsula with only two distant, previously known populations, one in the Central Pyrenees (Infante & Heras, 2010) and the other in Gredos Macizo Central (Infante & Heras, 2001). *Meesia triquetra* was also collected in Sierra de Guadarrama and Sierra Nevada Mountains, where it is probably extinct (Infante & Heras, 2010, 2012; Rams *et al.*, 2014). The four additional populations presented in this study considerably expand the area of the species in Gredos. One of the locations in the Peña Negra pass and the population of the Parador de Gredos present a large number of individuals covering almost completely an area of ca. 200 and ca. 400 m², respectively.

At Spanish level, the species was catalogued as CR [B2ab(i,ii,iii,iv)] based on a reduced AOO (IUCN, 2012). The populations newly reported here represent an improvement in the conservation status of the species, since the AOO would increase from 8 to 24 km², exceeding the 10 km² threshold for CR category (IUCN, 2012). According to this new data, we believe this species should be reevaluated as EN [B2ab(i,ii,iii,iv)] in Spain. Considering the disjunction between the Pyrenees and Gredos populations, in our opinion the criterion of fragmented distribution (sub-criterion a; IUCN, 2012) should be applied, as well as those corresponding to the reduction of the EOO, AOO, area, extent and/or quality of habitat and number of localities, taking into account the apparently extinct populations of Sierra Nevada and Guadarrama. In addition, our finding represents a considerable increase in the estimated coverage of *M. triquetra*, almost ten times the value formerly known for the species in Spain (Infante & Heras, 2012). We are aware that due to the peculiarities of IUCN methodology, EN category may not accurately represent the actual conservation status of this species, because the real area occupied by individuals of this species is far smaller than 24 km², and it only appears in very specific and rare habitats.

Plagiothecium piliferum (Schwartz) Schimp.

ÁVILA: **Macizo Occidental**, Solana de Ávila, El Chorro hydroelectric power station, ascent to the birch grove, 40° 18' 23.70"N / 5° 40' 20.30"W, 1480 m, very shady and wet deep fissure, 17-04-2014, *Cerrejón 169CCL14*, UPOS-101204.

The locality cited here is a novelty for the Central System. This species is very rare in the Iberian Peninsula (Casas *et al.*, 2006), and it was only previously known from few localities in the Cantabrian Range (Allorge, 1934; Fernández Ordóñez, 1985), growing on decaying wood of *Castanea sativa* L. and crevices of *Fagus sylvatica* L. exposed roots, respectively. A further locality in Asturias (Fernández Ordóñez, 1981) must be considered doubtful until revision, as it was reported growing on dry limestone, an unlikely habitat for this taxon (Schimper, 1876; Ireland, 2014). Its presence in Portugal (Mafra, Beira Litoral, cf. Henriques, 1889) was confirmed by Sérgio & Carvalho (2003).

Plagiothecium platyphyllum Mönk.

ÁVILA: **Macizo Central**, Los Conventos gorge, 40° 16' 8.16"N / 5° 11' 18.35"W, 2115 m, crannies in shady and wet granites, 19-08-2014, *Luceño 283ML14*, UPOS-101575. *Ibidem*, Las Pozas gorge, 40° 16' 3.16"N / 5° 14' 49.59"W, 1920 m, wet and shady granitic crannies, 27-06-2015, *Luceño 408ML15*, UPOS-102647. *Ibidem*, Arenas de San Pedro, San Pedro de Alcántara monastery road, 40° 13' 26.54"N / 5° 4' 39.19"W, 641 m, alder tree roots near a stream, 28-03-2014, *Pineda Labella 218VPL14*, UPOS-101016. *Ibidem*, La Nava gorge, 40° 15' 18.14"N / 5° 33' 57.32"W, 1494 m, wet and shady granites, 13-07-2014, *Muñoz*

2EMU14, UPOS-102073. *Ibidem*, Circo de Gredos, 40° 15' 15.61"N / 5° 16' 24.17"W, 2020 m, wet granitic crevices, 17-05-2014, *Cerrejón 526CCL14*, UPOS-101887. *Ibidem*, Cinco Lagunas, Cimera lagoon, 40° 15' 43.5"N / 5° 18' 15.90"W, 2150 m, fissures in granitic blocks with permanent melting snow runoff, 13-07-2015, *Luceño 558ML15*, UPOS-102719. **Macizo Occidental**, Circo de Peña Negra, 40° 21' 1.70"N / 5° 40' 38.88"W, 2025 m, natural spring margin, 06-08-2015, *Luceño 872ML15*, UPOS-102861. **Macizo Oriental**, Villarejo del Valle, Arroyo Mosquillos gorge, 40° 17' 5.27"N / 4° 58' 23.38"W, 907 m, between willow roots near a stream 16-04-2014, *Cerrejón 104CCL14*, UPOS-101273. *Ibidem*, Puerto del Pico pass, pathway to El Torozo, 40° 19' 13.50"N / 5° 0' 14.71"W, 1522 m, wet granites near a stream, 30-03-2014, *Pineda Labella 294VPL14*, UPOS-101080. *Ibidem*, between Navarrevisca and Serranillos, 40° 18' 0.10"N / 4° 56' 30.30"W, 1402 m, very shady granitic block near a stream, 25-04-2015, *Luceño 329ML15*, UPOS-102573.

This is, together with *P. succulentum* (Wils.) Lindb., the most common species of the genus by far in every altitudinal level of the Gredos range. In the Iberian Peninsula it is distributed in mountain ranges of the northern half (Casas *et al.*, 2006), although as far as we know no previous collections were made neither from Gredos nor from Ávila province.

This species is classified as VU (D2) in Spain, but the numerous populations found in the Central System would imply the removal from the list of threatened species because it would exceed the thresholds for the number of localities and AOO based on the criterion D2 (IUCN, 2012). Therefore, with the available data it should currently be considered as LC. Nonetheless, we consider more detailed studies are needed to test the applicability of other criteria (e.g. criterion B).

Pohlia bolanderi var. *seriata* A.J. Shaw

ÁVILA: **Macizo Central**, Cantos Coloraos pass, 40° 16' 10.96"N / 5° 19' 5.17"W, 2365 m, fissures, blocks and bare soil near a snowbed, 05-10-2014, *Luceño 355ML14*, UPOS-102990. *Ibidem*, near Güetere pass, 40° 15' 25.61"N / 5° 18' 12.56"W, 2483 m, granitic blocks and bare soil near a snowbed, 14-07-2015, *Luceño 599ML15*, UPOS-102881. *Ibidem*, headwaters of Los Conventos gorge, 40° 16' 4.14"N / 5° 11' 19.80"W, 2142 m, wet and shady crevices on granitic rocks where the snow remains for a long time, 28-06-2015, *Luceño 494ML15*, UPOS-102994. *Ibidem*, Circo de Gredos, 40° 15' 15.61"N / 5° 16' 24.17"W, 2020 m, wet and shady crevice near a snowbed, 17-05-2014, *Cerrejón 521CCL14*, UPOS-102226.

In the Sierra de Gredos, this taxon is quite rare and limited to the alpine belt, in shady and wet places where the snow remains for a long time. *Pohlia bolanderi* var. *seriata* was recently cited for Europe (Rams *et al.*, 2004). Its taxonomic value has been questioned by the author of the taxon (Shaw, 2014) and it is not recognized in Ros *et al.* (2013). Guerra (2010, 2016) considered it as a good variety known only from three localities in Spain: Pyrenees, Montes de León and Sierra Nevada Mountains. The var. *bolanderi* was reported from the Central System (Guerra *et al.*, 2007). Our finding represents the first report of var. *seriata* for the Central System in Spain.

At the species level, *P. bolanderi* is considered as VU (D2) in Spain. However, the number of populations currently known (17, cf. Guerra *et al.*, 2007), as well as its AOO, are inconsistent with the criterion D2, and thus this species should be removed from the threatened list of bryophytes, and to be considered as LC. However, like for the previous species (*Plagiothecium platyphyllum*), more detailed studies are needed to test the applicability of other criteria (e.g. criterion B). The conservation status of the variety *seriata* has not been evaluated in Spain.

Pohlia wahlenbergii var. *glacialis* (Brid) E.F. Warb.

ÁVILA: **Macizo Central**, Circo del Güetere, 40° 15' 32.40"N / 5° 18' 1.30"W, 2350 m, streams and granitic rocks with melting snow runoff, 17-08-2014, *Luceño 183ML14*, UPOS-101477.

Ibidem, Laguna Grande de Las Lagunillas, 40° 17' 3.67"N / 5° 18' 43.66"W, 1920 m, base of a granitic block near the lake, 4-10-2014, *Luceño 299ML14*, UPOS-101964. **Macizo Occidental**, headwaters of the Hoyo Malillo stream, 40° 17' 54.28"N / 5° 43' 56.87"W, 2330 m, wet granites, 05-10-2013, *Cerrejón 21CCL13*, UPOS-100541. *Ibidem*, Circo de Peña Negra, 40° 20' 56.83"N / 5° 40' 32.65"W, 2157 m, granitic wall with water runoff, 06-08-2015, *Luceño 882ML15bis*, UPOS-103223.

These are the first records for the Central System of this high mountain variety that was only known in the Iberian Peninsula from the Pyrenees and Sierra Nevada Mountains, and is considered just an orophyte ecotype (Guerra, 2010); all specimens from Gredos are of var. *glacialis* morphotype, always found in chionophilous communities, reasons for which we accept here the taxonomic value of this variety. Further systematic studies could shed some light on this issue.

The conservation status of this species varies according to the territorial scale: it has been considered as "Near Threatened" (NT) for Spain, and VU in the Canary Islands [B1ab(iii)+2ab(iii)]. In our opinion, based on the species distribution in the Iberian Peninsula and Canary Islands (Guerra, 2010), we consider it does not accomplish any criteria of the risk categories (IUCN, 2012), and therefore it should be considered as LC in Spain. The conservation status of the variety *glacialis* has not been evaluated for Spain.

Polytrichastrum sexangulare (Flörke *ex* Brid.) G.L. Sm.

ÁVILA: **Macizo Central**, Circo del Güetre, 40° 15' 32.49"N / 5° 18' 1.30"W, 2350 m, streams and granitic rocks with melting snow runoff, 17-08-2014, *Luceño 195ML14*, UPOS-101487. *Ibidem*, 13-07-2015, *Luceño 567ML15*, UPOS-102230.

The population from Gredos is restricted to a ground surface of around 9 m². To date, the Iberian distribution of this species was limited to the Pyrenees (Brugués & Ruiz, 2015c). Therefore, this chionophile taxon constitutes a noteworthy novelty for the Central System. Interestingly, the same locality where the population was found (Circo del Güetre), also harbours others arctic-alpine relicts, absent (*Hygrohypnum molle* and *Kiaeria falcata*) or scarce (*Andreaea nivalis*, *Pohlia bolanderi* var. *seriata* and *P. wahlenbergii* var. *glacialis*) in the remaining of the Central System, which indicates the extreme high mountain conditions of the Circo del Güetre, and highlights the great biogeographic and conservation interest of this place for scarce and threatened bryophytes.

At Spanish level, this species is classified as VU (D2). Nevertheless, the high number of localities known from Pyrenees (Brugués & Ruiz, 2016c), together with the population mentioned here, preclude the application of criterion D2 (IUCN, 2012). With our current knowledge, this species should be excluded from the list of threatened bryophytes of Spain, and be considered as LC.

Polytrichum longisetum Sw. *ex* Brid.

ÁVILA: **Macizo Central**, headwaters of the Navamediana gorge, 40° 16' 59.66"N / 5° 19' 46.53"W, 2167 m, submerged in a stream, 5-10-2014, *Luceño 324ML14*, UPOS-101992.

This species was previously collected in four Spanish localities: two Pyrenean populations, one in the Cantabrian Range and one in the Macizo Occidental of Gredos (Brugués *et al.*, 2012; Brugués & Ruiz, 2016d). However, none of the latter two were found recently (Brugués *et al.*, 2012). Therefore, the population found in the Macizo Central confirms the presence of this species in the Central range.

It was considered CR in Spain [B2ab(iii), D]. The delimitation of mature individuals takes into account the discrete units with diffuse distribution (cushions;

Brugués *et al.*, 2007b), so a single individual per population has been censused (Brugués *et al.*, 2012). The rise in the AOO due to our findings (from 8 to 12 km²) implies that the criterion B of the CR category is not applicable, so the species must be considered CR by criterion D exclusively.

Sphagnum fimbriatum Wilson

ÁVILA: **Macizo Central**, La Nava gorge, 40° 14' 10.23"N / 5° 34' 16.06"W, 1823 m, granitic blocks traversed by a stream and wet granitic corbels, 13-07-2014, *Muñoz 24EMU14*, UPOS-102097. *Ibidem*, Circo de Gredos, Laguna Grande, 40° 15' 3.57"N / 5° 16' 36.32"W, 1948 m, lake margin, 11-08-2014, *Luceño 127ML14*, UPOS-101419. *Ibidem*, Hoya Antón, 40° 14' 49.49"N / 5° 17' 3.67"W, 2050 m, pool margin, 11-08-2014, *Luceño 175ML14*, UPOS-101468.

So far it was only known from isolated localities in Pyrenees, Cantabrian Range and southern Iberian System (Brugués *et al.*, 2007c). It is a novelty for the Central System.

Syntrichia norvegica F. Weber

ÁVILA: **Macizo Central**, Cinco Lagunas pass, 40° 15' 39.10"N / 5° 18' 35.96"W, 2310 m, snowbeds, 14-07-2015, *Luceño 600ML15*, UPOS-102817. *Ibidem*, Circo de la Laguna del Barco, 40° 15' 49' 48"N / 5° 36' 39' 66"W, 2068 m, cranny in a granitic wall with water runoff, 24-10-2015, *Pineda Labella 54VPL15bis*, UPOS-102738.

Arctic-alpine moss (Smith, 2004) restricted in the Iberian Peninsula to the Pyrenees, Cantabrian Range, Sierra Nevada Mountains (Gallego, 2006; Rams *et al.*, 2014), and recently collected in the pre-Pyrenean Sierra del Cadí (Guerra *et al.*, 2013). After a scrutiny of the pertinent literature, we could not find any report of this species for Málaga province (Gallego, 2006), record that should be definitively discarded. This species has preference for basic soils, especially on crevices on limestone (Gallego, 2006) which are absent in the high Gredos; however, in the locations cited here there were certain rare vascular plants typical of calcicolous habitats; such as *Rumex scutatus* L., *Sedum dasyphyllum* L. and *Scutellaria alpina* L., suggesting a greater basicity of some granites in the area.

Liverworts

Calypogeia muelleriana (Schiffn.) Müll. Frib.

CÁCERES: **Macizo Occidental**, Honduras mountain pass, 40° 13' 4.64"N / 5° 52' 44.10"W, 1394 m, crannies in a stream, 11-05-2014, *Cerrejón 328CCL14*, UPOS-101712.

This species represents a novelty for the Spanish Central System and Extremadura region. It has marked oceanic requirements and appears sporadically in locations of the north, west and south Peninsula (Casas *et al.*, 2009). The closest populations are located in the portuguese Serra da Estrela (Sérgio *et al.*, 2013).

Fuscocephaloziopsis pleniceps (Austin) Lindb. [= *Cephalozia pleniceps* (Austin) Lindb.]

ÁVILA: **Macizo Central**, Puerto del Pico pass, 40° 19' 25.00"N / 5° 00' 52.00"W, 1375 m, wet slope in peatland, 24-06-2014, *Luceño 5ML14*, UPOS-100519.

Previously, this species was known from the Pyrenees, Iberian System and isolated localities in the Cantabrian Range, although it is strikingly absent in the Basque Country (Infante, 2000; Casas *et al.*, 2009). The present finding is, therefore, a relevant novelty for the Central System as a whole, and represents the southernmost populations in the Iberian Peninsula. It can be distinguished of similar species, such

as the frequent *Cephalozia bicuspidata*, by the homogeneously thin-walled apical cell of the leaves lobes, and its vertically disposed and frequently decurrent leaves. *Fuscocephalozipsis pleniceps* grows in a wide range of habitats, including basic fens and flushes (Paton, 1999); in Sierra de Gredos it forms small cushions in peatland margins mostly on acid granites, despite some may contain basic xenoliths.

This species was considered VU (D2) for Spain. Nevertheless, based on its distribution, it seems highly unlikely to meet the thresholds of number of localities and AOO according to criterion D2 (IUCN, 2012). In the absence of data regarding other criteria (e.g. criterion B), we propose to consider *F. pleniceps* as not endangered (LC).

Jungermannia pumila With.

ÁVILA: **Macizo Occidental**, El Chorro hydroelectric power station, ascent to the birch grove, 40° 18' 21.69"N / 5° 40' 19.96"W, 1472 m, stream rocks, 17-04-2014, *Cerrejón 174CCL14*, UPOS-101208.

This species was previously known in the Iberian Peninsula from isolated localities in the northern half and from Sierra Nevada Mountains (Casas *et al.*, 2009; Rams *et al.*, 2014). To our knowledge, this is the first collection from the Central System.

As in the case of *Pohlia wahlenbergii*, the conservation status of this species varies depending on the territorial scale considered. Thus, this liverwort is NT in Spain, while it has been considered as VU in the Canary Islands [B1ab(iii)+2ab(iii)]. In the light of its distribution in the Iberian Peninsula and the Canary Islands (Schwab *et al.*, 1986; Casas *et al.*, 2009; Rams *et al.*, 2014), *J. pumila* does not fulfill any criteria of the risk categories (IUCN, 2012), and thus it should be considered as LC in Spain.

Lejeunea lamacerina (Steph.) Schiffn.

ÁVILA: **Macizo Central**, Río Muelas gorge, 40° 10' 14.00"N / 5° 11' 45.98"W, 580 m, on wet granites in alder grove forest, near a *Prunus lusitanica* copse, 11-09-1999, *Heras & Infante s.n.*, VIT-1146/99.

The voucher is mature and bears abundant sporophytes. The value of the ravines with *Prunus lusitanica* is widely recognized as refugia for Oceanic species such as *L. lamacerina* (Albertos *et al.*, 1997; Casas *et al.*, 1999; Calleja *et al.*, 2001). The species was recorded in the Iberian Peninsula along Cantabrian and northern Atlantic coasts (Jovet-Ast & Bischler, 1976). The two populations known outside that range are two small *P. lusitanica* woodlands: the one reported here, and another in Montseny (Gerona province; Calleja *et al.*, 2001). This report constitutes a provincial novelty.

Mesoptychia heterocolpos (Thed. ex Hartm.) L. Söderstr. & Vána [= *Lophozia heterocolpos* (Thed. ex C. Hartm.) M. Howe]

ÁVILA: **Macizo Central**, Los Conventos gorge, 40° 16' 6.00"N / 5° 11' 17.06"W, 2120 m, crannies in wet and shady granites, 19-08-2014, *Luceño 251ML14*, UPOS-101543.

This species was only known from central Pyrenees and Sierra Nevada Mountains, where it is scarce (Guerra & Gil, 1981; Casas *et al.*, 2009; Rams *et al.*, 2014); therefore, this new record represents an important addition to the Central System bryoflora.

It was considered VU (D2) for Spain and also for the Canary Islands, and this new locality implies no enough increase in the distribution area to change this category.

Nardia geoscyphus (De Not.) Lindb.

ÁVILA: **Macizo Central**, Pinillo stream, 40° 17' 7.11"N / 5° 11' 51.62"W, 1780 m, cranny in a stream margin, 25-07-2014, *Luceño 54ML14bis*, UPOS-101402.

It was previously known from isolated localities in the northern Iberian Peninsula (Pyrenees, Iberian System; cf. Casas *et al.*, 2009; Garilleti & Albertos, 2012), as well as in the Canary Islands (Dirkse & Bouman, 1990). This new locality represents an interesting addition for the Central System.

This taxon was included in the category NT in Spain, while it is considered as VU in the Canary Islands. To our knowledge, no information is available about the number of known populations, which prevents us for reevaluating the conservation status of this species.

Solenostoma obovatum (Nees) C. Massal. [= *Jungermannia obovata* Nees]

ÁVILA: **Macizo Central**, Circo Central, pathway to Bermeja pass, 40° 14' 43.93"N / 5° 17' 31.68"W, 2237 m, shady rocks with temporary water runoff, 11-08-2014, *Luceño 158ML14*, UPOS-101448. *Ibidem*, Los Conventos gorge, 40° 16' 17.49"N / 5° 10' 33.86"W, 2100 m, wet and shady crannies, 19-08-2014, *Luceño 276ML14*, UPOS-101525. *Ibidem*, Chorreras del Tormes, 40° 20' 15.00"N / 5° 09' 23.20"W, 1420 m, wet slope near a small peatland, 18-08-2014, *Luceño 226ML14*, UPOS-101568. **Macizo Occidental**, Circo de Hoyo Malillo, 40° 17' 54.29"N / 5° 43' 56.87"W, 2330 m, wet granites, 05-10-2013, *Cerrejón 30CCL13-2*, UPOS-100549.

This is a frequent species in the high elevations of Sierra de Gredos, although sometimes can be observed slightly below 1500 m. It was only known from isolated localities in the north Iberian Peninsula, where it grows on wet acid soils in montane and high mountain areas (Casas *et al.*, 2009). The here reported new populations represent a novelty for the Central System and Ávila province.

Tritophozia quinquedentata (Huds.) Bakalin [= *Tritomaria quinquedentata* (Hudson) H. Buch]

ÁVILA: **Macizo Central**, El Cancho gorge, 40° 12' 39.00"N / 5° 31' 36.78"W, 1566 m, fissures in large granitic blocks, 09-07-2016, *Luceño 308ML16bis*, UPOS-103343. **Macizo Occidental**, El Chorro hydroelectric power station, ascent to the birch grove, 40° 18' 23.70"N / 5° 40' 20.30"W, 1480 m, very wet and deep fissures, 17-04-2014, *Cerrejón 167CCL14*, UPOS-101202.

This is an oceanic taxon only known so far from the northern Iberian Peninsula, where it is quite frequent, and grows mainly on acidic substrates in montane or high mountain areas (Casas *et al.*, 2009). The populations reported here represent an interesting finding for the Central System.

Hornworts*Anthoceros caucasicus* Steph.

ÁVILA: **Macizo Central**, Navamediana gorge, 40° 18' 40.54"N / 5° 24' 23.26"W, 1253 m, seasonally wet soils in the base of wet granites, 12-05-2014, *Cerrejón 363CCL14*, UPOS-101740. *Ibidem*, Arenas de San Pedro, Pescadores pathway, 40° 11' 56.54"N / 5° 6' 14.45"W, 493 m, seasonally wet soils in the base of a granitic block, 27-03-2014, *Pineda Labella 172VPL14-1*, UPOS-100971. *Ibidem*, Candeleda, White gorge, 40° 12' 54.05"N / 5° 14' 54.65"W, 945 m, seasonally wet soils in the base of granitic blocks, 24-03-2016, *Luceño 88ML16*, UPOS-103344.

CÁCERES: **Macizo Central**, Los Infiernos gorge, Los Pilones, 40° 12' 5.60"N / 5° 44' 56.28"W, 780 m, earthy wet slopes on a roadside, 14-04-2013, *Acal 60AA13*, UPOS-102993.

This is here reported for the first time from Sierra de Gredos, where it is more common than its congeneric *A. punctatus* L. In Portugal *A. caucasicus* is locally abundant in Serra da Estrela (Bieira Alta) and Estremadura and rarer in Alto Alentejo, but from Spain it is only known from two old collections from Segovia and Huelva provinces (Sérgio *et al.*, 2016). This species is also present in the Canary Islands (Dirkse *et al.*, 1993; González-Mancebo *et al.*, 2008).

Anthoceros caucasicus is classified as NT for Spain, while it is considered as LC in the Canary Islands. The four localities cited here would cover an AOO of 16 km² (2 × 2 km cells; cf. IUCN, 2012), which precludes the application of the criterion B2 for the CR category (threshold of 10 km²). However, the threshold for the category EN would be met (500 km²; cf. IUCN, 2012), even considering the other two populations (Huelva and Segovia). Moreover, the known populations are separated by more than 100 km, and thus they can be considered “severely fragmented”, fulfilling “subcriterion a” (IUCN, 2012). Finally, according to Brugués & González-Mancebo (2012), the known populations face several negative processes: area decline, extent and/or quality of habitat, and the number of mature individuals (subcriteria b(iii,v); cf. IUCN, 2012). We do not know the number of populations and their distribution in the Canary Islands, what would be necessary to carry out a complete evaluation at the national level. Therefore, with the current data, we may only propose the category EN [B2ab(ii,v)] for peninsular Spain.

Acknowledgments. We thank Montserrat Brugués (Barcelona, BCB) and Pedro García (Granada, GDAC) for their help with one specimen of *Lescuraea* from Sierra Nevada Mountains.

REFERENCES

- ALBERTOS B., LARA F., GARILLETI R. & MAZIMPAKA V., 1997 — Estudio brioflorístico de una formación relictica de *Prunus lusitanica* L. de la Sierra de Gredos (Ávila, España). *Cryptogamie, Bryologie-Lichénologie* 18: 303-313.
- ALLORGE P., 1934 — Notes sur la flore bryologique de la Péninsule ibérique IX. Muscinées des provinces du Nord et du Centre de l'Espagne. *Revue bryologique et lichénologique* 7: 249-301.
- ALLORGE P. & ALLORGE V., 1946 — Notes sur la flore bryologique de la Péninsule Ibérique X. Muscinées du Sud et de l'Est de l'Espagne. *Revue bryologique et lichénologique* 15: 172-200.
- ARIAS C., GRANZOW DE LA CERDA Í. & MAZIMPAKA V., 1989 — Fragmenta Chorologica Occidentalia, Bryophyta, 635-651. *Anales del jardín botánico de Madrid* 43: 436-437.
- BRUGUÉS M., CROS R.M. & GUERRA J. (eds), 2007a — *Flora Briofítica Ibérica. Volumen I*. Murcia, Universidad de Murcia, Sociedad Española de Briología.
- BRUGUÉS M., RUIZ E. & CASAS C., 2007b — *Polytrichastrum*. In: Brugués M., Cros R.M. & Guerra J. (eds), *Flora Briofítica Ibérica. Volumen I*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 123-128.
- BRUGUÉS M., MUÑOZ J., RUIZ E. & HERAS P., 2007c — *Sphagnum*. In: Brugués M., Cros R. M. & Guerra J. (eds), *Flora Briofítica Ibérica. Volumen I*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 17-78.
- BRUGUÉS M. & GONZÁLEZ MANCEBO J.M., 2012 — Lista Roja de los Briófitos Amenazados de España. In: Garilleti R. & Albertos B. (eds), *Atlas de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 26-42.
- BRUGUÉS M. & RUIZ E., 2012 — The genus *Kiaeria* in Spain, including *K. blyttii* (Bruch et Schimp.) Broth. new to Spain. *Cryptogamie, Bryologie* 33: 263-266.
- BRUGUÉS M., CROS R.M., RUIZ E. & ELÍAS M.J., 2012 — *Polytrichastrum longisetum* (Sw. ex Brid.) G. L. Sm. In: Garilleti R. & Albertos B. (eds), *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 76-77.
- BRUGUÉS M. & GUERRA J. (eds) 2015 — *Flora Briofítica Ibérica. Volumen II*. Murcia, Universidad de Murcia, Sociedad Española de Briología.

- BRUGUÉS M. & RUIZ E., 2015a — *Dichodontium*. In: Brugués M. & Guerra J. (eds), *Flora Briofítica Ibérica. Volumen II*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 56-60.
- BRUGUÉS M. & RUIZ E., 2015b — *Kiaeria*. In: Brugués M. & Guerra J. (eds), *Flora Briofítica Ibérica. Volumen II*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 69-72.
- BRUGUÉS M. & RUIZ E., 2015c — *Lescuraea radicata* (Mitt.) Mönk. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- BRUGUÉS M. & RUIZ E., 2016a — *Heterocladium*. In: Brugués M. & Guerra J. (eds), *Flora Briofítica Ibérica (Fascículos)*. Murcia, Universidad de Murcia, Sociedad Española de Briología.
- BRUGUÉS M. & RUIZ E., 2016b — *Heterocladium dimorphum* (Brid.) Schimp. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 13/10/2016.
- BRUGUÉS M. & RUIZ E., 2016c — *Polytrichastrum sexangulare* (Brid.) G.L. Sm. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- BRUGUÉS M. & RUIZ E., 2016d — *Polytrichastrum longisetum* (Sw. ex Brid.) G. L. Sm. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- CALLEJA J.A., ALBERTOS B., MAZIMPAKA V. & LARA F., 2001 — Brioflora epífita de las loreras de la Península Ibérica. *Boletín de la sociedad Española de briología* 18/19: 15-23.
- CASARES GIL A., 1914 — Una excursión briológica á Sierra Nevada. *Boletín de la real sociedad Española de historia natural* 14: 100-104.
- CASARES GIL A., 1915 — Enumeración y distribución geográfica de las muscíneas de la Península Ibérica. *Trabajos del museo nacional de ciencias naturales. Serie botanica* 8: 1-179 + 3 mapas.
- CASAS C., 1988 — Datos para la brioflora de la Sierra de Gredos. *Lazaroa* 10: 265-267.
- CASAS C., BRUGUÉS M., CROS R.M. & SÉRGIO C., 1999 — Briófitos de algunos barrancos de las Villuercas (Cáceres) con *Prunus lusitanica*. *Boletín de la sociedad Española de briología* 14: 1-6.
- CASAS C., BRUGUÉS M., CROS R.M. & SÉRGIO C., 2006 — *Handbook of mosses of the Iberian Peninsula and the Balearic Islands*. Barcelona, Institut d'Estudis Catalans.
- CASAS C., BRUGUÉS M., CROS R.M., SÉRGIO C. & INFANTE M., 2009 — *Handbook of Liverworts and Hornworts of the Iberian Peninsula and the Balearic Islands*. Barcelona, Institut d'Estudis Catalans.
- CROS R.M. & SÉRGIO C., 2007 — *Andreaea*. In: Brugués M., Cros R.M. & Guerra J. (eds), *Flora Briofítica Ibérica. Volumen I*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 81-98.
- CROS R.M., BRUGUÉS M. & SÉRGIO C., 2014 — *Hygrohypnum molle* (Hedw.) Loeske. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- CROS R.M., SÉRGIO C. & BRUGUÉS M., 2016a — *Andreaea heinemannii* Hampe & Müll. Hal. subsp. *crassifolia* (Luisier) Sérgio. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- CROS R.M., BRUGUÉS M. & SÉRGIO C., 2016b — *Andreaea heinemannii* Hampe & Müll. Hal. subsp. *heinemannii*. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófits. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- DIRKSE G.M. & BOUMAN A.C., 1990 — Additions to the bryophyte flora of the Canary Islands. *Lindbergia* 15: 145-150.
- DIRKSE G.M., BOUMAN A.C. & LOSADA-LIMA A., 1993 — Bryophytes of the Canary Islands, an annotated checklist. *Cryptogamie, Bryologie-Lichénologie* 14: 1-47.
- DIRKSE G.M. & LOSADA-LIMA A., 2010 — *Andreaea* Hedw. in the Canary Islands. *Journal of bryology* 32: 51-55.
- ELÍAS M.J., 1988a — Comentarios sobre algunos táxones interesantes de la brioflora ibérica. *Cryptogamie, Bryologie-Lichénologie* 9: 353-362.
- ELÍAS M.J., 1988b — Fragmenta Chorologica Occidentalia, Bryophyta, 1458-1493. *Anales del jardín botánico de Madrid* 45: 303-307.
- ELÍAS M.J., 1989a — Especies interesantes de la brioflora centro-occidental española. *Orsis* 4: 161-164.

- ELÍAS M.J., 1989b — Fragmenta Chorologica Occidentalia, Bryophyta, 1937-1954. *Anales del jardín botánico de Madrid* 45: 529-531.
- ELÍAS M.J., 1989c — Notas sobre brioflora salmantina. *Lazaroa* 11: 189-192.
- ELÍAS M.J., ALBERTOS B., BRUGUÉS M., CALABRESE G., CANO M.J., ESTÉBANEZ B., GALLEGU M.T., GARILLETI R., GUERRA J., HERAS P., INFANTE M., LARA F., MARTÍN M.A., MAZIMPAKA V., MEDINA R., MUÑOZ J., POKORNY L., PUCHE F. & SÁNCHEZ J.A., 2006 — Aportaciones al conocimiento de la flora briológica española. Nótula XV: musgos, antocerotas y hepáticas de la Sierra de Gredos (Ávila). *Boletín de la sociedad Española de briología* 28: 25-31.
- FERNÁNDEZ ORDÓÑEZ M.C., 1981 — Estudio de la flora briológica del valle del Nalón y Puerto de Tarna. *Boletín de ciencias de la naturaleza I.D.E.A.* 28: 43-218.
- FERNÁNDEZ ORDÓÑEZ M.C., 1985 — Flora briofítica del valle de Langreo y posibles efectos antrópicos sobre la misma. *Boletín de ciencias de la naturaleza I.D.E.A.* 35: 155-181.
- GALLEGU M.T., 2006 — *Syntrichia*. In: Guerra J. & Cros R.M. (eds), *Flora Briofítica Ibérica. Volumen III*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 120-143.
- GARILLETI R. & ALBERTOS B. (coord.), 2012 — *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales.
- GONZÁLEZ-MANCEBO J.M., ROMAGUERA F., ROS R.M., PATIÑO J. & WERNER O., 2008 — Bryophyte flora of the Canary Islands: An updated compilation of the species list with an analysis of distribution patterns in the context of the Macaronesian Region. *Cryptogamie, Bryologie* 29: 315-357.
- GONZÁLEZ-MANCEBO J.M., DIRKSE G.M., PATIÑO J., ROMAGUERA F., WERNER O., ROS R.M. & MARTÍN J.L., 2012 — Applying the IUCN Red List criteria to small-sized plants on oceanic islands: conservation implications for threatened bryophytes in the Canary Islands. *Biodiversity and conservation* 21: 3613-3636.
- GUERRA J. & GIL J.A., 1981 — Aportaciones a la flora briofítica de Andalucía. I. *Trabajos y monografías del departamento de botánica de la Universidad de Málaga* 2: 13-26.
- GUERRA J., CANO M.J. & ROS R.M. (eds) 2006 - *Flora Briofítica Ibérica. Volumen III*. Murcia, Universidad de Murcia, Sociedad Española de Briología.
- GUERRA J., CANO M.J. & HERAS P., 2007 — Morphological variability and new records of *Pohlia bolanderi* (Lesq.) Broth. (Mielichhoferiaceae, Bryophyta) in the Iberian Peninsula. *Nova Hedwigia* 85: 243-248.
- GUERRA J., 2010 — *Pohlia*. In: Guerra J. & Cros R.M. (eds), *Flora Briofítica Ibérica. Volumen IV*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 183-206.
- GUERRA J., BRUGUÉS M., CANO M.J. & CROS R.M. (eds), 2010 — *Flora Briofítica Ibérica. Volumen IV*. Murcia, Universidad de Murcia, Sociedad Española de Briología.
- GUERRA J., CANO M.J., ORGAZ J.D. & RÍOS D., 2013 — Novedades corológicas para la flora briofítica ibérica. V. *Anales de biología* 35: 9-11.
- GUERRA J., CANO M.J. & BRUGUÉS M. (eds), 2014 — *Flora Briofítica Ibérica. Volumen V*. Murcia, Universidad de Murcia, Sociedad Española de Briología.
- GUERRA J., 2016 — *Pohlia bolanderi* (Lesq.) Broth. var. *seriata* A.J. Shaw. In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófitos. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- HALLINGBÄCK T., HODGETTS N. G., RAEYMAEKERS G., SCHUMACKER R., SÉRGIO C., SÖDERSTRÖM L., STEWART N.F. & VÁÑA J., 1998 — Guidelines for the application of the revised IUCN threat categories to bryophytes. *Lindbergia* 23: 6-12.
- HENRIQUES J., 1889 — Os musgos. Catalogo dos Musgos encontrados em Portugal. *Boletim da sociedade Broteriana* 7: 181-223.
- HUSNOT T., 1884-1894 — *Muscologia gallica*. Paris, F. Savy.
- INFANTE M., 2000 — Las hepáticas y antocerotas (Marchantiophyta y Anthocerophyta) en la Comunidad Autónoma del País Vasco. *Guineana* 6: 1-345.
- INFANTE M. & HERAS P., 2001 — Sobre la presencia de *Meesia triquetra* (L.) Ångstr. (Bryophyta, Meesiaceae) en la Península Ibérica. *Boletín de la sociedad Española de briología* 18/19: 93-97.
- INFANTE M. & HERAS P., 2010 — *Meesia*. In: Guerra J. & Cros R.M. (Eds), *Flora Briofítica Ibérica. Volumen IV*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 81-84.
- INFANTE M. & HERAS P., 2012 — *Meesia triquetra* (L. ex Jolycl.) Ångström. In: Garilleti R. & Albertos B. (Eds), *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 68-69.

- IRELAND R.R., 2014 — Plagiotheciaceae M. Fleischer, *In: Flora of North America Editorial Committee (ed.), Flora of North America North of Mexico. Bryophyta, part 1. Volume 28.* New York, Oxford University Press, pp. 483-488.
- IUCN 2012 — *IUCN Red List Categories and Criteria: Version 3.1. Second edition.* Gland, Switzerland and Cambridge, UK, IUCN.
- IUCN 2014 — *Guidelines for using the IUCN Red List Categories and Criteria. Version 12. Prepared by the Standards and Petitions Subcommittee.* Gland, Switzerland and Cambridge, UK, IUCN.
- JOVET-AST S. & BISCHLER H., 1976 — Hépatiques de la Péninsule Ibérique: Énumération, notes écologiques. *Revue bryologique et lichénologique* 42: 931-987.
- LARA F. & MAZIMPAKA V., 1994 — Briófitos corticícolas de los robledales de la Sierra de Gredos (Ávila, España). *Cryptogamie, Bryologie-Lichénologie* 15: 161-169.
- LLORET F., CROS R. M., BRUGUÉS M. & GRANZOW DE LA CERDA Í., 1997 — Aspectos biogeográficos y corológicos de los briófitos de la Sierra de Gredos (España). *Cryptogamie, Bryologie-Lichénologie* 18: 151-164.
- LUCEÑO M. & VARGAS P., 1991 — *Guía botánica del Sistema Central español.* Madrid, Pirámide.
- LUCEÑO M., VARGAS P. & GARCÍA B., 2016a — *Guía de campo del Sistema Central.* Madrid, Raíces.
- LUCEÑO M., CERREJÓN C., GUERRA-CÁRDENAS S., MÁRQUEZ-CORRO J.I., PINEDA-LABELLA V., INFANTE M. & MUÑOZ J., 2016b — Novedades para la brioflora de la Sierra de Gredos (Sistema Central, España). *Boletín de la sociedad Española de briología* 46-47: 43-68.
- MAIER E., 1997 — Schlüssel zu den Arten der Gattung *Kiaeria* in den mitteleuropäischen Gebirgszügen. *Meylania* 12: 21-26.
- MILLER N. G., 2009 — Lichens and bryophytes of the alpine and subalpine zones of Katahdin, Maine, III: Bryophytes. *The bryologist* 112: 704-748.
- MURRAY B.M., 1988 — The genus *Andreaea* in Britain and Ireland. *Journal of bryology* 15: 17-82.
- OLIVÁN G., FUERTES E. & ACÓN M., 2007 — *Hygrohypnum* (Amblystegiaceae, Bryopsida) in the Iberian Peninsula. *Cryptogamie, Bryologie* 28: 109-143.
- PATON J.A., 1999 — *The liverwort flora of the British Isles.* Essex, Harley Books.
- RAMS S., ROS R.M., WERNER O. & SHAW J., 2004 — *Pohlia bolanderi* from Sierra Nevada (Spain), new to the European bryophyte flora. *The bryologist* 107: 312-315.
- RAMS S., WERNER O. & ROS R.M., 2014 — Updated checklist of the bryophytes from Sierra Nevada Mountains (S. of Spain). *Cryptogamie, Bryologie* 35: 261-311.
- RIVAS MARTÍNEZ S., 1963 — Estudio de la vegetación y flora de las Sierras de Guadarrama y Gredos. *Anales del instituto botánico A. J. Cavanilles* 21: 5-325.
- ROS R.M., MAZIMPAKA V., ABOU-SALAMA U., ALEFFI M., BLOCHEEL T.L., BRUGUES M., CROS R.M., DIA M. G., DIRKSE G.M., DRAPER I., EL-SAADAWI W., ERDAĞ A., GANEVA A., GABRIEL R., GONZÁLEZ-MANCEBO J. M., GRANGER C., HERRNSTADT I., HUGONNOT V., KHALIL K., KÜRSCHNER H., LOSADA-LIMA A., LUIS L., MIFSUD S., PRIVITERA M., PUGLISI M., SABOVljević M., SÉRGIO C., SHABBARA H. M., SIM-SIM M., SOTIAUX A., TACCHI R., VANDERPOORTEN A. & WERNER O., 2013 — Mosses of the Mediterranean, an annotated checklist. *Cryptogamie, Bryologie* 34: 99-283.
- RUÍZ E. & BRUGUÉS M., 2015 — *Lescurea saxicola* (Schimp.) Molendo. *In: Brugués M., Cros R.M. & Sérgio C., Cartografía de Briófitos. Península Ibérica i Illes Balears.* Electronic resource <http://briofits.iec.cat>. Accessed on 13/10/2016.
- SÁNCHEZ MATA D., 1989 — *Flora y vegetación del macizo oriental de la sierra de Gredos (Ávila).* Ávila, Institución "Gran Duque de Alba" de la Diputación Provincial de Ávila.
- SARDINERO S., 2004 — Flora y vegetación del macizo occidental de la Sierra de Gredos (Sistema Central, España). *Guineana* 10: 15-436.
- SCHIMPER W. P., 1876 — *Synopsis muscorum europaeorum. Vol. II. Specierum descriptio. Editio secunda valde aucta et emendata.* Stuttgartiae, E. Schweizerbart.
- SCHWAB G., SCHÄFER-VERWIMP A., LÜBENAU-NESTLE R. & VERWIMP I., 1986 — Beitrag zur Kenntnis der Moosflora der Kanariensinsel La Gomera. *Bryologische Beiträge* 6: 1-31.
- SÉRGIO C. & CARVALHO S., 2003 — Annotated catalogue of Portuguese bryophytes. *Portugaliae acta biologica* 21: 5-230.
- SÉRGIO C., 2004 — Notes on *Andreaea heinemannii* Hampe & Müll. Hal. in the Iberian Peninsula. *Cryptogamie, Bryologie Lichénologie* 25: 29-33.

- SÉRGIO C., GARCIA C.A., SIM-SIM M., VIEIRA C., HESPANHOL H. & STOW S., 2013 — *Atlas e Livro Vermelho dos Briófitos Ameaçados de Portugal (Atlas and Red Data Book of Threatened Bryophytes of Portugal)*. Lisboa, MUHNAC.
- SÉRGIO C., BRUGUÉS M. & CROS R.M., 2016 — *Anthoceros caucasicus* Steph. In: Brugués M., Cros R.M. & Sérgio C. Cartografia de Briófitos. Península Ibérica i Illes Balears. Electronic resource <http://briofits.iec.cat>. Accessed on 20/01/2017.
- SHAW A.J., 2014 — *Pohlia*. In: Flora of North America Editorial Committee (ed.), *Flora of North America North of Mexico, Volume 27, Bryophytes, Part 1*. New York, Oxford University Press, pp. 193-212.
- SMITH A.J.E., 2004 — *The moss flora of Britain and Ireland, ed. 2*. Cambridge, Cambridge University Press.
- SÖDERSTRÖM L., HAGBORG A., KONRAT M.V., BARTHOLOMEW-BEGAN S., BELL D., BRISCOE L., BROWN E., CARGILL D.C., COSTA D.P.D., CRANDALL-STOTLER B.J., COOPER E.D., DAUPHIN G., ENGEL J., FELDBERG K., GLENNY D., GRADSTEIN S.R., HE X., HENTSCHEL J., ILKIU-BORGES A.L., KATAGIRI T., KONSTANTINOVA N.A., LARRAÍN J., LONG D., NEBEL M., PÓCS T., PUCHE F., REINER-DREHWALD E., RENNER M., SASS-GYARMATI A., SCHÄFER-VERWIMP A., SEGARRA-MORAGUES J.G., STOTLER R.E., SUKKHARAK P., THIERS B., URIBE J., VÁÑA J., WIGGINTON M., ZHANG L. & ZHU R.-L., 2016 — World checklist of hornworts and liverworts. *PhytoKeys* 59: 1-828.