

Additions, corrections and comments to the Red List of bryophytes from mainland Spain and the Balearic Islands

Llorenç Sáez^{1,2}, Elena Ruiz³ & Montserrat Brugués³

Received: 13 April 2018 / Accepted: 6 July 2018 / Published online: 20 February 2019

Abstract. This article is a review of the conservation status of several taxa of bryophytes that were included in the Red List of Mainland Spain and the Balearic Islands, and those that were omitted, but should have been featured on the basis of most recent data. Of the 33 studied species that were regarded as threatened in the Red List, 31 have been downlisted upon re-evaluation, mostly as a result of better knowledge of species and their distribution. On the other hand, this study highlights the most urgent need to review all taxa assigned to the “Deficient Data” category in the Red List since most of these taxa are precisely the most likely to be truly threatened.

Keywords: Conservation; distribution; mosses; liverworts; Spain.

Adiciones, correcciones y comentarios para la Lista Roja de briófitos de España peninsular e Islas Baleares

Resumen. En este trabajo se realiza una revisión de varios taxones de briófitos que han sido incluidos en la Lista Roja de España peninsular y las islas Baleares, así como aquellos que, sobre la base de los datos más recientes, no han sido incluidos, si bien deberían serlo. De las 33 especies estudiadas y que fueron consideradas como amenazadas la Lista Roja de España peninsular y las islas Baleares, 31 han cambiado a categorías de menor riesgo, principalmente debido a la mejora en el conocimiento de las especies y su distribución. Por otro lado, este estudio pone de manifiesto la necesidad de revisar de forma prioritaria los taxones considerados “Deficient Data” en dicha Lista Roja, pues es precisamente entre éstas las que muy probablemente sean asimilables a categorías de riesgo.

Palabras clave: Conservación; distribución; musgos; hepáticas.

Introduction

In recent years there has been an increase in the interest for conservation of bryophytes in Spain, in the form of both, compiling red lists (Brugués *et al.*, 2014), and legislation at various administrative levels that provide protection to certain taxa (Infante *et al.*, 2017). Significant progress on IUCN Red List assessments has been made for bryophytes nationally and regionally despite difficulties when applying IUCN Red List Criteria to regional assessments (Garilleti & Albertos, 2012). The establishment of detailed IUCN Red List assessments for plants is a crucial step in conservation planning. Red lists, in addition to being a useful tool for selecting areas of botanical interest for threatened species and habitats (Anderson, 2002), allow to identify which taxa within a specific territory are threatened. IUCN (2012) criteria are widely used for classifying taxa into risk categories. Evaluating the risk status of bryophyte taxa according

to IUCN (2012) criteria demands a detailed knowledge of the species' demographics and population dynamics, which is very seldom feasible. This limiting factor affects not only bryophytes but also vascular plants (Sáez *et al.*, 2010) although for the former the dearth of available data is comparatively much worse.

The aim of this article is to update the red list of Mainland Spain and the Balearic Islands (Brugués *et al.*, 2014) following IUCN (2012) criteria, through: i) the addition of new taxa not considered threatened in Brugués *et al.* (2014) and ii) the reevaluation of the conservation status of some taxa included in the red list.

Methods

The extinction risk of several bryophyte species included in the red list of Mainland Spain and the Balearic Islands (Brugués *et al.*, 2014) was assessed using the IUCN Red

¹ Systematic and Evolution of Vascular Plants (UAB) – Associated unit to CSIC, Botany, Faculty of Biosciences Autonomous University of Barcelona. E-08193, Bellaterra, Barcelona, Spain. Email: gymnesicum@yahoo.es

² SHNB, Societat d'Història Natural de les Balears. C/Margarida Xirgu 16, E-07011 Palma de Mallorca, Spain.

³ Unit of Botany, Faculty of Biosciences, Autonomous University of Barcelona. E-08193, Bellaterra, Barcelona, Spain.

List Categories and Criteria version 3.1 (IUCN, 2012). This is not, however, an assessment of the entire red list, but only of those taxa occurring in the northeastern Iberian Peninsula and in the Balearic Islands with sufficiently detailed and current information that begs for correcting the criteria used by Brugués *et al.* (2014) and thus assignment to a different IUCN category. A preliminary documentation of distribution and historical information has been carried out by verifying herbarium material (mainly BCB) and data either published or recorded in databases such as *Banc de Dades de Biodiversitat de Catalunya* (BDBC, <http://biodiver.bio.ub.es/biocat/>, accessed in April 2018). In some cases, data from field surveys were also used. Attribution to a risk category follows prescriptions and recommendations of IUCN (2012, 2017) with a justification, in each case, for assigning a taxon to a specific category. For those species assessed as threatened or near threatened (IUCN, 2012), the extent of occurrence (EOO) and the area of occupancy (AOO) are provided. EOO and AOO were determined using the Geospatial Conservation Assessment Tool (Bachman *et al.*, 2011) with a default cell width of 2 km (IUCN, 2017). A potential rescue effect from populations located in adjacent territories has not been considered since, although it may exist in some cases, there is no evidence of its occurrence. Many of such species rarely develop sporophytes or their populations are extremely small, so rescue effect from adjacent areas (France, Andorra, etc.) through obvious geographic barriers (mostly the Pyrenees range) is regarded here as negligible. The herbaria codes follow Thiers (2018, continuously updated).

Results

Liverwort and moss taxa are listed below separately, arranged alphabetically. Acronyms for province names follow *Flora Briofítica Ibérica* (Guerra *et al.*, 2006).

Liverworts

Calypogeia suecica (Arnell & J.Perss.) Müll.Frib.
Previous category: EN B2ab(ii,iii,iv) (Brugués *et al.*, 2014).

New category: VU B1ab(iii)+2ab(iii)

The presence of this circumboreal species is confirmed in, at least, 6 areas from central Pyrenees (L province): Vall de Mulleres, Güells del Joieu, Liat and Mata de València (data from BCB), Aigüestortes (Casas Sicart, 1986) and the Aiguamog area (Carrillo *et al.*, 2008). These localities (most of them correspond to recent collections) are found in 7 UTM 1x1 km squares (AOO = 24 km², EOO = c. 510 km²). *C. suecica* is also known from nearby areas in France: Midi-Pyrénées region (Infante Sánchez, 2015) and Pyrénées-Orientales department [6 localities] (Hugonnot *et al.*, 2018), although the possibility of any rescue from French populations is unknown. Brugués *et al.* (2014) assigned *C. suecica* to “EN” since a population decline is inferred due to natural causes and disturbances induced by human activity. The available information suggests that the species’ range, in spite of being relatively restricted, is not severely fragmented (Figure 1) and exceeds the number of localities (sub-criterion “Ba”) for “EN”. Nevertheless, *C. suecica* may fulfill this sub-criterion for category “VU”, as proposed here.

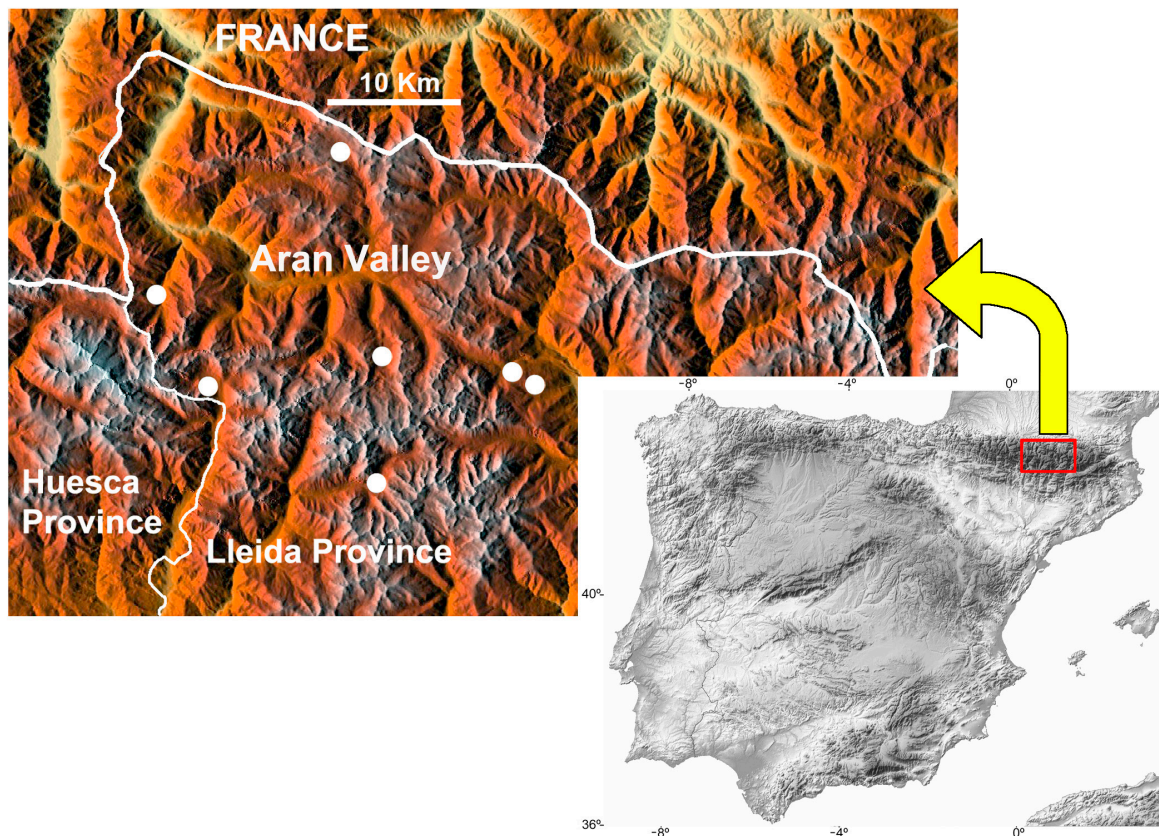


Figure 1. Distribution area of *Calypogeia suecica* in Spain.

***Gymnomitrium corallioides* Nees**

Previous category: CR B2a(ii,iv) (Brugués *et al.*, 2014).

New category: excluded from the Spanish Red List

According to the most recent data (Cros *et al.*, 2015), this bipolar species (circumpolar, arctic-alpine in the Northern Hemisphere) is only known from a single locality in Spain, which corresponds to the Pica d'Estats (L province). Previously, Casas Sicart (1986) reported it from another Pyrenean locality (L province, Amitges, 31TCH31) but the voucher specimen (BCB 10550) corresponds to *G. concinnatum* (Lightf.) Corda. A record from "Aigüestortes i Sant Maurici" (Infante & Heras, 2012) is based on an erroneous report by Casas Sicart (1986). However, the locality where *G. corallioides* was collected in Pica d'Estats corresponds to its northern slope ("cara N, 3130 m", BCB 52776), entirely located within France (Ariège department), so, despite its proximity, this species should be excluded altogether from the Spanish bryophyte flora and thus its Red List.

***Lophozia ascendens* (Warnst.) R.M.Schust.**

Previous category: EN B2ab(ii,iii,iv) (Brugués *et al.*, 2014).

New category: VU D2

This circumboreal species is reported from many European countries but generally regarded as rare (Söderström *et al.*, 2002). It is found in central Pyrenees (Hu and L provinces) where it grows on decaying wood. Information on its occurrence in Spain was published by Casas & Infante (1998) for localities in Artiga de Lin and Goelhs deth Joeu (Aran Valley, L province), where several subpopulations are found between 1,400 and 1,600 m asl. In addition, other localities are known: Ordesa (BCB 54051), Marimanya, (BCB 30679), Mata de València (BCB 53706) and Portilló de Bossost (BCB 59293) (AOO=20 km², EOO=c. 800 km²). *L. ascendens* is also known from nearby areas: Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) and Pyrénées-Orientales department [9 localities] (Hugonnot *et al.*, 2018). In absence of evidence regarding a continuous decrease in its Spanish populations (the subpopulation of Portilló de Bossost, which includes several stands, has been verified by us recently in July 2017 and there are no short-term threats), the "Bb" subcriterion ["B": small range (EOO and/or AOO), "b": continuing decline, observed, inferred or projected (IUCN, 2012)] cannot be applied. However, in view of the very restricted range and specificity for a fragile habitat, this species is here assessed as VU under criterion D2.

***Nardia insecta* Lindb.**

Previous category: DD-n (Brugués *et al.*, 2014).

New category: CR B1ab(iii)+2ab(iii); D

This species is known only from a single location in the northern slope of the Roca Blanca peak (L province), where it is extremely rare (Sáez *et al.*, 2011). In the French central Pyrenees (Hautes Pyrénées) it is a very rare species, which has been assigned to the CR category in the Midi-Pyrénées region (Infante Sánchez

et al., 2015). In Roca Blanca it has a very restricted population size (AOO and EOO=4 km²). A single patch measuring about 25 cm² was found. In this study a single discrete patch of *N. insecta* is regarded as an individual. It therefore meets the IUCN (2012) criteria for Critically Endangered, based on the number of individuals (fewer than 50) and a decline due to natural plant competition is inferred. The attribution of this species to CR is consistent with that same assignment for its conspecific, *N. breidlerii* (Limpr.) Lindb., with a similar conservation problem (Brugués *et al.*, 2014). Few minor changes related to the subcriteria [CR B1ab(iii)+ 2ab(iii)] are proposed here.

***Petalophyllum ralfsii* (Wilson) Nees & Gottsche**

Previous category: VU B2ab(iii,iv) (Brugués *et al.*, 2014).

New category: NT

This species is listed as *Vulnerable* in the *Red Data Book of European Bryophytes* (Steward *et al.*, 1995) and it has a scattered distribution in the Mediterranean region. Since its first discovery in the Balearic Islands (Casas de Puig, 1956), our knowledge of the distribution of *P. ralfsii* in the Balearic archipelago has improved significantly. Moreover, a recent record has expanded the limits of its distribution in eastern Spain (Segarra-Moragues & Puche, 2016). In Spain it is currently present in all the main islands of the Balearic archipelago (Figure 2) and a single locality in V province. The values of AOO and EOO are 84 km² and c. 4,630 km², respectively. Habitats listed for this species in mainland Spain and the Balearic Islands are diverse, e.g.: clayish soil in a stream mouth, streambanks, roadsides, among pine litter in a shaded north-facing gully, on flat clayish surfaces, temporary freshwater pools on siliceous or calcareous soil, and a rushing stream. Although there is no doubt that if mainland Spain was to be considered in isolation, the species well merits assessment as CR on the basis of D criterion, the assessment is very different when mainland Spain and the Balearic archipelago are taken together. There is no evidence of a continuous decline in the number of Balearic localities or AOO, and several populations currently contain hundreds of plants. Even if some of the less recently prospected populations were lost (possibly the case of a single coastal Majorcan locality: Port de Sóller towards Muleta), this circumstance cannot be considered as a continuous decline. To the contrary, some revisited Balearic populations do persist without reasonable conservation concerns. AOO value for *P. ralfsii* in the Balearic Islands and Mainland Spain has increased in recent decades (Figure 3). In fact Blockeel (2003) indicated that this species may be more common than presumed in some Mediterranean regions. Since Brugués *et al.* (2014) assessment, the species has increased its AOO by 16 km² (Pericàs *et al.*, 2016; Segarra-Moragues & Puche, 2016) and it seems that previous considerations about *P. ralfsii* being threatened were based on inaccurate knowledge of its actual distribution and status.

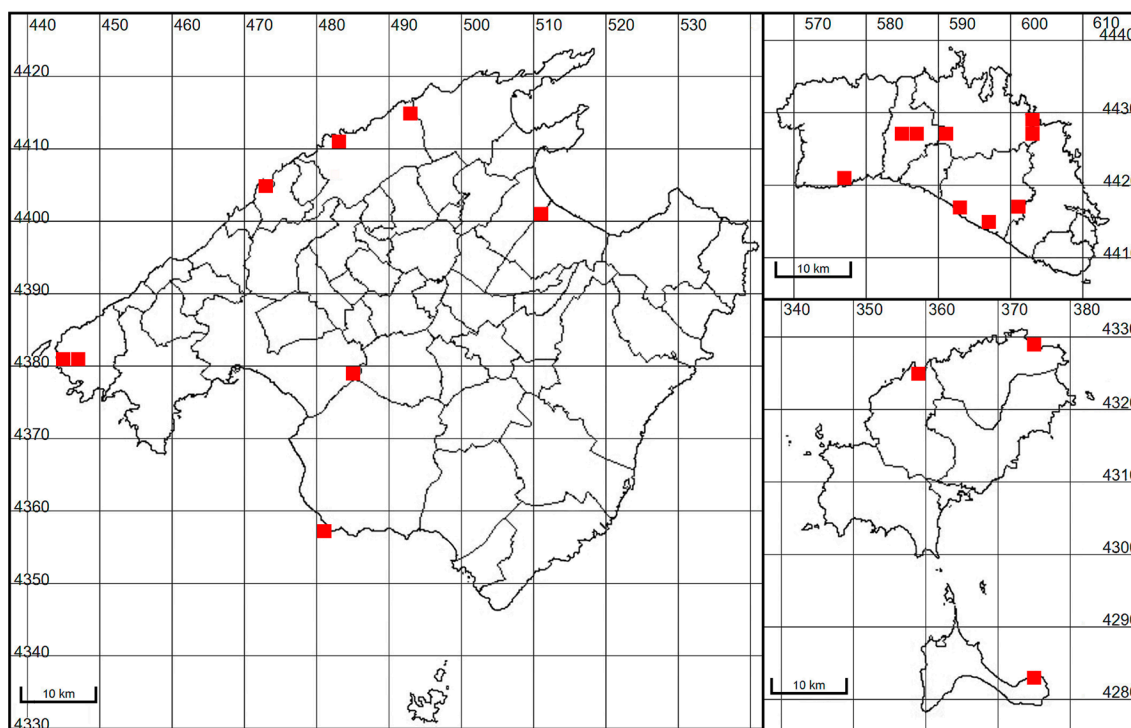


Figure 2. Distribution area of *Petalophyllum ralfsii* in the Balearic Islands by UTM 2 x 2 km squares.

Plagiochasma appendiculatum Lehm. & Lindenb.

Previous category: CR B2ab(ii,iii,iv) ["B2a (ii,iii,iv)"] (Brugués *et al.*, 2014).

New category: VU D2

The only European population of this species is located in northern Majorca, where it was initially known only from a karstic ravine: torrent de Coma Freda o des Guix (Cros *et al.*, 2005). Due to its extreme rarity and the existence of anthropic impacts on the population, it was attributed to the CR category. In the locality of Coma Freda there are small stands in a section of this ravine, between 235 and 320 m asl, and there is a risk of anthropogenic disturbances due to canyoning. Recently, J.A.W. Nieuwkoop (in Ellis *et al.*, 2016) has found a second and more abundant population of this species, which also corresponds to another karstic ravine (Torrent de Pareis) also located in northern Majorca. According to J.A.W. Nieuwkoop (l.c.), *P. appendiculatum* is found in several points of this ravine, between 20 and 100 m altitude. Considering all these new data, the values of AOO and EOO are 12 km². *P. appendiculatum* does not have an extremely restricted distribution in the territory considered as initially assumed (Cros *et al.*, 2005), so the category assigned by Brugués *et al.* (2014) must be reconsidered. Since there is no evidence of decline in the population or in quality, extent or area of habitat in order to qualify under subcriteria b of criteria B, *P. appendiculatum* is assessed as VU D2 on the basis of its restricted range and number of known locations, which makes it potentially vulnerable to stochastic events, as well as human activities. Extensive surveying in northern Majorca would also help to determine if further populations exist.

Scapania cuspiduligera (Nees) Müll. Frib.

Previous category: DD (Brugués *et al.*, 2014).

New category: VU D2

This is a very rare species in Spain, where it is currently known from central and eastern Pyrenees: Vall d'Assua (Manobens i Rigol & Casas Sicart 1985) and Serra de Cadí (B and L provinces) (Ruiz *et al.*, 2018a) (AOO = 20 km², EOO = c. 70 km²). In addition, *S. cuspiduligera* was reported from Valle de Oro (Casares, 1911) (Lu province) where its presence has not been confirmed recently. *S. cuspiduligera* was assessed as DD (Brugués *et al.*, 2014) since it was excluded from the Spanish bryoflora by Brugués *et al.* (2011). Both Pyrenean populations grow on shady calcareous rocky places (between 1,700 and 2,700 m asl) and are found within protected areas. It is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez, 2015) and Pyrénées-Orientales department (Hugonnot *et al.*, 2018) although its rarity would prevent an eventual rescue effect (IUCN, 2003). There could be a decline in EOO and AOO if we accept that the population from Lugo province was lost (which would require confirmation), but this is not considered a continuous decline. The species is assessed as VU D2 given its rarity in our area (small area of occupancy, small number of known locations) which makes it potentially vulnerable to stochastic events.

Tritomaria scitula (Taylor) Jörg.

Previous category: DD-n (Brugués *et al.*, 2014).

New category: CR B1ab(iii)+2ab(iii)

It is known from the north slope of the Pic del Pinetó in L province (Sáez *et al.*, 2011) where there

are two small stands located in the same UTM 1x1 km square (31TCH3918) (AOO and EOO = 4 km²), with the coverage of c. 4 m². These stands are found near the base of some cliffs where there are several equipped climbing routes, so there is a risk of anthropogenic disturbances on the population and its habitat. In fact, since its discovery, it has maintained and expanded the climbing routes in the area, so a population decline is inferred due to disturbances

induced by human activity. In the Iberian Peninsula, *T. scitula* was previously only known from Andorra (Sotiaux & Schumacker, 2002), where it is currently considered rare (Sotiaux & Vanderpoorten, 2017), while its presence in the French slope of the Pyrenees (Hautes Pyrénées) is uncertain (Infante Sánchez, 2015), so it seems that the isolation of the population is important or, at least, rule out an eventual rescue effect (IUCN, 2003).

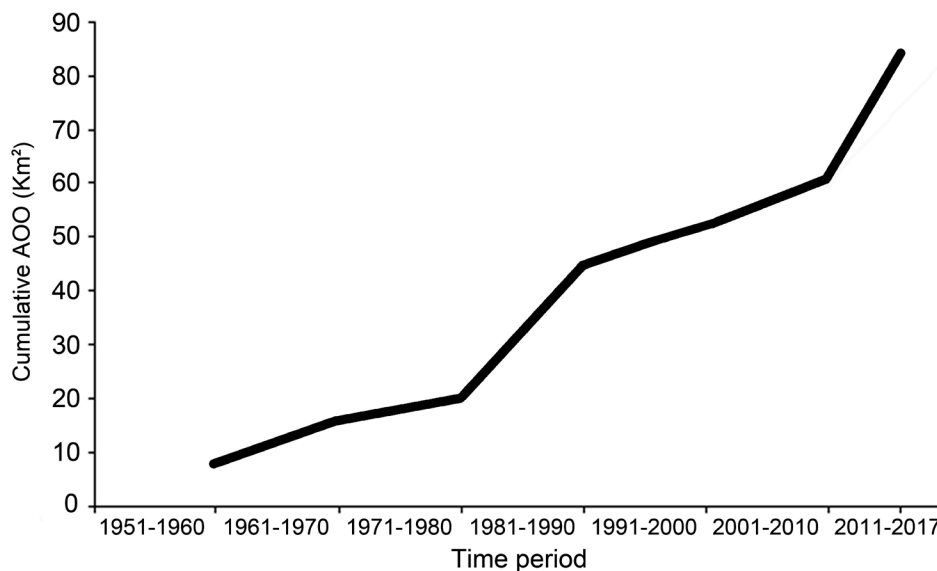


Figure 3. Total cumulative area of occupancy (AOO) by decade for *Petalophyllum ralfsii* in mainland Spain and Balearic Islands.

Mosses

Acaulon fontiquerianum Casas & Sérgio

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

This species has a relatively wide but scattered distribution in eastern Iberian Peninsula. Until a decade ago this species was only known from Almería province (Guerra, 2006a), but in recent years its Spanish distribution has been significantly expanded. Brugués *et al.* (2016a) listed *A. fontiquerianum* from 6 provinces (Ab, Al, CR, Ge, Mu and V) where it is distributed in 13 UTM 10x10 km squares. Assuming that *A. fontiquerianum* exists only in 1 UTM 1x1 km square for each UTM 10x10 km squares, the values of AOO (c. 52 km²), EOO (> 20,000 km²) and the number of localities greatly exceed the thresholds established for criterion D2. Although there is no clear evidence of recent population declines or significant population fluctuations, in some localities its habitat is vulnerable to anthropogenic disturbances. Therefore, it is assessed as Near Threatened.

Andreaea nivalis Hook.

Previous category: VU D2 (Brugués *et al.*, 2014); EN B2ab(ii,iv,v) (Luceño *et al.*, 2017).

New category: NT

This artic-alpine species is distributed through the Iberian Central System, Cantabrian mountain range and

central Pyrenees (Av, Hu, L, O, S and Sa provinces). Luceño *et al.* (2017) provide a detailed distribution of this species in the Central Iberian System, where there are at least 4 main well delimited populations groups exist. In Spain at least 17 localities are known (AOO = 68 km², EOO = c. 115,600 km²), what precludes the assignation of this species to VU D2 (IUCN, 2012), as Luceño *et al.* (2017) rightly suggested. However, according to the latter authors this species could be considered as EN B2ab(ii,iv,v) in Spain, since i) the threshold for AOO in the criterion B2 is not exceeded in EN category, ii) its distribution is fragmented (subcriterion a) and iii) the observed climate warming and fluctuations in precipitations are probably reducing the effective number of localities and individuals (subcriterion b).

According to IUCN (2012), 'severely fragmented' refers to the situation in which increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated populations and these small populations may go extinct, with a reduced probability of recolonization. However, this situation does not seem to be the case of *A. nivalis* in mainland Spain, since this species can be locally "abundant at high elevations" in the Iberian Central System (Luceño *et al.*, 2017) [11 localities, 8 UTM 1x1 km squares, AOO=32 km²]. This regional population is self-sustaining, and it is not dependent on immigration for long-term survival. On the other hand, the connection and continuity of the populations

from the Spanish Pyrenees with those located in France (Infante-Sánchez *et al.*, 2015; Hugonnot *et al.*, 2018) and Andorra (Sotiaux & Vanderpoorten, 2017) has not been considered. Certainly, the climate warming is probably affecting the viability of some populations (subcriterion Bb), but at present there are no empirical data to support the supposed continue demographic decline. For taxa with very restricted distribution, classification as VU D2 is only permissible if the effects of climate change are such that the taxon is capable of becoming CR or extinct in a very short period of time after the effects of the threat become apparent (IUCN, 2017: 87-88). If the species has a AOO < 20 km² but is not declining or under specific threat or experiencing extreme fluctuations, although it may be affected by the climate change but the effects are expected to be gradual and slow (which will not trigger any criteria for CR or cause extinction within three generations) it does not meet VU D2. The case of the chionophile species *Polytrichastrum sexangulare* (see below) is especially interesting, because although it is only known from a single locality in Iberian Central System (Luceño *et al.*, 2017) where it grows together with *A. nivalis*, in this case the effects of climate warming have not been considered (although AOO in the criterion B2 is not exceeded neither in EN nor in VU categories), and it was assessed as LC in Spain. In our opinion, considering the Spanish populations, it does not seem possible to infer or project a continuous decline in the AOO or in the number of subpopulations, as established by the criterion “Bb”. This species is listed here as NT as it is close to qualifying for VU under criterion D2.

Anoetangium aestivum (Hedw.) Mitt.

Previous category: DD (Brugués *et al.*, 2014).

New category: VU D2

This species was considered as Regionally Extinct (RE) for the Iberian Peninsula and Balearic Islands by Brugués & González-Mancebo (2012), as only a few confirmed records for Hu, Le and Po provinces in the late nineteenth and early twentieth century were known (see Cano *et al.*, 2016). Recently, Guerra & Cano (2013) and Cano *et al.* (2016) have found this species in the central Pyrenees (La Renclusa, Hu province) and in the Cantabrian range (El Angliru, O province). The values of AOO and EOO are 8 km². In the Midi-Pyrénées region it is also a rare species (Infante-Sánchez, 2015, Infante-Sánchez *et al.*, 2015) while there are no records from eastern Pyrenees (Hugonnot *et al.*, 2018), so it seems unlikely an eventual rescue effect (IUCN, 2003) from French populations. If ancient records were considered, the apparent decline of this species in Spain may not be real or severe, it may be overlooked or the concrete areas from where *A. aestivum* was found have not been explored in detail subsequently.

Although the category DD highlights taxa lacking sufficient information for a sound status assessment, if the taxon range is suspected to be narrow, or if a considerably period of time has elapsed since the last record of the taxon, considering it as threatened may be justified (IUCN, 2017: 10). Since *A. aestivum* is a very rare species in Spain, it is assessed as VU D2 based on

its geographical restriction, which makes it vulnerable to stochastic events, as well as human activities.

Anomodon longifolius (Schleich. ex Brid.) C.Hartm.

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

In the Iberian Peninsula this species is found in northern mountainous areas (B, Ge, Hu, Na, SS and Vi provinces), where it grows on calcareous rocky places. Based on bibliographic references (Allorge, 1955; Granzow de la Cerda, 1988; Heras *et al.*, 2002), herbarium data and field surveys values of AOO and EOO are 36 km² and c. 1,810 km², respectively. It is also known from nearby areas in France: Midi-Pyrénées region (Infante Sánchez, 2015). The number of localities and AOO value preclude the assignation of this species to VU D2 (IUCN, 2012). Therefore, in absence of evidence regarding a continuous decrease in AOO or the disappearance of a significant number of subpopulations, it is assessed as NT.

Anomodon rostratus (Hedw.) Schimp.

Previous category: VU B2ab(ii,iv) [“B2a(ii,iv)”] (Brugués *et al.*, 2014).

New category: NT

This species is found in Spain in Ge, Hu, Na, SS, Te and Vi provinces, in 15 localities (AOO = 52 km², EOO = c. 47,290 km²). It is also known from nearby areas in France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) –where it was regarded as VU and Pyrénées-Orientales department [6 localities] (Hugonnot *et al.*, 2018). The assignment to the VU category (Brugués *et al.*, 2014) was based on the AOO, severe fragmentation of the area (or known less than 10 localities) and that there is a continuous decrease in the area of occupation and the number of locations or subpopulations. It is unclear if the fragmentation can be classified as severe (it does not seem attributable to destruction of its habitat), because only in the area of Vidrà (Ge province) 7 subpopulations are close to each other and spread over 4 UTM of 1x1 km squares. It has not disappeared from a significant number of subpopulations, nor can a continuous decline in the occupation area be inferred or projected. On the basis of this reinterpretation of the available information, *A. rostratus* is listed as NT.

Aschisma carniolicum (F.Weber & D.Mohr) Lindb.

Previous category: VU B2ab(ii,iii,iv) [“B2a(ii,iii,iv)”] (Brugués *et al.*, 2014).

New category: NT

It is a widely distributed species in peninsular Spain and the Balearic Islands according to Brugués *et al.* (2016c) in A, Al, Ab, CR, Ge, H, Mu, PM, V and Vi provinces (AOO = 84 km², EOO = c. 300,000 km²). This species grows on bare soil in open grassland and scrublands. The fragmentation of its area is not severe (in southern Spain it is rather relative) and the number of known localities is clearly higher than 10. On the other hand, in relation to the sub-criteria of criterion B, it is possible that some populations have been exposed (or may

be exposed in the near future) to anthropogenic disturbances, but this can not be extrapolated to the whole Spanish population of *A. carniolicum*, since most of the populations are in well-conserved areas. The probability of immigration from southern Portugal is unknown, thus the category is not up- or downlisted. *Aschisma carniolicum* in Spain no longer meets the criteria for being globally threatened and it is hence listed as NT.

***Atrichum flavisetum* Mitt.**

Previous category: DD-n (Brugués *et al.*, 2014).

New category: VU D2

Two confirmed Iberian populations of this species are known, corresponding to Baga de Queràs (BCB 22767) and Valle de Pineta (BCB 52091) (G and Hu provinces, respectively). The values of AOO and EOO are 8 km². Although no detailed population data are available, both populations were found in subalpine forests located in protected areas (National and Natural Parks). Its presence is not known in Andorra (Sotiaux & Vanderpoorten, 2017) or in the Midi-Pyrénées region (Infante-Sánchez *et al.*, 2015). Due to its strong geographical restriction and apparently without probability of immigration from neighbouring countries, it is advisable to assign this species, at least temporarily, as VU D2, according to IUCN (2017) recommendations (see comments under *Anoectangium aestivum*).

***Brachythecium erythrorrhizon* Schimp.**

Previous category: Not listed by Brugués *et al.* (2014).

New category: VU D2

Only two Iberian locations of this species are known (Orgaz *et al.*, 2012, Guerra *et al.*, 2015; Orgaz, 2018), corresponding to recent collections: Tavascan, estany de Romedo Baix (MUB 38468, MUB 38469) and Ansó, valle de Las Cabretas, entre Las Cabretas y el ibón de Estanés (VIT 29624) (Hu and L provinces). The values of AOO and EOO are 8 km². The species is not listed for nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France (Infante Sánchez, 2015; Hugonnot *et al.*, 2018). In the absence of more or less concrete demographic data, it is provisionally assessed as VU D2 based on low AOO value and the small number of localities, which makes it potentially vulnerable to stochastic events, as well as human activities.

***Brachythecium mildeanum* (Schimp.) Schimp.**

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

According to the data provided by Orgaz *et al.* (2009) and Orgaz (2018) the distribution of *B. mildeanum* is relatively broad in the N and CW of Spain (B, Ge, Hu, Na, Sg, SS, To Vi and Za provinces) where there are, at least, 13 localities, which mostly correspond to mountain areas (between 580 and 1,900 m asl) in which no significant disturbances are predictable. The values of AOO and EOO are 52 km² and c. 116,000 km², respectively. The species is also known from nearby areas in France: Midi-Pyrénées region (Infante Sánchez,

2015). It is classified as Near Threatened because it is close to qualify as threatened under criterion D2 due to its relatively small AOO and number of localities.

***Brachythecium turgidum* (C.Hartmann) Kindb.**

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

In the Iberian Peninsula this species is found in seven Pyrenean localities (B and L provinces) where it grows on humid calcareous rocky places, between 1,900 and 2,600 m asl (Cros *et al.*, 2010; Sáez *et al.*, 2011; Orgaz *et al.*, 2012; Ruiz *et al.*, 2018a; BCB). It is also known from nearby areas in France (Midi-Pyrénées region), where *B. turgidum* has been assessed as NT (Infante Sánchez *et al.*, 2015). Values of AOO and EOO are 28 km² and c. 1,530 km², respectively. All the Spanish localities are not subject to any problem to their conservation. All of them correspond to protected spaces. In a locality recently discovered by one of us (LS) in the Pedraforca massif (B province) *B. turgidum* is not particularly scarce, it appears in the form of several stands in almost inaccessible areas. Available data (number of localities and AOO value) in addition to the fact that the Spanish population of *B. turgidum* is not prone to the effects of human activities or stochastic events within a very short time period in an uncertain future that could drive the species to CR or EX preclude the assignation of this species to VU D2 (IUCN, 2012). However, since the species has a relatively restricted range in mainland Spain, it is assessed as NT.

***Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl.**

Previous category: VU B2ab(ii,iii,iv) (Brugués *et al.*, 2014).

New category: NT

This species, which is generally restricted to decaying wood, is currently known from 24 UTM 10x10 km squares in Spain (B, Ge, Hu, L, Na and Vi provinces). The values of AOO and EOO are 136 km² and c. 24,900 km², respectively. In recent years new populations have been found even in Pyrenean sectors where *B. viridis* was unknown, such as the eastern Pre-Pyrenees (Carnicero & Unzeta, 2016; Ruiz *et al.*, 2018a) and Andorra (Ellis *et al.*, 2017). It is also known from nearby areas in France: Pyrénées-Orientales department [15 localities] (Hugonnot *et al.*, 2018) and Midi-Pyrénées region (Infante Sánchez, 2015). Some Spanish populations that were regarded extinct at the regional level have been relocated, as for example in their southernmost Iberian population (Sáez *et al.*, 2018). Most populations are found within protected areas: National Parks (Ordesa-Monte Perdido and Aigüestortes and Estany de Sant Maurici), Natural Parks (Posets-Maladeta, Alt Pallars, Cadí-Moixeró, Capçaleres del Ter and Freser, Montseny, etc.) and no reductions in their habitat or anthropic threats are predicted in the short or medium term (at least in Catalonia), although sporophyte consumption has been detected in central and western Pyrenees (Infante & Heras, 2018). Our preliminary results of population monitoring in three Pyrenean locations (L province) and the Montseny massif (B province), over 5-7 years, do not indicate, for the moment, a decline in the sporophytes production. Population management actions

have even been developed to favor subpopulations in some protected areas (Ordesa-Monte Perdido National Park and Montseny Natural Park). On the basis of all this information, it is most reasonable to assign *B. viridis* to NT. We have here assigned this species to NT because their populations are not strong from a demographic point of view (although this is an intrinsic characteristic of the species) and are found at the limit of its range, but cannot be ruled out the rescue effect (IUCN, 2003) from the populations of the northern slope of the Pyrenees. IUCN (2012) recommends the assimilation to the LC category to those abundant and widely distributed taxa, which does not conform to *B. viridis*, at least within our area. Our assessment of not considering this species as threatened at regionally level agrees with other studies conducted in other southern European peninsulas (Spitale & Mair, 2017).

Conostomum tetragonum (Hedw.) Lindb.

Previous category: Not listed by Brugués *et al.* (2014).

New category: VU D2

It is a very rare species in Spain (Heras & Infante, 2016) where only 5 localities are known: one from the Cantabrian mountain range (Pico Curavacas, Pa province) and the rest from the central Pyrenees (Hu and L provinces): Ibón de Paderna, Amitges, Certescan and Liat (AOO = 20 km², EOO = c. 5,470 km²). Its presence in Sierra Nevada is doubtful (Rams *et al.*, 2014). *Conostomum tetragonum* is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) and Pyrénées-Orientales department (Hugonnot *et al.*, 2018). The species is here assessed as VU D2 given its rarity in our territory (small area of occupancy, small number of known locations) which makes it potentially vulnerable to stochastic events, as well as human activities.

Cynodontium polycarpon (Hedw.) Schimp.

Previous category: DD (Brugués *et al.*, 2014).

New category: VU D2

There are only 3 localities of this species known in our territory, all correspond to the Pyrenees: Vilallonga de Ter (Ge), Aigüestortes (L) and Monte Mendaur (Na). The values of AOO and EOO are 12 km² and c. 1,250 km², respectively. The species grows in fissures of acidic rocks, between 1,100 and 1,800 m asl. It is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) and Pyrénées-Orientales department (Hugonnot *et al.*, 2018) although its rarity would prevent an eventual rescue effect (IUCN, 2003). *Cynodontium polycarpon* is categorized as VU in Spain according to IUCN (2017) recommendations (see comments under *Anoetangium aestivum*).

Cyrtomnium hymenophylloides (Huebener) T. Kop.

Previous category: Not listed by Brugués *et al.* (2014).

New category: VU D2

This circumpolar arctic-alpine species is known only from two distinct locations in the Pyrenees: Pineta and

Serra de Cadí (Ruiz *et al.*, 2018b), where it grows in calcareous rocky places. The values of AOO and EOO are 8 km². These populations are relatively isolated, since the nearest populations are found in the Alps (Hofmann, 2013). In the population of Serra de Cadí, there are several stands so this species is not particularly scarce in the concrete locality in which it has been found. Its persistence in this area is favored by vegetative spread, since it was recorded sterile (sporophytes and male plants are rare in this species). Both Pyrenaean populations are within protected areas (National and Natural Parks). Since there is no evidence of decline in the population or in quality, extent or area of habitat in order to qualify under subcriteria b of criteria B, *C. hymenophylloides* is assessed as VU D2 on the basis of its restricted AOO and presence at two locations, which makes it potentially vulnerable to stochastic events. If there was any evidence of decline, this species would qualify as EN under criterion B1ab+2ab. *Cyrtomnium hymenophylloides* is not redlisted in Europe (ECCB, 1995), but is threatened at a regional level in some countries (Sabovljevic *et al.*, 2009).

Dicranum muehlenbeckii Bruch & Schimp.

Previous category: Not listed by Brugués *et al.* (2014).

New category: RE

The only known locality of this species in the Iberian Peninsula corresponds to a beech forest in the region of La Garrotxa (Ge province), where this species was collected growing on rocks by C. Casas in 1952. Although this area has been subject of bryological studies (see Brugués *et al.*, 2007) and that several specific surveys have been conducted to relocate this species, the presence of *D. muehlenbeckii* in the area has not been confirmed, so it is assigned to the RE category.

Dicranum spadiceum J.E.Zetterst.

Previous category: EN B2ab(ii,iv) (Brugués *et al.*, 2014).

New category: NT

The Spanish populations are found in the Pyrenees and Cantabrian range, between Pico Tresmares and the valley of Setcases (Ge, Hu L and S provinces) (Brugués & Ruiz, 2015). The values of AOO and EOO are 32 km² and c. 3,570 km², respectively. It grows on rocky places and subalpine scrubs, between 2,000 and 2,600 m asl. In the Midi-Pyrénées region, the occurrence data of *D. spadiceum* dates back to the end of the 19th century (Infante-Sánchez, 2015), while in eastern Pyrenees there are at least 12 localities of this species (Hugonnot *et al.*, 2018), most of which are very close to the Núria and Setcases populations (Gerona province). In Catalonia there are 4 main areas in which the presence of this species is known: Restanca, Portarrò d'Espòt, Núria and Setcases (in these last two areas with two subpopulations in each of them). These Catalan localities are found in little frequented protected areas, and without remarkable threats for the habitat of *D. spadiceum*. Considering all the Spanish populations, it does not seem possible to infer or project a continuous decline in the area of occupation or the number of subpopulations,

as established by the criterion “B”. This species is listed as NT as it is close to qualifying for VU under criterion D2.

Encalypta affinis Hedw.

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

It is known from few sites in the central and eastern Pyrenees in Catalonia (B, Ge and L provinces: La Molina, Comabella, Meranges, Muntanyó de Llacs, Taüll, Pla de Beret and Tuc de Crabera (Casas Sicart, 1986; Canalis & Casas, 1992; Casas *et al.*, 2006; Ruiz *et al.*, 2018a) and in a single Aragonese locality (Hu province): Pico de Paderna, Maladeta massif (Casas Sicart, 1986). This species grows on calcareous rocky places between 1,800 and 2,600 m asl. The values of AOO and EOO are 32 km² and c. 1,810 km², respectively. The species has been reported from nearby areas in France: Midi-Pyrénées region (Infante Sánchez, 2015) although the possibility of any rescue from French populations is unknown. Most of the Spanish localities correspond to protected areas and without remarkable threats for the habitat of *E. affinis*. The number of localities (8) and AOO value preclude the assignation of this species to VU D2 (IUCN, 2012).

Eurhynchium angustirete (Broth.) T.J.Kop.

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

This species is currently known from central and eastern Pyrenees in Spain (Ge, Hu and L provinces), where it grows in humus-rich-soils and rocks, in montane or subalpine areas (between 1,100 and 1,800 m asl). At least 10 concrete localities are known, mostly Catalan except two Aragonese: Benasque (BCB 30261) and Sierra de Chía (Heras *et al.*, 2004). The values of AOO and EOO are 40 km² and c. 2,490 km², respectively. *Eurhynchium angustirete* also has populations in nearby areas: Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez, 2015) and Pyrénées-Orientales department [5 localities] (Hugonnot *et al.*, 2018). In Spain there is no indication of a continuous population decline, and most of its range lies within protected areas. The AOO value and the number of localities in Spain greatly exceed the thresholds established for criterion D2. However, since *E. angustirete* has a restricted range in Spain limited to few locations on mountain areas, it is assessed as NT.

Grimmia elongata Kaulf.

Previous category: NT (Brugués *et al.*, 2014).

New category: VU D2

There are 4 confirmed Spanish localities of this species in central Pyrenees (Casas *et al.*, 2006; Muñoz *et al.*, 2015): Portalet, Pico Vallhivierna, Amitges and Areu (Hu and L provinces). The values of AOO and EOO are 16 km² and c. 1,250 km², respectively. This species was reported from Pica d'Estats (L province) by Casas *et al.* (2006). However, the locality where *G. elongata* was collected in Pica d'Estats corresponds to its northern slope (“*cara N*, 3130 m”, BCB 52371), entirely located within France (Ariège department).

The species is assessed as VU D2 because of the small area of occupancy, small number of known locations, which makes it potentially vulnerable to stochastic events, as well as human activities (anthropic impacts can not be ruled out in Portalet locality). Moreover, *G. elongata* has been assessed as VU D2 in the Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) which would prevent an eventual rescue effect (IUCN, 2003), and species of the same genus and similar ecological requirements, with a similar number of known localities were regarded as VU D2 by Brugués *et al.* (2014).

Herzogiella striatella (Brid.) Z.Iwats.

Previous category: EN B2ab(ii,iii,iv) (Brugués *et al.*, 2014).

New category: NT

The Spanish populations are found in the Central Pyrenees (Hu and L provinces), between Maladeta massif (ibón Alto de Vallimuerta, MUB 27378) and Tavascan (estany Romedo Baix, MUB 45092). The values of AOO and EOO are 32 km² and c. 410 km², respectively. It grows in wet places in subalpine forests, sometimes in rocky places, between 975 and 2,050 m asl (Guerra, 2018). It is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and French Pyrenees (Luchon, Gorges du Lys, BCB 1855) where we have verified its presence. All Spanish localities correspond to protected areas and without remarkable threats for the habitat of *H. striatella*. Considering all these populations, it does not seem possible to infer or project a continuous decline in the area of occupation or the number of subpopulations, as established by the criterion “Bb”. This species is listed as NT as it is close to qualifying for VU under criterion D2.

Hygrohypnum smithii (Sw.) Broth.

Previous category: VU B2ab(ii,iv) (Brugués *et al.*, 2014).

New category: NT

It is a relatively rare species in Spain. It is known from several localities in the central Pyrenees (Hu and L provinces) where it grows on the rocks in or beside streams, between 1,850 and 2,490 m asl (Oliván & Fuertes, 2018). The values of AOO and EOO are 52 km² and c. 1,310 km², respectively. It is also known from nearby areas in France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) and Pyrénées-Orientales department [6 localities] (Hugonnot *et al.*, 2018). Most of the Spanish localities correspond to protected areas (a National Park and two Natural Parks). The available information suggests that the area of the species, in spite of being relatively restricted, is not severely fragmented and far exceeds the number of 10 localities (sub-criterion “a”). On the other hand, a decline in the area of occupation or the number of subpopulations cannot be inferred. According to Oliván *et al.* (2007), *H. smithii* cannot be considered as a vulnerable species in the Iberian Peninsula since it only agrees with the first part of criterion B as defined by Hallingbäck *et al.* (1998). Moreover, Oliván *et al.* (2007) observed that Pyrenaean populations are large and usually with sporophytes,

which suggests a healthy condition. Although rare in Spain, *H. smithii*, no longer meets the criteria for being regionally threatened and is hence listed as NT.

Orthotrichum philibertii Venturi

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: LC

This montane Mediterranean-oceanic species exists in 14 provinces according to Lara & Garilleti (2014). Neither data related to its distribution in Spain, nor those related to its ecology (it grows on a remarkable number of phorophytes, in a wide altitudinal range, colonizing even artificial substrates such as fiber-cement siding) suggest that this species can accommodate VU on the basis of criterion D2. We assign it to LC since it does not even seem to be considered as NT according to IUCN criteria (2012).

Orthotrichum rogeri Brid.

Previous category: Not listed by Brugués *et al.* (2014).

New category: VU D2

Surprisingly, this rare epiphyte was not included in the Spanish Red List (Brugués *et al.*, 2014) although it is worthy of being assigned to a threat category IUCN (2012) in our territory, and it is also included in European legislation (Annex II of the Habitats Directive). At least 4 localities of this species in the Iberian Peninsula are known, all relatively recent and corresponding to the axial Pyrenees (Hu and L provinces): Bujaruelo, port de la Bonaigua, Estany de Sant Maurici y Parque Natural de Posets-Maladeta (Garilleti *et al.*, 2002; Infante & Heras 2012: 237). A report from Montgarri (Venturi, 1887) is excluded, since it is referable to *O. stramineum* Brid. (Garilleti *et al.*, 2002). There is a recent record (year 2005) of *O. rogeri* from Sierra del Cadí-Moixeró (BDBC), and in case it is confirmed it would expand its Iberian distribution to the eastern Pyrenees. According to Infante Sánchez (2015), this species is found in the Ariège and Hautes-Pyrénées departments (recent observations, 2004 and 2014). On the other hand, Infante Sánchez *et al.* (2015) do not consider *O. rogeri* a threatened species, and assessed it as NT. Similarly, *O. rogeri* has a significant number of populations (around 20) in Pyrénées-Orientales department, where it is in a clearly satisfactory situation (Hugonnot *et al.*, 2018). There is currently no evidence of decline in Spain, although its geographic restriction (AOO=16 km², EOO=c. 395 km²) and low number of localities makes it vulnerable to stochastic events.

Orthotrichum scanicum Gronvall

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: LC

It is a mainly sub-Mediterranean species, present in the Pyrenees, Galicia, Iberian System, reaching even the Sierra de la Alhamilla (Medina *et al.*, 2008). Similarly to *O. philibertii*, it has a wide distribution, since it is found at least in 11 provinces (Lara & Garilleti, 2014). Moreover, there are no indications that the subpopulations are especially vulnerable to the effects of human activity, at least in the

medium or short term, such as to consider CR or disappear (at the regional level), as established by IUCN (2012). By not satisfying criteria that allow this species to be included in a risk category, it must be considered LC.

Pohlia andalusica (Höhn.) Broth.

Previous category: VU D2 (Brugués *et al.*, 2014).

New category: NT

According to Guerra (2010), this species is found in our area in the Pyrenees and Sierra Nevada (Gr, Hu, L and Na provinces). Its presence has been documented of at least 16 UTM 1x1 km squares (AOO = 60 km², EOO = c. 97,450 km²). At least 5 populations are found in Sierra Nevada located in high altitude areas, above 2,860 m (Rams *et al.*, 2014) and in the Pyrenees, where the altitudinal gradient is much wider, and correspond to well conserved areas. Both, the number of localities and the value of AOO far exceed the geographical restriction threshold established for VU D2. In the absence of evidence regarding a continuous decrease in AOO or the disappearance of a significant number of subpopulations, *P. andalusica* is assigned to NT.

Polytrichastrum sexangulare (Brid.) G.L.Sm.

Previous category: VU D2 (Brugués *et al.*, 2014); LC (Luceño *et al.*, 2017).

New category: LC

The Spanish populations of this chionophile species are found in the Pyrenees and the Central System (Gredos) (Av, Ge, Hu and L provinces). Excluding the Andorran localities, this species has a total of 30 localities (AOO = 104 km², EOO = 40,300 km²). In addition, *P. sexangulare* grows in a wide altitudinal range, between 2,100 and 3,100 m asl, so the effects of an eventual loss of potential habitat related to changes in the climate would not be immediate. The available data far exceed the thresholds established for D2 criterion, so this species is assigned to LC.

Pseudoleskeella rupestris (Berggr.) Hedenäs & L. Söderstr.

Previous category: DD (Brugués *et al.*, 2014).

New category: VU D2

This saxicolous species is extremely rare in the Iberian Peninsula. It seems to be restricted to the central Pyrenees: Ordesa and Escarrilla (Hu province) and Loseron forest, Valle de Arán (L province), where it grows in calcareous rocky places, between 1,120 and 1,600 m asl (Brugués & Ruiz, 2018). The collections are relatively recent (end of the last century) except in the case of the collected by Allorge in Escarrilla (PC 002592). In addition, there is a small population near the top of Puig Major in Majorca (cover c. 10 cm²) (Sáez & Brugués, 2018). The values of AOO and EOO are 16 km² and c. 11,620 km², respectively. On the basis of its strong geographical restriction in our territory which makes it potentially vulnerable to stochastic events, as well as human activities and encroachment of habitat by other

bryophytes (in the case of the Balearic subpopulation), it is advisable to assimilate *P. rupestris* to VU D2.

Pseudostereodon procerrimus (Molendo) M.Fleisch.

Previous category: VU D2 (Brugués *et al.*, 2014, sub *Hypnum procerrimum* Molendo).

New category: NT

According to Ríos *et al.* (2018), this species is distributed through the Pyrenees, the Cantabrian range and mountains of Guipúzcoa (Aitzgorri) in the provinces Hu, L, Lo, O, S and SS. It grows in forests and meadows in a wide altitudinal range (530-2,500 m asl). Ríos *et al.* (2018) also listed this species for Cu province based on a bibliographic reference. At least 14 localities are known (AOO = 56 km², EOO = c. 33,500 km²), which greatly exceeds the threshold established for VU D2. Considering the available corological data and the fact that there is no evidence of a continuous decline in the occupation area of *P. procerrimus* or disappearance of a significant number of subpopulations, it is assessed as NT.

Ptilium crista-castrensis (Hedw.) De Not.

Previous category: EN D ["D2"] (Brugués *et al.*, 2014).

New category: VU D2

It is a rare species in Spain (Ge, L and Na provinces), known from 6 Pyrenean localities (AOO = 20 km², EOO = c. 2,560 km²). These populations are found between the Port of Eraize (Montserrat *et al.*, 1988) and the Ter valley (Lloret, 1989) and mostly correspond to protected areas. The subpopulations are found in humid places in montane forests, between 1,100 and 1,600 m asl (Gallego, 2018). The supposed isolation of Spanish populations is scarce: at least one Aranese population (Portilló de Bossost) is connected with those of the French Pyrenees (populations located in Val d'Astau, L. Sáez pers. obs.) and with the adjacent Bois Neuf (L. Sáez pers. obs.). *P. crista-castrensis* is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) –where it was assessed as LC– and Pyrénées-Orientales department [3 localities] (Hugonnot *et al.*, 2018). The attribution to EN based on criterion D (population size less than 250 individuals) is difficult to maintain since in some of the localities *P. crista-castrensis* occurs in the form of scattered stands. In fact, this criterion is rarely used solely to assign a species of bryophyte to a specific IUCN (2012) category. There is currently no evidence of decline in Spain, although its geographic restriction and low number of localities makes it vulnerable to stochastic events as well as forest management activities.

Sarmentypnum sarmentosum (Wahlenb.) Tuom. & T.J. Kop.

Previous category: DD (Brugués *et al.*, 2014).

New category: EN B2ab(iii)

It is a very rare species in Spain, known from 4 Cantabrian-Pyrenean localities (Ge, Hu, Na and P provinces) (AOO = 16 km², EOO = c. 10,130 km²) where it grows in permanently wet and oligotrophic places, between

1,000 and 1,850 m asl (Brugués & Ruiz, 2003; Fuertes *et al.*, 2006, 2010). The localities that are based on collections after 1970 correspond to the Curavacas area (P province) and the Estanys de la Pera (Ge province). The locality from Huesca province is based on a collection of Fourcade in 1866 (Brugués & Ruiz, 2003), whereas the label of a specimen from Roncesvalles (MA 12657) does not include date or collector name. The species is also very rare in the Pyrénées-Orientales department (Hugonnot *et al.*, 2018) and the Midi-Pyrénées region where it has been assessed as EN (Infante Sánchez *et al.*, 2015). *Sarmentypnum sarmentosum* has an extremely restricted range in our area and it is especially sensitive to environmental changes. The species is assessed as EN because of the small area of occupancy, small number of known locations. A population decline is inferred due to modifications of the water regime induced by human activity and natural causes.

Schistidium papillosum Culm.

Previous category: DD (Brugués *et al.*, 2014).

New category: LC

This saxicolous species is found in mountain areas in northern Spain (Ge, Gu, Hu, L, Le, O and S provinces; Suárez & Muñoz, 2015). It is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez, 2015) and Pyrénées-Orientales department [5 localities] (Hugonnot *et al.*, 2018). Almost twenty localities (AOO = 64 km²) are known solely in Ge and L provinces that mostly correspond to protected areas (one National park and several Regional natural parks), none subject to any problem to its conservation. Since it is not a rare species and that most populations are located in protected areas it is assessed as LC.

Sciuro-hypnum curtum (Lindb.) Ignatov

Previous category: DD (Brugués *et al.*, 2014).

New category: VU D2

In the Iberian Peninsula this species is known from four localities that correspond to the Cantabrian Range and the central Pyrenees (Hu, L, P and S provinces) (Orgaz *et al.*, 2012; Orgaz 2018). The values of AOO and EOO are 16 km² and c. 2,600 km², respectively. Apparently the isolation of these Iberian populations is important, since the presence of this species in the French Pyrenees and in Andorra is unknown (Orgaz *et al.*, 2011; Infante Sánchez, 2015; Hugonnot *et al.*, 2018; Sotiaux & Vanderpoorten, 2017). The collections are recent except in the case of the locality of La Renclusa, dating from 1966, where we can not rule out direct anthropic impacts, related to works carried out (after 1966) in this area. On the other hand, trampling by cattle and habitat changes can not be ruled out in these Spanish localities. With the data available, it is somewhat risky to apply criterion B2ab(iii,iv), both for EN and for VU, since it is not possible to infer a continuous population decrease in view of the habitats it occupies (subalpine and alpine meadows and snowbeds, between 1,900 and 2,100 m). The species is here assessed as VU D2 given its rarity in our territory (small area of occupancy, small number of

known locations) which makes it potentially vulnerable to stochastic events, as well as human activities.

Sciuro-hypnum glaciale (Schimp.) Ignatov & Huttunen
Previous category: VU D2 (Brugués *et al.*, 2014).
New category: NT

According to Orgaz *et al.* (2011) and Orgaz (2018), this species is distributed in Spain along the Pyrenean-Cantabrian ranges, with one population in Sierra Nevada (Ge, Gr, Hu, L, S and P provinces). It grows in humid rocky places and snowbeds between 1,600 and 3,000 m asl. At least 14 localities are known (AOO = 56 km², EOO = c. 192,770 km²). The number of localities and the AOO value far exceed the threshold established for VU D2. However, since *S. glaciale* has a restricted range, limited to few locations on mountain ridges, it is here assessed as NT.

Sphagnum warnstorffii Russow
Previous category: VU D1 (Brugués *et al.*, 2014).
New category: NT

According to Brugués *et al.* (2016b) and BDBC, there are c. 20 localities of this species are known in Spain which are found in the Pyrenees, Ge, Hu and L provinces (AOO = 64 km², EOO = c. 2,700 km²). In our area there is no indication of a continuous population decline, and most of its range lies within protected areas. *Sphagnum warnstorffii* was assigned to VU D1, which establishes that the estimated population is less than 1,000 mature individuals. The delimitation of individuals is complex in *Sphagnum*, but considering the remarkable number of localities and subpopulations, it is unlikely that less than 1,000 individuals exist. Until further data based on field research can be gathered, it is assessed as NT.

Stegonia latifolia (Schwägr.) Venturi ex Broth.
Previous category: VU B2ab(ii,iv) (Brugués *et al.*, 2014).
New category: NT

This is a rare species in Spain. It is known from few sites in the central Pyrenees (L province: Montsent de Pallars, Pla de Baqueria, Coll de Cabús and Roca Blanca) and the Cantabrian Mountains (Bu and O provinces: macizo de Castro Valnera, Peña Ubiña and alto de la Farrapona) (Cano *et al.*, 2017), where it occurs on calcareous rocky places across a wide altitudinal range (between 1,445 and 2,647 m asl). The values of AOO and EOO are 32 km² and c. 15,995 km², respectively. This species is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) and Pyrénées-Orientales department [5 localities] (Hugonnot *et al.*, 2018). The available data do not suggest a continuous decline. On the other hand, the number of localities and AOO value preclude the assignation of this species to VU D2 (IUCN, 2012), thus it is assessed as NT.

Stereodon callichrous (Brid.) Braithw.
Previous category: VU B2ab(ii,iv) (Brugués *et al.*, 2014, sub *Hypnum callichroum* Brid.).
New category: NT

The Spanish populations of this species are found in the central and eastern Pyrenees (Ge, Hu and L provinces), between the Pico Crabioules and Puigmal (Ruiz & Brugués, 2011). It grows on rocks, soil and bark between 1,500 and 2,200 m (Ríos *et al.*, 2018). In total, 13 localities are known (AOO = 52 km², EOO = c. 1,510 km²). Some records (especially those corresponding to Aragon region) are old and correspond to high mountain areas that are in good condition with very little anthropogenic disturbances and that in some cases have not been prospected in recent times. The Catalan subpopulations are found in 9 UTM squares 1x1 km (EOO = c. 1,330 km²; AOO = 36 km²) and all of them correspond to protected areas (a National park and two Natural parks). This species also exists in nearby localities of Andorra (Ruiz & Brugués, 2011; Sotiaux & Vanderpoorten, 2017) and the French Pyrenees (Ariège, Haute Garonne, Hautes-Pyrénées) (Infante Sánchez, 2015). This species is assigned to NT instead of LC following the same reasoning as exposed for *Hygrohypnum smithii*.

Syntrichia sinensis (Müll.Hal.) Ochyra
Previous category: VU D2 (Brugués *et al.*, 2014).
New category: NT

In the Iberian Peninsula this species is known from two main areas in Eastern Pyrenees (B and Ge provinces): Castellar de n'Hug and Alta Vall del Ter (Lloret Maya, 1986; Lloret, 1989; Gallego, 2005; Ros & Werner, 2006). The values of AOO and EOO are 28 km² and c. 80 km², respectively. The known populations are found on shaded siliceous rocky places, between 1,100 and 2,300 m asl. At least two populations are also known from nearby areas in the Pyrénées-Orientales department (Hugonnot *et al.*, 2018). Although *S. sinensis* has a relatively restricted range in Spain, limited to a few locations on mountain areas, it is unlikely to be declining markedly. This species is therefore here listed as NT, although it is close to qualifying for VU under criterion D2.

Timmia austriaca Hedw.
Previous category: VU D2 (Brugués *et al.*, 2014).
New category: LC

It is distributed through the Cantabrian mountain range and Pyrenees (B, Ge, Hu, L and O provinces) where it grows in rocky places, slopes and woods (Álvaro, 2010; Ruiz *et al.*, 2018a) throughout a wide altitudinal range (120-2,495 m). At least 24 localities are currently known (AOO = 92 km², EOO = c. 15,000 km²) [data from Manobens i Rigol (1984, 1985), Cros *et al.* (2010), Ruiz *et al.* (2018a), BCB and BCN], most of them located in protected areas (National and Natural Parks). In the Pedraforca massif and Serra de Cadí (B and L provinces) *T. austriaca* is not particularly scarce in almost inaccessible areas. In eastern French Pyrenees there are at least 19 localities for the species (Hugonnot *et al.*, 2018), whereas in the Midi-Pyrénées region it was regarded as "DD" (Infante-Sánchez *et al.*, 2015). The value of AOO and the number of localities greatly exceed the threshold established for criterion D2.

On the other hand, there is no evidence to indicate that *T. austriaca* is especially vulnerable to anthropogenic disturbances or to fortuitous events in a short period of time in an uncertain future to be regarded as CR or EX categories. It is thus here assigned to LC.

Tortula viridifolia (Mitt.) Blockeel & A.J.E. Sm.
Previous category: VU D2 (Brugués *et al.*, 2014).
New category: NT

According to Ros *et al.* (2011), this species is restricted in Spain to a few localities in the southeastern Iberian Peninsula (Al, Gr and Mu provinces, corresponding to 4 UTM squares 10x10 km). Based on this restricted range, it was assigned to VU D2 by Brugués *et al.* (2014). The species also exists in 3 localities in the northeastern Iberian Peninsula (Ge province) and also in the Balearic Islands (2 localities in Minorca; Brugués & Ros, 2017). A Majorcan report (Sáez *et al.*, 2002) accepted by Brugués & Ros (2017) is due to confusion with *T. pallida* (Lindb.) R.H. Zander, whereas reports from M and Po provinces require verification. The confirmed Spanish populations of *T. viridifolia* are found across a wide altitudinal range, from sea level to 1500 m. The values of AOO and EOO are 36 km² and c. 102,400 km², respectively. The number of localities and AOO value precludes assigning this species to VU D2 (IUCN, 2012). It has some potential threats (see Ros *et al.*, 2011), but these are not thought to be severe at the moment, so the species is unlikely to be declining markedly. It is to be therefore listed as NT.

Weissia wimmeriana (Sendtn.) Bruch & Schimp.
Previous category: VU D2 (Brugués *et al.*, 2014).
New category: NT

It is a relatively rare species restricted to high mountains or regions with cold climates (Werner *et al.*, 2004). In mainland Spain *W. wimmeriana* is known from around 20 mountain localities from the Pyrenees and Sierra Nevada (Ge, Gr, Hu and L provinces) where it grows in rock crevices and slopes (Guerra, 2006c). AOO and EOO values are 48 km² and c. 57,000 km², respectively (data from BCB and Rams *et al.*, 2014). It is also known from nearby areas in Andorra (Sotiaux & Vanderpoorten, 2017) and France: Midi-Pyrénées region (Infante Sánchez *et al.*, 2015) and Pyrénées-Orientales department [5 localities] (Hugonnot *et al.*, 2018). In Spain there is no indication of a continuous population decline, and most of its range lies within protected areas. The number of localities and AOO value precludes assigning this species to VU D2 (IUCN, 2012). However, since the species has a relatively restricted range in mainland Spain, it is assessed as NT.

Discussion

The review of the information available for the species studied, together with new data on their distribution and relative frequency in the territory considered, led to establish new IUCN categories for 48 taxa. Four species that were not included in Brugués *et al.* (2014)

red list have been identified and subsequently assessed as VU, while an additional species has been assessed as regionally extinct. Given that this study is mainly focused on species present in northeastern Iberian Peninsula, it is advisable to review the Spanish list of bryophytes in order to extend the current red list further as to correct for possible absences.

Regarding category changes –taxa assessed by Brugués *et al.* (2014) as threatened [CR, EN and VU]– our results indicate that downlisting (moving a species to a category of lower threat) is more frequent than uplisting. The vast majority of the taxa studied (31 of a total of 33, excluding *Gymnomitrium coralloides*, to be excluded from the Spanish bryoflora) see an improvement in their situation by qualifying for a lower IUCN (2012) category. Specifically, of the 31 taxa downlisted, 25 no longer qualify for risk categories (that is, they pass to NT or LC). This is in accordance to a general trend of downlisting species when information about its distribution improves. In other cases (i.e., *Orthotrichum philibertii*, *O. scanicum*) the fact that the taxa can no longer be assigned to a risk category is not due to better corological data available, but rather to their initial assignment to a risk category that is questionable and needed to be reconsidered.

In contrast, of the 10 taxa presented here that were regarded as DD by Brugués *et al.* (2014), all but one (*Schistidium papillosum*) have been found to be threatened species according to IUCN (2012) criteria: 6 VU, 1 EN and 2 CR. This highlights the need to review in greater detail any taxon before it is designated as DD, which may have been the problem with some in Brugués *et al.* (2014), especially since DD makes up the largest group (82 taxa) in that red list. Species assessed as DD are very likely to be threatened, like *Scorpidium revolvens* (Sw. ex anon.) Rubers and *Warnstorfia fluitans* (Hedw.) Loeske. Both mosses are extremely rare in Spain (Canalis *et al.*, 1984; Fuertes *et al.*, 2006, 2010), restricted to few localities and are especially sensitive to anthropic disturbances. They can confidently be assessed as CR or EN under criteria B2ab. On the other hand, included within the DD group are also species of obvious wide distribution in Spain, such as *Gyroweissia tenuis* (Hedw.) Schimp., which is listed from 14 Spanish provinces (Guerra, 2006b).

The classification protocol provided by IUCN (2012, 2017) is a simple and flexible method for determining species' vulnerability to extinction. Accurate and standardized conservation status assessments for the IUCN Red List are limited by a lack of adequate information, so there is a need for consistent and unbiased interpretation of that information (Hayward *et al.*, 2015). Although the IUCN has developed a set of detailed guidelines for using categories and criteria, biases and incorrect applications of the protocols (or mistakes interpreting thresholds and criteria) are not uncommon (Regan *et al.*, 2005, Hayward *et al.*, 2015). The result of these evaluations usually translates into an overrepresentation of taxa in red lists, but also in a higher attribution of the risk status, unrealistically superior to what a taxon may actually have. Although data referring to a species' population dynamics are seldom

available for applying criterion B correctly (although IUCN procedures allow for establishing inferences), it is nonetheless widely used despite no clear evidence of population decline. Yet precision of assessments remains a non-trivial problem because, among other things, the criteria provide no real guidance for the use of inference (Regan *et al.*, 2005).

Another source of inaccurate assessments is the inadequate use of the VU D2 criterion. IUCN (2017: 69) emphasizes that the restricted AOO (typically < 20 km²) –or five or less locations– is to be applied to species whose populations are prone to effects of human activities or to stochastic events in an uncertain future, and the species is thus subject to become Critically Endangered or even Extinct in a very short time (e.g., within one or two generations after the threatening event occurs). Much of category changes proposed in this study correspond to improper use of the criterion D2.

Finally, another aspect that may cause deviations is to assign risk categories to taxa that, strictly, do not meet the minimum objective criteria for being granted any risk category according to IUCN (2012). Such inaccurate assessments may be explained because these taxa are under some kind of legal protection. This could be the case with species such as *Petalophyllum*

ralfsii and *Buxbaumia viridis*, which have become protected by various European and Spanish regulations. Reviewing available data for these species shows that the “Bb” subcriterion [small range (EOO and/or AOO) and continuing decline] is not applicable in these and several other cases, at least not in the short-medium term. Perhaps this legal protection does not favor a critical re-evaluation of the available data that will likely lead to their removal from red lists. Higher attribution of the risk situation than a species merits could actually be very detrimental to conservation because it distracts from more serious conservation problems. Attention is drawn in the wrong direction and resources are diverted away from species that are genuinely at risk of extinction, while favouring species that are not. Unwarranted uplisting of species is considered for these reasons counterproductive to the general goals of biodiversity conservation (Webb, 2000, 2008).

Acknowledgements

We would like to express our gratitude to Íñigo Granzow-de la Cerda for his comments and advice on

language and style. We thank Juan Carlos Moreno and Juan Guerra for valuable comments on the manuscript and nomenclatural advice, respectively.

References

- Allorge, V. 1955. Catalogue préliminaire des Muscinées du Pays basque français et espagnol. *Rev. Bryol. Lichénol.* 24: 96–131.
- Álvaro, I. 2010. *Timmia Hedw.* In: Guerra, J., Brugués, M., Cano, M.J. & Cros, R.M. (Eds.). *Flora Briofítica Ibérica Vol. IV*. Pp. 290–295. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Anderson, S. 2002. Identifying important plant areas. PlantLife International, London. www.cbd.int/doc/pa/tools/Identifying%20important%20plant%20areas.pdf
- Bachman, S., Moat, J., Hill, A.W., Torre, J. & Scott, B. 2011. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *Zookeys* 150: 117–126. doi.org/10.3897/zookeys.150.2109
- Bloekel, T.L. 2003. New records of bryophytes from Cyprus. *Bocconea* 16(1): 105–113. www.herbmedit.org/bocconea/16-0105.pdf
- Brugués, M. 2017. *Anoectangium aestivum* (Hedw.) Mitt. In: *Cartografía de Briòfits. Península Ibèrica i Illes Balears*. briofits.iec.cat/.
- Brugués, M. & González-Mancebo J.M. 2012. Lista roja de los briòfitos amenazados de España. In: Garilletei, R. & Albertos, B. (Coords.). *Atlas y Libro Rojo de los Briòfitos Amenazados de España*. Pp. 25–44. Madrid: Org. Aut. Par. Nac., Madrid. www.mapama.gob.es/es/biodiversidad/temas/inventarios-nacionales/briofitos_tcm30-198033.pdf
- Brugués, M. & Ros, R.M. 2017. *Tortula viridifolia* (Mitt.) Bloekel & A.J.E.Sm. In: *Cartografía de Briòfits. Península Ibèrica i Illes Balears*. briofits.iec.cat/.
- Brugués, M. & Ruiz, E. 2003. Nota sobre *Drepanocladus sendtneri* (H. Müll.) Warnst., *Callialaria curvicaulis* (Jur.) Ochyra y *Warnstorfia sarmentosa* (Wahlenb.) Hedenäs en la Península Ibèrica. *Bol. Soc. Esp. Briol.* 22–23: 17–20.
- Brugués, M. & Ruiz, E. 2015. *Dicranum Hedw.* In: Brugués, M. & Guerra, J. (eds). *Flora Briofítica Ibérica Vol. II*. Pp. 105–128. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Brugués, M. & Ruiz, E. 2018. *Pseudoleskeella Kindb.* In: Guerra, J., Cano, M.J. & Brugués, M. (eds). *Flora Briofítica Ibérica Vol. VI*. Pp. 22–27. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Brugués, M., Casas, C. & Solé, L. 2007. Los briòfitos de la zona volcánica de Olot. *Bol. Soc. Esp. Briol.* 30–31: 19–24.

- Brugués, M., Cros, R.M. & Infante, M. 2014. Lista Roja de los briófitos amenazados de España peninsular y balear. In: Garilleti, R. & Albertos, B. (Coords.). Atlas de los briófitos amenazados de España. Univ. València. www.uv.es/abraesp. Published online 04/07/2014.
- Brugués, M., Cros, R.M., Sérgio, C., Cano, M.J. & Guerra, J. 2016a. Acaulon fontiquerianum Casas & Sérgio In: Cartografía de Briòfits. Península Ibèrica i Illes Balears. briofits.iec.cat/.
- Brugués, M., Infante, M. & Cros, R.M. 2011. Anotaciones sobre hepáticas de España. Bol. Soc. Esp. Briol. 36: 3–8.
- Brugués, M. & Ruiz, E., Infante, M. & Heras, P. 2016b. Sphagnum warnstorffii Russow In: Cartografía de Briòfits. Península Ibèrica i Illes Balears. briofits.iec.cat/.
- Brugués, M., Sérgio, C. & Cros, R.M. 2016c. Aschisma carniolicum (F.Weber & D.Mohr) Lindb. In: Cartografía de Briòfits. Península Ibèrica i Illes Balears. briofits.iec.cat/.
- Canalis, V. & Casas, C. 1992. Encalypta affinis Hedw. f. i Encalypta alpina Sm. als Pirineus. Act. Simp. Int. Bot. Pius Font i Quer, 1988, 1: 223–229.
- Canalis, V., Baulies, X., Sebastià, T. & Ballesteros, E. 1984. Aportació al coneixement florístic de l'Alta Ribagorça i de la Vall d'Aran. Butll. Inst. Catalana Hist. Nat. 51: 135–137.
- Cano, M.J., Guerra, J., Cabezudo, B. & Tamajón, R. 2017. Novedades corológicas para la flora briofítica ibérica. VIII. An. Biol. 39: 203–209.
- Cano, M.J., Ríos, D. & Guerra, J. 2016. Novedades corológicas para la flora briofítica ibérica. VII. Anales Biol. 38: 115–117.
- Carnicero, P. & Unzeta, M. 2016. Primera cita de la molsa protegida Buxbaumia viridis (Buxbaumiaceae) pels Prepirineus catalans. Butll. Inst. Cat. Hist. Nat. 80: 83–85.
- Casares, A. 1911. Muscíneas nuevas para la flora española. Bol. R. Soc. Esp. Hist. Nat. 10: 242–244.
- Casas, C. & Infante, M. 1998. Aportaciones al conocimiento del género Lophozia en la Península Ibérica. Orsis 13: 43–50.
- Casas, C., Cros, R.M., Brugués, M., Ruiz, E., Sérgio, C., Barrón, A. & Lloret, F. 2006. Aportaciones a la brioflora del Pirineo. Bol. Soc. Esp. Briol. 28: 73–86.
- Casas de Puig, C. 1956. Aportación a la flora briológica balear. Hepáticas de Mallorca. Boll. Soc. Hist. Nat. Balears 2: 63–67.
- Casas Sicart, C. 1986. Catálogo de los briófitos de la vertiente española del Pirineo Central y de Andorra. Collect. Bot. (Barcelona) 16: 255–321.
- Cros, R.M., Brugués, M., Ruiz, E., Sáez, L., Barrón, A. & Pérez, A. 2010. Els briòfits de les Planes de Son i la Mata de València. In: Germain, J. [cur.]. Els sistemes naturals de les Planes de Son i la mata de València. Treb. Inst. Catalana Hist. Nat. 16: 229–253. Barcelona.
- Cros, R.M., Brugués, M. & Sérgio, C. 2015. Gymnomitron corallioides Nees. In: Cartografía de Briòfits. Península Ibèrica i Illes Balears. briofits.iec.cat/.
- Cros, R.M., Sáez, L. & Rosselló, J.A. 2005. Plagiochasma appendiculatum Lehm. & Lindenb. (Marchantiales, Aytoniaceae), a species new to the European bryophyte flora. J. Bryol. 27: 3–6. doi.org/10.1179/174328205X40527ECCB
- Ellis, L.T., Ah-Peng, C., Aranda, S.C., Bednarek-Ochyra, H., Borovichev, E.A., Cykowska-Marzencka, B., Duarte, M.C., Enroth, J., Erzberger, P., Fedosov, V., Fojcik, B., Gabriel, R., Coelho, M.C.M., Henriques, D.S.G., Ilna, O.V., Gil-Novoa, J.E., Morales-Puentes, M.E., Gradstein, S.R., Gupta, R., Nath, V., Asthana, A.K., Koczur, A., Lebouvier, M., Mesterházy, A., Mogro, F., Mežaka, A., Németh, C., Orgaz, J.D., Sakamoto, Y., Paiva, J., Sales, F., Pande, N., Sabovljević, M.S., Pantivić, J., Sabovljević, A.D., Pérez, A., Pinheiro da Costa, D., Plášek, V., Sawicki, J., Szczecińska, M., Chmielewski, J., Potemkin, A., Schäfer-Verwimp, A., Schofield, W.B., Sérgio, C., Sim-Sim, M., Sjögren, S., Spitale, D., Stebel, A., Ștefănuț, S., Suárez, G.M., Flores, J.R., Thouvenot, L., Váňa, J., Yoon, Y.-J., Kim, J.H. & Zubel, R. 2016. New National and regional bryophyte records, 48. J. Bryol. 37: 235–259. doi.org/10.1080/03736687.2016.1206685
- Ellis, L.T., Alataş, M., Aleffi, M., Alegro, A., Šegota, V., Ozimec, S., Vuković, N., Koletić, N., Prlić, D., Bontek, M., Asthana, A.K., Gupta, D., Sahu, V., Rawat, K.K., Bakalin, V.A., Klimova, K.G., Baráth, K., Beldiman, L.N., Csiky, J., Deme, J., Kovács, D., Cano, M.J., Guerra, J., Czernyadjeva, I.V., Dulin, M.V., Erzberger, P., Ezer, T., Fedosov, V.E., Fontinha, S., SimSim, M., Garcia, C.A., Martins, A., Granzow-de la Cerda, I., Sáez, L., Hassel, K., Weibull, H., Hodgetts, N.G., Infante, M., Heras, P., Kiebacher, T., Kučera, J., Lebouvier, M., Ochyra, R., Ören, M., Papp, B., Park, S.J., Sun, B.-Y., Plášek, V., Poponessi, S., Venanzoni, R., Purger, D., Reis, F., Singila, M., Stebel, A., Ștefănuț, S., Uyar, G., Vončina, G., Wigginton, M.J., Yong, K.-T., Chan, M.S. & Yoon, Y.-J. 2017. New national and regional bryophyte records, 52. J. Bryol. 39: 285–304. doi.org/10.1080/03736687.2017.1341752
- Fuertes, E., Oliván, G. & Acón, M. 2006. Warnstorffia (Bryopsida, Calliergonaceae) in the Iberian Peninsula. Cryptog. Bryol. 27: 225–239.
- Fuertes, E., Oliván, G., Acón, M. & León, C. 2010. Notula chorologica Iberica (Bryophyta). Bot. Complutensis 34: 31–40.
- Gallego, M.T. 2005. A taxonomic study of the genus Syntrichia Brid. (Pottiaceae, Musci) in the Mediterranean region and Macaronesia. J. Hattori Bot. Lab. 98: 47–122.
- Gallego, M.T. 2018. Ptilium De Not. In: Guerra, J., Cano, M.J. & Brugués, M. (eds.). Flora Briofítica Ibérica. Vol. VI. Pp. 328–331. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Garilleti, R. & Albertos, B. 2012. Bases de conocimiento y marco metodológico del Atlas y Libro Rojo de los Briófitos de España. In Garilleti, R. & B. Albertos 2012 Coords. Atlas y Libro Rojo de los Briófitos amenazados de España: 10–17. Organismo Autónomo Parques Nacionales. Madrid, 288 pp. www.mapama.gob.es/es/biodiversidad/temas/inventarios-nacionales/briofitos_tcm30-198033.pdf

- Garilleti, R., Lara, F. & Mazimpaka, V. 2002. New differential characters for *Orthotrichum rogeri* Brid. (Orthotrichaceae, Bryopsida). *Nova Hedwigia* 75: 207–216. doi.org/10.1127/0029-5035/2002/0075-0207
- Granzow-de la Cerda, I. 1988. Distribución de las especies del género *Anomodon* (Hedw.) Hook. & Tayl. (Musci) en la Región Occidental. *Fontqueria* 16: 9–24.
- Guerra, J. 2006a. *Acaulon* Müll.Hal. In: Guerra, J., Cano, M.J. & Ros, R.M. (Eds.). *Flora Briofítica Ibérica* Vol. III. Pp. 208–217. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Guerra, J. 2006b. *Gyroweissia* Schimp. In: Guerra, J., Cano, M.J. & Ros, R.M. (Eds.). *Flora Briofítica Ibérica* Vol. III. Pp. 39–42. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Guerra, J. 2006c. *Weissia* Hedw. In: Guerra, J., Cano, M.J. & Ros, R.M. (Eds.). *Flora Briofítica Ibérica* Vol. III. Pp. 63–77. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Guerra, J. 2010. *Pohlia* Hedw. In: Guerra, J., Brugués, M., Cano, M.J. & Cros, R.M. (Eds.). *Flora Briofítica Ibérica* Vol. IV. Pp. 183–206. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Guerra, J. 2018. *Herzogiella* Broth. In: Guerra, J., Cano, M.J. & Brugués, M. (Eds.). *Flora Briofítica Ibérica*. Vol. VI. Pp. 298–302. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Guerra, J. & Cano, M.J. 2013. *Anoetangium aestivum* (Hedw.) Mitt. (Pottiaceae) rediscovered in the Iberian Peninsula. *Bol. Soc. Esp. Briol.* 40–41: 47–48.
- Guerra, J., Cano, M.J., Orgaz, J.D. & Ríos, D. 2015. Novedades corológicas para la flora briofítica ibérica. VI. *An. Biol.* 37: 39–41.
- Guerra, J., Cano, M.J. & Ros, R.M. (Eds.). 2006. *Flora Briofítica Ibérica* Vol. III. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Hallingbäck, T., Hodgetts, N., Raeymaekers, G., Schumacker, R., Sérgio, C., Söderstrom, L., Stewart, N. & Vana, J. 1998. Guidelines for application of the revised IUCN threat categories to bryophytes. *Lindbergia* 23: 6–12. www.slu.se/globalassets/ew/subw/artd/bryophyte-conservation/bryoconservation/pdf-artiklar-etc/hallingback_et_al_1998_iucn_to-bryophytes.pdf
- Hayward, M.W., Child, M.F., Kerley, G.I.H., Lindsey, P.A., Somers, M.J. & Burns, B. 2015. Ambiguity in guideline definitions introduces assessor bias and influences consistency in IUCN Red List status assessments. *Frontiers in Ecology and Evolution* 3, Article number 87. doi.org/10.3389/fevo.2015.00087
- Heras, P. & Infante, M. 2016. *Conostomum tetragonum* (Hedw.) Lindb. in *Cartografía de Briòfits*. Península Ibèrica i Illes Balears. briofits.iec.cat/
- Heras, P., Infante, M., Casas, C., Cros, R.M. & Brugués, M. 2004. Contribución a la brioflora del Pirineo aragonés. *Bol. Soc. Esp. Briol.* 25: 25–31.
- Heras, P., Infante, M. & Ugarte, I. 2002. Briófitos del Parque Natural de Pagotea (Aya, Guipúzcoa). *Naturzale* 17: 97–110. hedatuz.euskomedia.org/8026/1/17097110.pdf
- Hofmann, H. 2013. The Swiss bryophyte collection of Paul Frédéric Culmann (1860-1936) in Zurich. *Herzogia* 26: 405–416. doi.org/10.13158/heia.26.2.2013.405
- Hugonnot, V. 2015. Five remarkable bryophytes from the eastern part of the Pyrenees. *Bol. Soc. Esp. Briol.* 44–45: 37–43.
- Hugonnot, V., Chavoutier, L., Pépin, F. & Vergne, T. 2018. Les bryophytes des Pyrénées-Orientales. *Naturalis Publ., Turriers*.
- Infante, M. & Heras, P. 2012. Red preliminar de Áreas Importantes para los Briófitos (IBrA). In: Garilleti, R. & B. Albertos (Coords.). *Atlas de los briófitos amenazados de España*. Universitat de València. www.mapama.gob.es/es/biodiversidad/temas/inventarios-nacionales/briofitos_tcm30-198033.pdf
- Infante, M. & Heras, P. 2018. Notes on the Herbivory on *Buxbaumia viridis* Sporophytes in the Pyrenees. *Cryptog., Bryol.* 39: 185–194. doi.org/10.7872/cryb/v39.iss2.2018.185
- Infante, M., Muñoz, L., Albertos, B., Garilleti, R. & Heras, P. 2017. View on Bryophyte Conservation in Peninsular and Balearic Spain: Analysis of Red Lists and Legal Protection. *Cryptog., Bryol.* 38(1): 19–51. doi.org/10.7872/cryb/v38.iss1.2017.19
- Infante Sánchez, M. 2015. Catalogue des bryophytes de la région Midi-Pyrénées 2015. Conservatoire botanique National des Pyrénées et Midi-Pyrénées. www.fcbn.fr/sites/fcfn.fr/files/ressource_telechargeable/bryophyte_catalogue_midi-pyr_rapp_finale30062015.pdf
- Infante Sánchez, M., Corriol, G. & Hamdi, E. 2015. La liste rouge d'espèces menacées de bryophytes en Midi-Pyrénées selon la méthodologie UICN – Version finale. Conservatoire botanique National des Pyrénées et Midi-Pyrénées. www.fcbn.fr/sites/fcfn.fr/files/ressource_telechargeable/lr_uicn_bryophyte_midi-pyr_version_finale_aout2015.pdf
- Lara, F. & Garilleti, R. 2014. *Orthotrichum* Hedw. In: Guerra, J., Cano, M.J. & Brugués, M. (eds.). *Flora Briofítica Ibérica*. Vol. V. Pp. 50–135. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Lloret, F. 1989. Briófitos del alto valle del Ter. *Orsis* 4: 11–45.
- Lloret Maya, M.F. 1986. *Tortula sinensis* (C. Müll) Broth. y *Tortula fragilis* Tayl., novedades para la brioflora de la Península Ibérica. *An. Jard. Bot. Madrid* 42: 303–308.
- Luceño, M., Cerrejón, C., Guerra-Cárdenas, S., Márquez-Corro, J.I., Pineda-Labela, V., Martín-Bravo, S., Infante, M. & Muñoz, J. 2017. A contribution to the knowledge of Bryophytes from Sierra de Gredos (Central Spain) including a reevaluation of their national conservation status. *Cryptog. Bryol.* 38: 281–302.

- Manobens i Rigol, R.M. 1984. Aportaciones al conocimiento de la brioflora de los Pirineos. *Anales Biol.* 2: 327–333.
- Manobens i Rigol, R.M. 1985. Brioflora de la Vall d'Àssua (Serra d'Altars-Montsent de Pallars). Tes. Lic. (inéd.). Univ. Barcelona.
- Manobens i Rigol, R.M. & Casas Sicart, C. 1985. *Mielichhoferia elongata* (Musci), espècie nova per a la brioflora ibèrica, i altres aportacions. *Collect. Bot. (Barcelona)* 16: 323–326.
- Medina, N.G., Medina, R., Lara, F. & Mazimpaka, V. 2008. Brioflora epífita de la Sierra de la Alhamilla (Almería). *Bol. Soc. Esp. Briol.* 32/33: 1–7.
- Montserrat, P., Casas, C., Brugués, M. & Cros, R.M. 1988. Musgos del herbario JACA recolectados en el Pirineo por P. Montserrat y sus colaboradores. *Monogr. Inst. Pir. Ecol. Homenaje a Pedro Montserrat* 4: 131–141.
- Muñoz, J., Cezón, K., Hespahol, H. & Quandt, D. 2015. *Grimmia Hedw.* In: Brugués, M. & Guerra, J. (eds.). *Flora Briofítica Ibérica. Vol. II.* Pp. 210–261. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Oliván G., & Fuertes E. 2018. *Hygrohypnum Lindb.* In: Guerra, J., Cano, M.J. & Brugués, M. (eds.). *Flora Briofítica Ibérica. Vol. VI.* Pp. 88–99. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Oliván G., Fuertes E. & Acón M. 2007. *Hygrohypnum* (Amblystegiaceae, Bryopsida) in the Iberian Peninsula. *Cryptog. Bryol.* 28(2): 109–143.
- Orgaz, J.D. 2018. *Brachythecium Schimp.* In: Guerra, J., Cano, M.J. & Brugués, M. (Eds.). *Flora Briofítica Ibérica. Vol. VI.* Pp. 148–186. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Orgaz, J.D., Cano, M.J. & Guerra, J. 2009. Nuevos datos sobre la distribución, morfología y habitat de *Brachythecium mildeanum* (Schimp.) Schimp. (Brachytheciaceae, Bryophyta) en la Península Ibérica. *An. Biol.* 31: 37–41.
- Orgaz, J.D., Cano, M.J. & Guerra, J. 2011. *Sciuro-hypnum* (Brachytheciaceae) in the Mediterranean region. *Bryologist* 114(3): 595–610. doi.org/10.1639/0007-2745-114.3.595
- Orgaz, J.D., Cano, M.J. & Guerra, J. 2012. Typification, taxonomy and distribution of *Brachythecium erythrorrhizon* Schimp. (Brachytheciaceae, Bryophyta) in the Mediterranean Region. *Nova Hedwigia* 95: 227–231. doi.org/10.1127/0029-5035/2012/0040
- Pericàs, J., Fraga, P., Mascaró, J. & Rosselló, J.A. 2016. New and interesting bryophyte records for Minorca (Balearic Islands, Spain). *Fl. Montiberica* 62: 92–99.
- Rams, S., Werner, O. & Ros, R.M. 2014. Updated check-list of the brophytes from the Sierra Nevada Mountains (S of Spain). *Cryptog., Bryol.* 35: 261–311. doi.org/10.7872/cryb.v35.iss3.2014.261
- Regan T.J., Burgman M.A., McCarthy M.A., Master L.L., Keith D.A., Mace G.M. & Andelman S.J. 2005. The consistency of extinction risk classification protocols. *Conserv. Biol.* 19: 1969–1977. doi.org/10.1111/j.1523-1739.2005.00235.x
- Ríos, D., Gallego, M.T. & Guerra, J. 2018. *Hypnum Hedw.* In: Guerra, J., Cano, M.J. & Brugués, M. (eds.). *Flora Briofítica Ibérica. Vol. VI.* Pp. 336–367. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Ros, R.M. & Werner, O. 2006. *Stegonia Venturi* In: Guerra, J., Cano, M.J. & Ros, R.M. (eds.), *Flora Briofítica Ibérica. Vol. III.* Pp. 180–182. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Ros, R.M., Rams, S. & Werner, O. 2011. *Tortula viridifolia* (Mitt.) Blockeel & A.J.E. Sm. In: Garilleti, R. & B. Albertos (Coords.). *Atlas de los briófitos amenazados de España*: 161–162. Universitat de València.
- Ruiz, E. & Brugués, M. 2011. Distribución de las Secciones *Revolutohypnum* Mönk., *Hamulosa* Schimp. y *Pseudostereodon* (Broth.) Ando del género *Hypnum* Hedw. en la Península Ibérica e Islas Baleares. *Bol. Soc. Esp. Briol.* 37: 25–34.
- Ruiz, E., Aymerich, P., Brugués, M. & Sáez, L. 2018a. Aportaciones al conocimiento de la flora briológica de la Sierra del Cadí-Moixeró (Barcelona y Lérida). *Bol. Soc. Esp. Briol.* 50 (in press).
- Ruiz, E., Aymerich, P., Sáez, L. & Brugués, M. 2018b. *Cyrtomnium hymenophylloides* in New National and regional bryophyte records, 56. *J. Bryol.* 40. doi.org/10.1080/03736687.2018.1487687
- Sabovljevic, M., Lakusic, D. & Surina, B. 2009. *Cyrtomnium hymenophylloides* (Huebener) T.J.Kop. New national and regional bryophyte records, 22. *J. Bryol.* 31: 203. doi.org/10.1179/037366809X12469790518367
- Sáez L. & Brugués, M. 2018. *Pseudoleskeella rupestris* (Berggr.) Hedenäs & L. Söderstr. in New National and regional bryophyte records, 57. *J. Bryol.* 40. doi.org/10.1080/03736687.2018.1523601
- Sáez, L., Aymerich, P. & Blanché, C. 2010. *Llibre Vermell de les plantes vasculars endèmiques i amenaçades de Catalunya.* Argania editio. Barcelona.
- Sáez L., Casas, C. Cros, R.M. & Brugués, M. 2002. New bryological data for the Balearic Islands. *Cryptog. Bryol.* 23: 181–187.
- Sáez, L., Infante, M. & Brugués, M. 2011. Two new liverworts for the bryophyte flora of Spain. *Cryptog. Bryol.* 32(2): 135–137. doi.org/10.7872/cryb.v32.iss1.2011.135
- Sáez, L., Ruiz, E., Granzow, I. & Brugués, M. 2018. The Bryophyte Flora of the Montseny Massif (Northeastern Iberian Peninsula): Conservation Issues and an Updated Check–List. *Cryptog. Bryol.* 39(1): 3–46. doi.org/10.7872/cryb/v39.iss1.2018.3
- Segarra-Moragues, J.G. & Puche, F. 2016. The bryophyte flora of Sierra Calderona (Valencia and Castellón provinces, eastern Spain). *Bol. Soc. Esp. Briol.* 46–47: 11–35.
- Söderström L, Urmi E. & Váña J. 2002. Distribution of Hepaticae and Anthocerotae in Europe and Macaronesia. *Lindbergia* 27: 3–47. doi.org/10.2307/20150088
- Sotiaux, A. & Schumacker, R. 2002. Catalogue des hépatiques d'Andorre. *Lejeunia* 170: 1–42.

- Sotiaux, A. & Vanderpoorten, A. 2017. A checklist of the bryophytes of Andorra. *J. Bryol.* doi.org/10.1080/03736687.2017.1346744
- Spitale, D. & Mair, P. 2017. Predicting the distribution of a rare species of moss: The case of *Buxbaumia viridis* (Bryopsida, Buxbaumiaceae). *Pl. Biosyst.* 151: 9–19. doi.org/10.1080/11263504.2015.1056858
- Stewart, N., Schumacker, R., Hodgetts, N.G. & Martiny, Ph. (Eds.). 1995. Red Data Book of European bryophytes. Trondheim, European Committee for the Conservation of Bryophytes.
- Suárez, G.-M. & Muñoz, J. 2015. *Schistidium* Bruch & Schimp. In: Brugués, M. & Guerra, J. (eds.) *Flora Briofítica Ibérica*. Vol. II. Pp. 290–325. Univ. Murcia y Soc. Esp. Briología, Murcia.
- Thiers, B. 2018 [continuously update]. Index Herbariorum: A global directory of public herbaria and associated staff. – New York Botanical Garden's Virtual Herbarium. sweetgum.nybg.org/ih/
- Venturi, G. 1887. *Orthotrichum*. In: T. Husnot, *Muscologia gallica*. Cahan, Caen.
- Webb, G.J.W. 2000. Are all species equal? A comparative assessment. In: Hutton J, Dickson, B. (Eds.). *Endangered species threatened convention*. Pp. 98–106. Earthscan Publ., London.
- Webb, G.J.W. 2008. The dilemma of accuracy in IUCN Red List categories, as exemplified by hawksbill turtles *Eretmochelys imbricate*. *Endangered Species Research* 6: 161–172. doi.org/10.3354/esr00124
- Werner, O., Ros, R.M., Guerra, J. & Cano M.J. 2004. Inter-Simple Sequence Repeat (ISSR) markers support the species status of *Weissia wimmeriana* (Sendtn.) Bruch & Schimp. (Pottiaceae, Bryopsida). *Cryptog. Bryol.* 25(2): 137–146. www.pottiaceae.com/imagenes/pdf/Cryptogamie_Bryologie_25_137.pdf

Websites

- ECCB. Red Data Book of European bryophytes, 1995. Trondheim, European Committee for the Conservation of Bryophytes. www.nhm.ac.uk/our-science/data/uk-species/checklists/NBNSYS0000000098/index.html
- IUCN 2003. Guidelines for Application of IUCN Red List Categories and Criteria at Regional Levels: Version 3.0. Gland, Switzerland and Cambridge. s3.amazonaws.com/iucnredlist-newcms/staging/public/attachments/3101/reg_guidelines_en.pdf
- IUCN 2012. Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge. portals.iucn.org/library/node/10315
- IUCN 2017. Guidelines for Using the IUCN Red List Categories and Criteria: Version 13. Standards and Petitions Subcommittee. Gland, Switzerland and Cambridge. cmsdocs.s3.amazonaws.com/RedListGuidelines.pdf