

View on bryophyte conservation in Peninsular and Balearic Spain: analysis of Red Lists and legal protection

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Abstract – Current knowledge on the bryophyte flora of Peninsular and Balearic Spain has been highly improved in the past decades, yielding to a still evolving list of 1143 taxa (862 mosses, 5 hornworts, 276 liverworts). Despite its low endemism (a scarce 0.5% of the bryophyte flora), the Spanish enrolment, both by researchers and by administration, is key in bryophyte conservation science and protection, since it hosts over 40 species that are exclusive or extremely rare both at a European scale and worldwide. The state of bryophyte conservation in Peninsular and Balearic Spain is discussed through comparison of the three national Red Lists already published (1994, 1996, 2014) with the legal protection lists at different scales (European, national and regional). There are 271 threatened species according to the current Peninsular and Balearic Spanish Red List. They represent the 24% of the Bryophyte flora, while in the first Red List published in 1994 they were only the 10%. Only 79 taxa are listed in all existing national and regional catalogues. In other words, only 29% of all 271 threatened bryophyte taxa are under certain level of protection in Balearic and Peninsular Spain.

Balearic Islands / Europe / Iberian Peninsula / hornworts / liverworts / mosses

Resumen – El conocimiento actual de la brioflora de la España peninsular y balear se ha visto altamente mejorado en las últimas décadas, dando lugar a una lista aún en evolución de 1143 taxones (862 musgos, 5 antocerotas, 276 hepáticas). Pese a su baja endemism (un escaso 0.5% de la brioflora), la responsabilidad española, tanto desde el punto de vista científico como desde la administración, es clave en la conservación de briófitos, ya que alberga más de 40 especies exclusivas o extremadamente raras a escala europea o mundial. Se discute el estado de la conservación de los briófitos en la España peninsular y balear a través de la comparación de las tres listas rojas nacionales ya publicadas (1994, 1996, 2014) con las listas legales de protección a diferentes escalas (europea, nacional y regional). Actualmente 271 especies se consideran amenazadas, que representan el 24% de la flora total, mientras que en la primera lista publicada en 1994 eran solo el 10% en 1994. Solo 79 taxones se hallan en alguno de los catálogos nacionales o regionales; en otras palabras, sólo un 29% de los 271 briófitos amenazados se encuentran bajo algún nivel de protección en la España peninsular y balear.

Islas Baleares / Europa / Península Ibérica / antocerotas / hepáticas / musgos

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INTRODUCTION

Peninsular and Balearic Spain extends over 498,506 km² according to the official website of the government of Spain (Gobierno de España, 2016). For the following discussion only this region will be considered, since Canary Islands show a very different bryophyte flora and much higher endemism rate (González-Mancebo *et al.*, 2008), and should be discussed on their own.

Current knowledge on the bryophyte flora of Peninsular and Balearic Spain has been highly improved in the past decades, yielding to a still evolving list of 1143 bryophyte taxa (862 mosses, 5 hornworts, 276 liverworts) according to Brugués & Cros (2015) and Cros *et al.* (2015). Grolle & Long (2000) and Hill *et al.* (2006) listed 1790 taxa in the European bryoflora, in this context Spanish bryophytes (excluding Canary Islands) amount to 64% of European bryophytes.

Whereas the endemism rate for vascular plants in Peninsular Spain is a substantial 15.5% (952 endemics against 6152 taxa, Aedo *et al.*, 2013), the territory shows a low rate of bryophyte endemism just as other European countries, as well as large parts of the world (Tan & Pòcs, 2000; Vanderpoorten & Goffinet, 2009; Medina *et al.*, 2011). Similarly, the endemism rate for bryophytes in Europe is low compared to that of vascular plants: Hallingbäck & Hodgetts (2000) state 219 endemic bryophytes for Europe of which 50 are exclusively Macaronesian; overall the endemism rate for European bryophytes – excluding the macaronesic endemics – is 9.4%. Bryophyte endemism in Spain is restricted to species level as no genera have been found exclusive from this region. Previous estimates accounted for five species being exclusive of Peninsular and Balearic Spain (Infante & Heras, 2005). Since then, only two remain in this category, namely *Acaulon dertosense* Casas, Sérgio, Cros & Brugués and *Orthotrichum casasianum* F. Lara, Garilleti & Mazimpaka. Present estimations arise up to six endemic species, representing a scarce 0.5% of the Peninsular and Balearic Spanish bryophyte flora (Table 1).

Despite its low endemism, the Spanish enrolment is key in bryophyte conservation science and protection, and extends beyond these six restricted endemic species to broader types of endemism (Table 1). In addition to this, Spain holds the only European populations of several species: *Orthotrichum consobrinum* Cardot, *Plagiochasma appendiculatum* Lehm. & Lindenb., *Tetralophozia filiformis* (Steph.) Urmi (Cros *et al.*, 2005; Garilleti & Albertos, 2012). Altogether, Spain hosts 42 species that are exclusive or extremely rare both at a European scale and worldwide, for example *Orthotrichum hispanicum* F. Lara, Garilleti & Mazimpaka (Lara & Garilleti, 2014), all species in genus *Riella* (Cirujano *et al.*, 1988; Segarra-Moragues *et al.*, 2014) or *Sphagnum pylaesii* Brid. (Rodríguez-Oubiña *et al.*, 2001). Some caution should be taken into account, however, as our knowledge on the distribution areas of different species is rapidly increasing and these figures may vary.

A revision of bryophyte presence in the Spanish legislation was previously made by Infante & Heras (2005); nevertheless, in the past decade, the panorama of the administrative lists analysed in that publication has been highly modified. Therefore, this review aims at updating all data on the current status of bryophyte conservation and legislation, as well as analysing for the first time the evolution of categories of threat along the different Red Lists published from 1994 to date.

Table 1. Different types of endemism present in Peninsular and Balearic Spain. An asterisk (*) indicates that the species is also present in Canary Islands; two asterisks (**) indicates that the species is also present in Canary and Madeira Islands. IUCN categories are according to Brugués & González-Mancebo (2014). Abbreviations as follows: EX = Extinct, RE = Regionally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient

Endemisms	Peninsular and Balearic Spain	Mediterranean	European	Iberian	Iberian-macaronesian
<i>Acaulon dertiosense</i> Casas, Sérgio, Cros & Brugués	X (LC)				
<i>Aschisma cuynetii</i> (Bizot & R.B. Pierrot) J. Guerra & M.J. Cano	X (VU)				
<i>Cinclidotus vivesii</i> Ederra	X (CR)				
<i>Exsertotheca baetica</i> (J. Guerra) Draper, González-Mancebo, O. Werner, J. Patiño & Ros	X (VU)				
<i>Orthotrichum casasianum</i> F. Lara, Garillei & Mazimpaka	X (CR)				
<i>Syntrichia abranchesii</i> (Luisier) Ochyra	X (EX)				
<i>Exormotheca welwitschii</i> Stephani				X	
<i>Fossombronía mittentii</i> Tind.		X			
<i>Riella helicophylla</i> (Bory & Mont.) Mont.		X			
<i>Riella mediterranea</i> Segarra, Puche, Sabovl., M. Infante & P. Heras		X			
<i>Riella notarisii</i> (Mont.) Mont.		X*			
<i>Riella bialata</i> Trab.		X			
<i>Riella echinata</i> (Müll. Frib.) Segarra, Puche & Sabovl.		X*			
<i>Anomobryum lusitanicum</i> (I. Hagen ex Luisier) Thér.				X	
<i>Bryum minii</i> Podp.		X		X	
<i>Dicranum crassifolium</i> Sérgio, Ochyra & Séneca			X		
<i>Didymodon erosus</i> J.A. Jiménez & J. Guerra			X		
<i>Entosthodon commutatus</i> Durieu & Mont.		X*			
<i>Entosthodon kroontarkii</i> Dirkse & Brugués					X
<i>Goniomitrium seroi</i> Casas					X

Table 1. Different types of endemism present in Peninsular and Balearic Spain. An asterisk (*) indicates that the species is also present in Canary Islands; two asterisks (**) indicates that the species is also present in Canary and Madeira Islands. IUCN categories are according to Brugués & González-Mancebo (2014). Abbreviations as follows: EX = Extinct, RE = Regionally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient (*continued*)

Endemisms	Peninsular and Balearic Spain	Mediterranean	European	Iberian	Iberian- macaronesian
<i>Grimmia horrida</i> J. Muñoz & Hespanhol				X	
<i>Isoethecium algarvicum</i> W.E. Nicholson & Dixon					X
<i>Microbryum longipes</i> (J. Guerra, J.J. Martínez & Ros) R.H. Zander				X	
<i>Orthotrichum comosum</i> F. Lara, Medina & Garilleti		X**			
<i>Orthotrichum ibericum</i> F. Lara & Mazimpaka			X		
<i>Orthotrichum macrocephalum</i> F. Lara, Garilleti & Mazimpaka		X			
<i>Orthotrichum tortidontium</i> F. Lara, Garilleti & Mazimpaka		X			
<i>Orthotrichum vittii</i> F. Lara, Garilleti & Mazimpaka		X			
<i>Pseudotaxiphyllum laetevirens</i> (Dixon & Luisier ex F. Koppe & Düll) Hedenäs					X
<i>Pterygoneurum sampatanum</i> (Guim.) Guim.			X		
<i>Racomitrium hespericum</i> Sérgio, J. Muñoz & Ochyra				X	
<i>Rhynchostegium confusum</i> Cezón, J. Muñoz, Hedenäs & Huttunen				X	
<i>Schizymenium pontevedrense</i> (Luisier) Sérgio, Casas, Cros & Brugués				X	
<i>Syntrichia minor</i> (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & Sánchez-Moya			X*		
<i>Tetrastichium fontanum</i> (Mitt.) Cardot					X
<i>Tetrastichium virens</i> (Cardot) S.P. Churchill					X
<i>Triquetrella arapilensis</i> Luisier				X	
<i>Zygodon catarinoi</i> C.A. García, F. Lara, Sérgio & Sim-Sim		X			
Total number of endemisms	6	13	5	9	6

MATERIAL AND METHODS

Three Red Lists have been made in Spain since 1994 (Sérgio *et al.*, 1994; Sérgio *et al.*, 2007; Brugués & González-Mancebo, 2012). The Red List published in 2007 was denominated by the authors “*The 2006 Red List ... of the Iberian Peninsula*” and therefore, it will be referred from here on as the 2006 list. The 2012 Red List was updated in the on-line version in 2014 including two changes: *Anoetangium aestivum* (Hedw.) Mitt. and *Uloa phyllantha* Brid. were removed from RE and changed to DD and CR respectively. This list will be referred hereafter as Brugués & González-Mancebo (2014). In order to allow comparison and further analysis of these lists, the following tasks were performed: 1) Carrying out a homogenization of the nomenclature according to Ros *et al.* (2007, 2013); 2) Elaborating an equivalence table for categories in the Red List 1994 and those of IUCN in Red Lists 2006 and 2014 (Table 2). Category R (Rare) as defined in 1994 may correspond to several of the new ones, thus it was decided not to assign it to any.

On the other hand, all legislation, national and regional, was compiled and updated to September 2015 in Table 3.

Table 2. Category equivalences for the three Red Lists already published in Peninsular and Balearic Spain (abbreviations of 2006 and 2014 as in Table 1)

	1994	2006 and 2014
EX	Extinct species or probably vanished Species recorded before 1950 but not collected afterwards Some species were not confirmed due to lack of herbarium material	RE
E	Endangered species Species found in few sites, some of which no longer exist and, therefore the possibility of finding those species again in those sites is remote Species in small populations or directly threatened environments	EN
V	Vulnerable species Species collected in few sites, some of which have vanished or are threatened; species described in just one site, without imminent danger Species from vulnerable habitats	VU
R	Rare species Species with few known sites, or in small populations, but without imminent danger Species which are nowadays geographically restricted (recently described), or which still exist in rare environments or habitats, or in restricted areas that are presumably not threatened	
N	Not threatened species	LC
K	Insufficiently known species Species of unknown distribution/Species of uncertain presence and/or taxonomy	DD

Species number		79	10	9	8	1	9	1	7	4	40	26	1	1
2014 Red List		Bern Convention	Habitat Directive	National	Andalusia	Aragon	Asturias	Basque Country	Castile-La Mancha	Catalonia	Galicia	Madrid	Valencia	
EN	<i>Ptilidium pulcherrimum</i> (F. Weber) Vain.										VU			
CR	<i>Radula holtii</i> Spruce											VU		
LC	<i>Riccia crustata</i> Trab.						Special interest							
VU	<i>Riccia fluitans</i> L.										VU	VU	Sensitive to habitat alteration	
VU	<i>Riccia huebeneriana</i> Lindenb.											VU		
EN	<i>Riella cossoniana</i> Trab.									Special interest	EN			
EN	<i>Riella helicophylla</i> (Bory & Mont.) Mont.	X	X	X	X		Sensitive to habitat alteration			Special interest				X
VU	<i>Riella notarisii</i> (Mont.) Mont.						EN			Special interest				
RE	<i>Scapania verrucosa</i> Heeg.										EN			
VU	<i>Telaranea europaea</i> J.J. Engel & G.L.S. Merrill [= <i>Telaranea nematodes</i> (Gott. ex Aust.) Howe]								VU			VU		
Mosses														
NT	<i>Acaulon casasianum</i> Brugués & H.A. Crum											VU		
VU	<i>Acaulon fontiquerianum</i> Casas & Sérgio											VU		
VU	<i>Anomodon longifolius</i> (Schleich. ex Brid.) Hartm.											VU		
VU	<i>Aschisma cuynetii</i> (Bizot & R.B. Pierrot) J. Guerra & M.J. Cano											EN		

Species number		79	10	9	8	1	9	1	7	4	40	26	1	1
2014 Red List		Bern Convention	Habitat Directive	National	Andalusia	Aragon	Asturias	Basque Country	Castile-La Mancha	Catalonia	Galicia	Madrid	Valencia	
VU	<i>Entodon cladorrhizans</i> (Hedw.) Müll. Hal.										VU			
NT	<i>Entosthodon duriaei</i> Mont.										EN			
DD-n	<i>Entosthodon kroonkurk</i> Dirkse & Brugués										EN			
VU	<i>Entosthodon mouretii</i> (Corb.) Jelenc										EN			
LC	<i>Fontinalis squamosa</i> Hedw.											VU		
EN	<i>Hamatocaulis vernicosus</i> (Mitt.) Hedenäs	X	X	X								VU		
VU	<i>Hylocomiastrum umbratum</i> (Hedw.) M. Fleisch.										VU			
LC	<i>Leptobarbula berica</i> (De Not.) Schimper.										EN			
VU	<i>Oedipodiella australis</i> (Wager & Dixon) Dixon										VU			
CR	<i>Oncophorus wahlenbergii</i> Brid										EN			
RE	<i>Orthodontium pellucens</i> (Hook.) Bruch & Schimp.											VU		
CR	<i>Orthotrichum casasianum</i> F. Lara, Garilleti & Mazimpaka							EN						
LC	<i>Orthotrichum rogeri</i> Brid.	X	X	X			EN							
CR	<i>Polytrichum longisetum</i> Sw. ex Brid.													
LC-att	<i>Pterygoneurum sampaianum</i> (Machado-Guim.) Machado-Guim.						Special interest							

Table 3. Bryophyte taxa protected in Spain according to European, national or regional legislation with their categories (in nine Spanish Autonomous Communities) (abbreviations as in Table 1; X = presence in the list without any category) (*continued*)

<i>Species number</i>	79	10	9	8	1	9	1	7	4	40	26	1	1
2014 Red List		Bern Convention	Habitat Directive	National	Andalusia	Aragon	Asturias	Basque Country	Castile-La Mancha	Catalonia	Galicia	Madrid	Valencia
LC	<i>Pterygoneurum subsessile</i> (Brid.) Jur.					EN							
VU	<i>Pyramidula tetragona</i> (Brid.) Brid.	X											
VU	<i>Schistostega pennata</i> (Hedw.) F. Weber & D. Mohr							VU			VU		
EN	<i>Scorpidium scorpioides</i> (Hedw.) Limpr.									VU			
EN	<i>Sphagnum centrale</i> C.E.O. Jensen										EN		
CR	<i>Sphagnum fuscum</i> H. Klinggr										EN		
VU	<i>Sphagnum magellanicum</i> Brid.									VU	VU		
VU	<i>Sphagnum molle</i> Sull.											VU	
LC-att	<i>Sphagnum pylaesii</i> Brid.	X	X	X			Special interest					VU	
VU	<i>Sphagnum squarrosum</i> Crome							EN					
	<i>Sphagnum</i> L. (genus)								Special interest				
VU	<i>Splachnum ampullaceum</i> Hedw.										EN		
VU	<i>Syntrichia fragilis</i> (Taylor) Ochyra										VU		
VU	<i>Syntrichia sinensis</i> (Müll. Hal.) Ochyra										VU		
EN	<i>Tayloria froehlichiana</i> (Hedw.) Mitt. ex Broth.										EN		

Species number		79	10	9	8	1	9	1	7	4	40	26	1	1
2014 Red List		Bern Convention	Habitat Directive	National	Andalusia	Aragon	Asturias	Basque Country	Castile-La Mancha	Catalonia	Galicia	Madrid	Valencia	
VU	<i>Tayloria tenuis</i> (Dicks.) Schimp.									VU	VU			
CR	<i>Timmia megapolitana</i> Hedw. subsp. <i>megapolitana</i>									EN				
VU	<i>Tomentypnum nitens</i> (Hedw.) Loeske									EN				
LC	<i>Tortula pallida</i> (Lindb.) R.H. Zander					EN								
RE	<i>Tortula solmsii</i> (Schimp.) Limpr.										VU			
VU	<i>Ulota calvescens</i> Wilson										VU			
VU	<i>Ulota coarctata</i> (P. Beauv.) Hammar										VU			
EN	<i>Warnstorfia sarmetosa</i> (Wahlenb.) Hedenäs									EN				
DD	<i>Zygodon conoideus</i> (Dicks.) Hook. & Taylor										EN			
Species number		79	10	9	8	1	9	1	7	3	40	26	1	1

RESULTS

Temporal changes in the number of bryophyte taxa included in categories

The number of Peninsular and Balearic Spanish bryophyte taxa in the current IUCN threat categories (EX, Extinct; RE, Regionally Extinct; CR, Critically Endangered; EN, Endangered; VU, Vulnerable) (IUCN Standards and Petitions Subcommittee, 2016) increased since 1994. On the contrary, there was an important decrease from 2006 to 2014 among all non-threat categories, namely those considered as DD (Data Deficient) and NT (Near Threatened) (Figs 1, 2). All lists by IUCN categories are shown in Annexes 1 to 4.

Extinct. Only one species, *Syntrichia abrangesii* (Luisier) Ochyra is considered today as Extinct (Figs 1, 2). It was described in 1916 (Luisier, 1916) based on sterile specimens and it is still only known from its original gathering.

Later efforts to collect it again were both intense and unsuccessful, even those focused on its *locus classicus ipsissimus* (La Flecha, Salamanca); nowadays, this is an urban area in development and consequently its natural habitat has been deeply reduced and disturbed (Gallego *et al.*, 2012).

Regionally Extinct. Fourteen taxa (1% of the red-listed species) are included in this category according to current estimates (Figs 1, 2). However, a total of 25 (three liverworts and 22 mosses) have been recorded in any of the three Red Lists produced to date (Annex 1). Changes within this category are very heterogeneous as illustrated by the following examples:

a) Out of nine species recorded as RE in 1994, only *Ptychomitrium incurvum* (Schwägr.) Spruce was listed also in 2014 under this category. Later field surveys and herbarium revisions led to change the status of the remaining ones: *Fissidens kosaninii* Latzel was merged into the *Fissidens viridulus* complex; *Orthotrichum rogeri* Brid. was relocated as Least Concern (LC); and two were excluded from the Spanish check-list: *Hygrohypnum polare* (Lindb.) Loeske (Oliván *et al.*, 2007), and *Pohlia atropurpurea* (Wahlenb.) Lindb. (Guerra, 2010). The remaining ones are considered nowadays as CR (*Meesia triquetra* (Richter) Ångstr., *Tetrastichium virens* (Cardot) S.P. Churchill); VU (*Entodon cladorrhizans* (Hedw.) Müll. Hal.) and DD (*Zygodon conoideus* (Dicks.) Hook. & Taylor).

b) Three species [*Bryum arcticum* (R. Br.) Bruch & Schimp., *Hennediella heimii* (Hedw.) Mitt. and *Tortula solmsii* (Schimp.) Limpr.] were initially considered as DD. In the last published Red List these taxa have been confirmed as RE.

c) *Jungermannia handelii* (Schiffn.) Amakawa, considered VU in 1994, was transferred to RE in 2006. Further and detailed in-field based analysis as part of the Spanish Red Book project lead to its reconsideration as CR in 2012 (Infante & Heras, 2012). Its natural habitat was drastically reduced and it is now confined to Galicia.

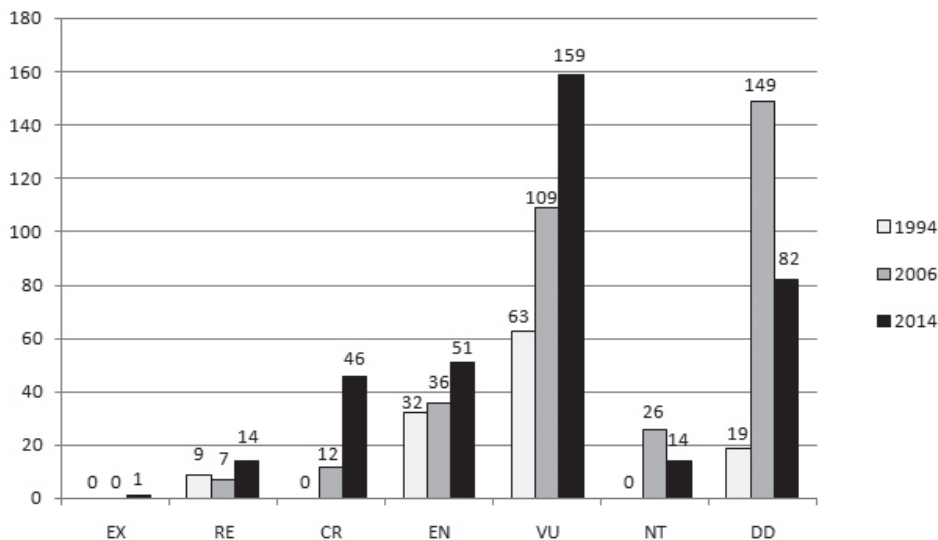


Fig. 1. Evolution of the number of bryophyte taxa by IUCN category in the three Red Lists already published in Peninsular and Balearic Spain (abbreviations as in Table 1; categories in 1994 list were adjusted according to Table 2).

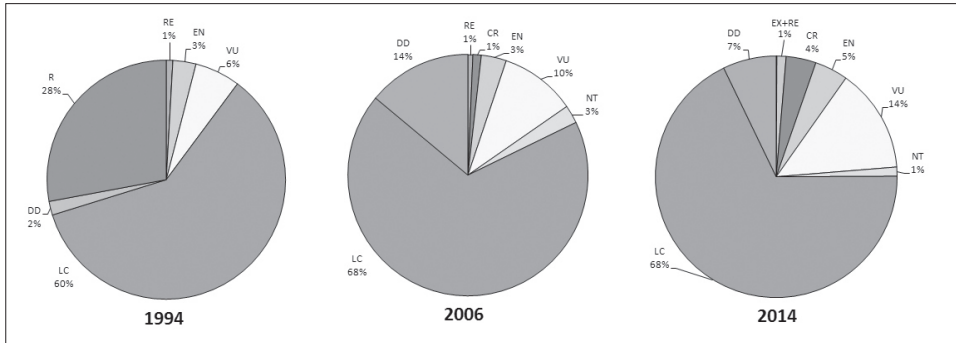


Fig. 2. Evolution of the percentages of categories assigned to bryophyte taxa in the three Red Lists already published in Peninsular and Balearic Spain (abbreviations as in Table 1, and R = Rare). EX and RE are merged into one single category to simplify the figure, since there is only one Extinct species in the 2014 Red List (0,001%).

d) Despite the surveying effort focused on five species considered EN or VU in 1994 [*Haplomitrium hookeri* (Sm.) Nees, *Scapania verrucosa* Heeg, *Hygrohypnum cochlearifolium* (Venturi) Broth., *Isopterygium bottinii* (Breidl.) Kindb., *Orthodontium pellucens* (Hook.) Schimp.], they have not been recorded again and are now listed as RE.

e) Overall, four taxa have been excluded from the Peninsular Spanish catalogue: those mentioned above (*Fissidens kosaninii*, *Hygrohypnum polare*, *Pohlia atropurpurea*) and *Callicladium haldanianum* (Grev.) H.A. Crum (Brugués & Ruiz, 2011).

Critically Endangered. This category was first used in Spain in the Red List of 2006. At that moment there were 10 taxa (1% of the red-listed species) and this figure has increased up to 46 (4%) according to the most recent list (an increasing of 60%) (Figs 1, 2, Annex 2). Among all IUCN threat categories, this one shows the greatest change in terms of number of taxa during the studied period. In general, the threat level for most of taxa included nowadays in this category has increased since 1994 with a few exceptions, such as *Meesia triquetra* (EX to CR) and *Sphagnum centrale* C.E.O. Jensen (CR to EN). The casuistry of the change can be summarized as follows:

a) Twelve of the taxa now considered as CR were incorporated into the Spanish bryophyte flora after the elaboration of the 1994 Red List. Most of them were already present in the 2006 Red List as DD-n. This is a non-official category defined to include the new taxa (*i.e.* species newly described or previously unknown in the area) whose ecology and distribution in Spain was not well known.

b) Seventeen bryophytes considered as R in 1994 are now confirmed as threatened taxa (CR or EN).

c) Four species considered CR in 2006 are currently under different categories: in addition to the already mentioned *Scapania verrucosa*, *Sphagnum centrale* and *Hennediella heimii* to RE. Finally, *Fontinalis dalecarlica* Bruch & Schimp. was excluded from the Spanish catalogue (Brugués *et al.*, 2012).

Endangered. A total number of 83 species have ever been considered EN, with 51 species (5%) in the current Red List (Figs 1, 2, Annex 3). A general trend for all EN taxa cannot be identified as some have been recently added or excluded

from the current Spanish check-list, and others have been relocated in a different category. These changes are summarized below:

- a) Ten taxa are recent additions to the Spanish catalogue. Most of them were already present in the 2006 Red List as DD-n.
- b) Sixteen have increased their category since 2006.
- c) Fourteen have decreased their threat level.
- d) Four taxa have been excluded from the Peninsular and Balearic Spanish catalogue: the mentioned *Callicladium haldanianum* and *Fontinalis dalecarlica*, as well as *Clasmatodon parvulus* (Hampe) Sull. (Heras *et al.*, 2006) and *Ptychostomum cyclophyllum* (Schwägr.) J.R. Spence (Ros *et al.*, 2013).

Vulnerable. A total of 229 species have ever been considered VU (Annex 4). The general trend has shown an increase in the number of taxa under this category, from 39 (6%) in 1994 and 82 (10%) in 2006 up to 159 (14%) in the current Red List (Figs 1, 2).

- a) Twenty one taxa constitute contributions recorded after 1994. Most of them were present in the 2006 Spanish Red List as DD-n.
- b) Sixty seven species remain in this category since 2006 and 15 even since 1994.
- c) Forty one have increased in risk category since 2006.
- d) Only seven have decreased in risk category since 2006.
- e) *Campylopus oerstedianus* (Müll. Hal.) Mitt. (Sérgio *et al.*, 2015) and *Rhabdoweisia crenulata* (Mitt.) Jameson (Heras & Infante, 2015) were eliminated from the Spanish check-list.

Summary of main changes in threat categories

There is no serious study that evidences an increase in threat to bryophytes since 1994. However, both the continuous surveying of Spanish bryoflora and its taxonomical revision have contributed to its better understanding, perception and monitoring in the recent years (Table 4, Fig. 2). In brief, the number of threatened taxa has increased since the first list was published from 104 to 271 taxa (*n.b.* removal of the so-called Rare category in 1994 may distort this figure), as well as their percentage of threatened species (*n.b.* percentage of threatened taxa in 2014 was made in relation to the total number obtained in 2015 by Brugués & Cros, 2015 and Cros *et al.*, 2015). The number of DD species has halved between 2006 and 2014. It is remarkable that the national catalogue has been enlarged in 122 taxa (12%) from 1994 (1021 taxa) to 2015 (1143 taxa).

Bryophyte conservation efforts are still anecdotic in Spain. Recent improvement of bryological knowledge relies mainly on the update of red lists in Peninsular and Balearic Spain. Behind this, there are two projects that deserve special mention. One is *Flora Briofítica Ibérica*, a large project coming to an end aiming at the publication of six volumes on mosses, from which already five have been published (Guerra *et al.*, 2006, 2010, 2014; Brugués *et al.* 2007; Brugués & Guerra, 2015). A large number of bryologists all over the country are involved, allowing for a substantial surveying all across the territory. The other one is the *Atlas y Libro Rojo de los Briófitos Amenazados de España* (Garillete & Albertos, 2012), accomplishment of this project involved intensive work on 74 threatened species. As a result, the third version of the Spanish Red List was published.

Table 4. Number of taxa both in the Spanish check-list and threatened according to the three Red Lists already published in Peninsular and Balearic Spain, with indication of the percentage with respect to the total number of species included in the check-list (* according to Brugués & Cros, 2015 and Cros *et al.*, 2015)

	1994	2006	2014
Threatened taxa (%)	104 (10%)	164 (15%)	271 (24%)
Spanish check-list	1021	1068	1143*

Review of the presence of bryophytes in the legislation

Both the Bern Convention (BC) and Annex II of the Habitat Directive (HD-II) include a low number of bryophytes, 26 and 31 species respectively. Only nine species (eight as BC and HD-II, and one as BC only) have been found in Peninsular and Balearic Spain (Table 3). Additionally, *Leucobryum juniperoides* (Brid.) Müll. Hal. and genus *Sphagnum* in Annex V of the Habitat Directive are also present in the territory.

The effectiveness of both the Bern Convention and the Habitat Directive is rather limited, mainly because of the low number of taxa concerned. The transposition of European laws into the Spanish national legislation has rarely been accompanied with an inclusion of bryophytes of high concern for this region.

Spanish National Catalogue of Protected and Threatened Species

The most recent Spanish national catalogue of protected and threatened species was published in the *Real Decreto 139/2011, de 4 de febrero para el desarrollo del Listado de Especies Silvestres en Régimen de Protección Especial y del Catálogo Español de Especies Amenazadas. Boletín Oficial de España B.O.E. 46, 23 February 2011, pp. 20912-20951* (LESRPE, in Spanish).

This decree derogated the precedent catalogue (*Real Decreto 439/1990*) and additionally, other seven decrees that had come into force between 1990 and 2006. On the whole, these covered a large number of vascular plants but no bryophytes.

The decree produced two lists: first the LESRPE, that defines a “wild species under special protection” as a “species worth giving special attention and protection as a result of its scientific, ecological and cultural value, singularity, rarity or threat level, scientifically justified, as well as that protected in the directive annexes and international conventions ratified by Spain”, and second, it develops the Spanish Catalogue of Threatened Species (CEEA, in Spanish) assigning a threat category to each of the included taxa.

Those bryophytes included in Annex II of Habitat Directive that had been reported in Peninsular and Balearic Spain are listed in the LESRPE (with the exception of *Dicranum viride* (Sull. & Lesq.) Lindb., which was found after this decree was drafted). Only *Buxbaumia viridis* (Moug. ex Lam. & DC.) Moug. & Nestl. was included in the CEEA as VU.

By law, all species in both LESRPE and CEEA lists must be subject of specific monitoring, not only at a national scale, but also in each of the Spanish Autonomous Communities according to their ecological distribution, and this should be repeated every six years.

Spanish Regional catalogues of threatened species

In Spain, all seventeen Autonomous Communities have already created their own regional catalogue of threatened species and, in some occasions, also a list of wild species under special protection similar to the national LESRPE.

After the last review on the conservation status of bryophytes in Spain (Infante & Heras, 2005) was completed, the number of Autonomous Communities that have assigned a certain level of protection to bryophyte taxa has increased from five (Aragon, Asturias, Castile-La Mancha, Catalonia and Madrid) to nine in 2015: Andalusia, Basque Country, Galicia and Valencia are the latest to safeguard these plants under their respective laws (Table 5).

Table 5. Legislations in force of the Spanish Autonomous Communities containing bryophyte taxa

<i>Spanish Autonomous Community</i>	<i>Legislation in force</i>
Andalusia	Decreto 23/2012, de 14 de febrero por el que se regula la conservación y el uso sostenible de la flora y la fauna silvestres y sus hábitats. Boletín Oficial de la Junta de Andalucía B.O.J.A. núm. 60, de 27 de marzo de 2012, págs. 114-163.
Aragon	Decreto 181/2005, de 6 de septiembre del Gobierno de Aragón, por el que se modifica parcialmente el Decreto 49/1995, de 28 de marzo, de la Diputación General de Aragón, por el que se regula el Catálogo de Especies Amenazadas de Aragón. Boletín Oficial de Aragón B.O.A. núm. 114, de 23 de septiembre de 2005, págs. 11527-11532.
Asturias	Decreto 65/1995, de 27 de Abril, por el que se crea el Catálogo Regional de Especies Amenazadas de la Flora del Principado de Asturias y se dictan normas para su protección. Boletín Oficial del Principado de Asturias B.O.P.A. núm. 128, de 5 de junio de 1995.
Basque Country	Orden de 18 de junio de 2013, de la Consejera de Medio Ambiente y Política Territorial, por la que se modifica el Catálogo Vasco de Especies Amenazadas de Fauna y Flora Silvestre y Marina. Boletín Oficial del País Vasco B.O.P.V. núm. 128, de 5 de julio de 2013.
Castile-La Mancha	Decreto 33/1998, de 5 de Mayo, por el que se crea el Catálogo Regional de Especies Amenazadas de Castilla-La Mancha. Diario Oficial de Castilla-La Mancha D.O.C.M. núm. 22, de 15 de mayo de 1998.
Catalonia	Resolución AAM/732/2015, de 9 de abril, por la que se aprueba la catalogación, descatalogación y cambio de categoría de especies y subespecies del Catálogo de flora amenazada de Cataluña. Diario Oficial del Gobierno de Cataluña D.O.G.C. núm. 6854, de 20 de abril de 2015.
Galicia	Decreto 88/2007 de 19 de abril, por el que se regula el Catálogo gallego de especies amenazadas. Diario Oficial de Galicia D.O.G. núm. 89, de 9 de mayo de 2007, págs. 7409-7423.
Madrid	Decreto 18/1992, de 26 de Marzo, por el que se aprueba el Catálogo Regional de especies amenazadas de fauna y flora silvestres y se crea la categoría de árboles singulares de la Comunidad de Madrid. Boletín Oficial de la Comunidad de Madrid B.O.C.M. nº 85, de 9 de abril de 1992.
Valencia	Orden 6/2013, de 25 de marzo, de la Consejería de Infraestructuras, Territorio y Medio Ambiente, por la que se modifican los listados valencianos de especies protegidas de flora y fauna. Diario Oficial de la Comunidad Valenciana D.O.C.V. núm. 6996, de 4 de abril de 2013, págs. 8682-8690.

Nevertheless, bryophyte presence in most of these lists is merely testimonial (one to four taxa). Catalonia (40), Galicia (26) and Aragon (9) are the Autonomous Communities with the highest number of bryophytes in their legislation (Fig. 3, Table 3). The following communities still lack bryophytes in their laws: Balearic Islands, Cantabria, Castile-Leon, Extremadura, La Rioja, Murcia and Navarra.



Fig. 3. Number of bryophyte taxa protected by regional legislation in every Spanish Autonomous Community.

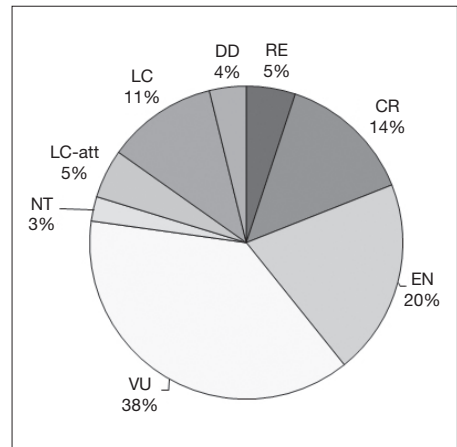


Fig. 4. Percentages of bryophyte taxa protected in Peninsular and Balearic Spain by national of regional legislations included in any IUCN category according to the Spanish Red List updated in 2014 (abbreviations as in Table 1).

DISCUSSION

It is remarkable that eight bryophyte species alone were included for the first time at national level in Spain in the LESRPE published in 2011 and just one entered the CEEA considered as threatened. At a regional level, the total number of bryophytes protected by law has increased from 19 to 74 species since 2005. On the whole, autonomous legislation accounts for 21 liverworts and 53 mosses together with the genera *Sphagnum* (in Castile-La Mancha) (Table 3). Adding national and regional levels, the final figure of protected bryophyte taxa reaches 79.

In terms of the total number of bryophytes known in Balearic and Peninsular Spain, the percentage of species protected by law is around 6.9%. This estimation does not take into account the *Sphagnum* genus protected by the current regional legislation in Castile-La Mancha. It should be highlighted that the designation process for protected bryophytes is still erratic and perhaps too reliant on the Habitat Directive (*n.b.* 10% of all protected bryophytes in Spain are those listed in the Habitat Directive).

Another issue to be addressed is the existing lack of communication and joint work in between the bryologists' community and the Administration body, already pointed out in Infante & Heras (2005), but still an issue ten years later. The case of Catalonia, the most recent law to come in force, might be regarded as exceptional, since the designation process was relied on local scientists and adjusted to the needs of regional bryophyte taxa. Even with the Catalan bright spot in mind, still further implication and government funding for new projects on the conservation of bryoflora are critical to overcome this matter. For instance, it is desirable that the *Atlas y Libro Rojo de los Briófitos Amenazados de España*, which was funded by the Spanish Government as mentioned before, is renewed for a longer period.

Despite all progress achieved in the last decade, there are two key questions that still evoke interest in conservation bryology. First, some reasonable doubts arise on how appropriate the selected bryophytes to be protected are to meet conservation purposes. Second, there are no studies published to date on the suitability (or not) of the amount of protected bryophytes given that some species under legal protection are not threatened.

A potential approach to answer the first question consists in assessing the corresponding category assigned to all protected species according to the most recent Red List (Brugués & González-Mancebo, 2014). Following this approach, it has been estimated that 77% of all protected bryophytes are included into threat categories within the Red List drafted in 2014 (Table 3, Fig. 4). Thus, it could be concluded that most of them satisfy the selection criteria for protected species.

About the second question presented above, there are 271 threatened species according the current Red List whilst 79 taxa are listed in all existing national or regional catalogues, namely 3,5:1. In other words, only 29% of all 271 threatened bryophytes are under certain level of protection in Peninsular and Balearic Spain nowadays.

This is not just a matter of numbers itself. In 2005 none of the peninsular Spanish endemisms were recorded in any catalogue. At present, only *Orthotrichum casasianum* (Mazimpaka *et al.*, 2012) is included in the Basque catalogue where all its known populations are located. With regard to other endemism (Table 1), only *Riella helicophylla* (Bory & Mont.) Mont. and *R. notarisii* (Mont.) Mont. (Mediterranean and Mediterranean-Canarian endemics, respectively) were added to national and regional lists. The vast majority of endemisms still lack of certain degree of protection.

CONCLUSIONS

Bryology in Spain has gained institutional support in recent times through several projects. Particularly, *Flora Briofítica Ibérica* and *Atlas y Libro Rojo de los Briófitos Amenazados de España* have been key in the context of bryophyte conservation science. As a result, the knowledge basis on the ecological status of bryophytes is solid enough towards their effective conservation in the long term. Even so, the number and selection of protected species is perhaps inappropriate as many bryophytes in the current Spanish Red List are not included either in regional or national catalogues. Consequently, many are partially protected if so.

New initiatives are needed in order to enhance communication and exchange of scientific knowledge between experts in the field and administrative domains. In turns, this is to create new and effective mechanisms for the inclusion of protected bryophytes into legal lists, both at national and regional scales, that are complementary to those which already exist (e.g. via transposition of EU and international conventions into the Spanish legislation).

In addition, it is required to elaborate a proposal to include a number of bryophytes into the national LESRPE and CEEA as well as the continuing of the Red Book, being that many species are yet to be properly evaluated.

Despite the number of taxonomists in Spain is considerable, their generational replace is not secured. The feasibility of bryological work in the near future could be achieved with the implementation of training programmes associated to both national and international research projects.

And still ten years after, there is still a lot left to do.

REFERENCES

- AEDO C., MEDIDA L. & FERNÁNDEZ-ALBERT M., 2013 — Species richness and endemism in the Spanish vascular flora. *Nordic journal of botany* 30: 1-11.
- BRUGUÉS M., CROS R.M. & GUERRA J. (eds.), 2007 — *Flora Briofítica Ibérica Vol. I: Sphagnales, Andreaeales, Polytrichales, Tetraphidales Buxbaumiiales, Diphysciales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, 183 p.
- BRUGUÉS M. & RUIZ E., 2011 — Sobre la presencia de *Callicladium haldanianum* (Grev.) H.A. Crum en España. *Boletín de la sociedad española de briología* 36: 1-2.
- BRUGUÉS M. & GONZÁLEZ-MANCEBO J.M., 2012 — Lista Roja de los Briófitos Amenazados de España. In: Garilleti R. & Albertos B. (coords.), *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 26-44.
- BRUGUÉS M., RUIZ E., PUCHE F. & MUÑOZ J., 2012 — Especies a excluir del catálogo de musgos de España. *Boletín de la sociedad española de briología* 38-39: 1-4.
- BRUGUÉS M. & GONZÁLEZ-MANCEBO J.M., 2014 — Lista Roja de los Briófitos Amenazados de España. http://www.uv.es/abraesp/ABrA/Listas_Rojas.html. Accessed 25.11.2015.
- BRUGUÉS M. & CROS R.M., 2015 — *Catàleg de les moltes de l'Espanya peninsular i les Illes Balears*. <http://pagines.uab.cat/briologia/content/catàleg-de-les-moltes-de-lespanya-peninsular>. Accessed 25.11.2015.
- BRUGUÉS M. & GUERRA J. (eds), 2015 — *Flora Briofítica Ibérica Vol. II: Archidiales, Dicranales, Fissidentales, Seligeriales, Grimmiales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, 355 p.
- CIRUJANO S., MONTES C., MARTINO P., ENRÍQUEZ S. & GARCÍA MURILLO P., 1988 — Contribución al estudio del género *Riella* Mont. (Sphaerocarpaceae, Riellaceae) en España. *Limnética* 4: 41-50.
- CROS R.M., SAEZ L. & ROSSELLÓ J.A., 2005 — *Plagiochasma appendiculatum* Lehm. & Lindenb. (Marchantiales, Aytoniaceae), a species new to the European bryophyte flora. *Journal of bryology* 27(1): 3-6.

- CROS R.M., BRUGUÉS M. & INFANTE M., 2015 — *Catàleg de les antocerotes i les hepàtiques de l'Espanya peninsular i les Illes Balears*. <http://pagines.uab.cat/briologia/content/catàleg-deles-antocerotes-i-les-hepàtiques-de-lespanya-peninsular>. Accessed 25.11.2015.
- GALLEGO M.T., CANO M.J. & GUERRA J., 2012 — *Syntrichia abrahamii* (Luisier) Ochyra. In: Garilleti R. & Albertos B. (coords.), *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 50-51.
- GARILLETI R. & ALBERTOS B. (coords.), 2012 — *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, 288 p.
- GOBIERNO DE ESPAÑA, 2016 — *Geografía*. <http://www.lamoncloa.gob.es/espana/paishistoriaycultura/geografia/Paginas/index.aspx>. Accessed 01.05.2016
- GONZÁLEZ-MANCEBO J.M., ROMAGUERA F., ROS R.M., PATIÑO J. & WERNER O., 2008 — Bryophyte flora of the Canary Islands: an updated compilation of the species list with an analysis of distribution patterns in the context of the Macaronesian Region. *Cryptogamie, Bryologie* 29(4): 315-357.
- GROLLE R. & LONG D.G., 2000 — An annotated check-list of the Hepaticae and Anthocerotae of Europe and Macaronesia. *Journal of bryology* 22(2): 103-140.
- GUERRA J., CANO M.J. & ROS R.M., (eds.), 2006 — *Flora Briofítica Ibérica Vol. III: Pottiales, Encalyptales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, 305 p.
- GUERRA J., 2010 — *Pohlia* Hedw. In: Guerra J., Brugués M., Cano M.J. & Cros R.M. (eds.), *Flora Briofítica Ibérica Vol. IV: Funariales, Splachnales, Schistostegales, Bryales, Timmiales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 183-203.
- GUERRA J., BRUGUÉS M., CANO M.J. & CROS R.M. (eds.), 2010 — *Flora Briofítica Ibérica Vol. IV: Funariales, Splachnales, Schistostegales, Bryales, Timmiales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, 317 p.
- GUERRA J., CANO M.J. & BRUGUÉS M. (eds.), 2014 — *Flora Briofítica Ibérica Vol. V: Orthotrichales, Hedwigiales, Leucodontales, Hookeriales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, 261 p.
- HALLINGBÄCK T. & HODGETTS N. (comps.), 2000 — *Mosses, Liverworts and Hornworts. Status Survey and Conservation Action Plan for Bryophytes*. IUCN/SSC Bryophyte Specialist Group. Gland, Switzerland and Cambridge, IUCN.
- HERAS P., INFANTE M. & BUCK W.R., 2006 — On the presence of *Clasmatodon parvulus* (Bryopsida) in Europe. *Herzogia* 19: 317-321.
- HERAS P. & INFANTE M., 2015 — *Rhabdoweisia* Bruch & Schimp. In: Brugués M. & Guerra J. (eds.), *Flora Briofítica Ibérica Vol. II: Archidiales, Dicranales, Fissidentales, Seligeriales, Grimmiiales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 85-88.
- HILL M.O., BELL N., BRUGGEMAN-NANNENGA M.A., BRUGUÉS M., CANO M.J., ENROTH J., FLATBERG K.I., FRAHM J.-P., GALLEGO M.T., GARILLETI R., GUERRA J., HEDÉN S.L., HOLYOAK D.T., HYVÖNEN J., IGNATOV M.S., LARAF., MAZIMPAKA V., MUÑOZ J. & SÖDERSTRÖM L., 2006 — An annotated check-list of the mosses of Europe and Macaronesia. *Journal of bryology* 28 (3): 198-267.
- INFANTE M. & HERAS P., 2005 — Bryophytes in the Spanish law. *Boletín de la sociedad española de briología* 26-27: 5-16.
- INFANTE M. & HERAS P., 2012 — *Meesia triquetra* (L. ex Jolycl.) Ångström. In: Garilleti, R. & Albertos B. (coords.), *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 68-69.
- IUCN STANDARDS AND PETITIONS SUBCOMMITTEE, 2016 — Guidelines for Using the IUCN Red List Categories and Criteria. Version 12. Prepared by the Standards and Petitions Subcommittee, 101 p. <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>. Accessed 04.03.2016.
- LARA F. & GARILLETI R., 2014 — *Orthotrichum* Hedw. In: Guerra J., Cano M.J. & Brugués M., (eds.), *Flora Briofítica Ibérica Vol. V: Orthotrichales: Orthotrichaceae; Hedwigiales: Hedwigiaceae; Leucodontales: Fontinalaceae, Climaciaceae, Anomodontaceae, Cryphaeaceae, Leptodontaceae, Leucodontaceae, Neckeraceae; Hookeriales: Hypopterygiaceae, Hookeriaceae, Leucomiaceae, Pilotrichaceae*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 15-135.
- LUISIER A., 1916 — Fragments de Bryologie Ibérique, 11-13. *Brotéria* 14: 106-117.
- MAZIMPAKA V., LARA F., GARILLETI R., INFANTE M. & HERAS P., 2012 — *Orthotrichum casasianum* F. Lara, Garilleti & Mazimpaka. In: Garilleti R. & Albertos B. (coords.), *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid, Organismo Autónomo Parques Nacionales, pp. 70-71.

- OLIVÁN G., FUERTES E. & ACÓN M., 2007 — *Hygrohypnum* (Amblystegiaceae, Bryopsida) in the Iberian Peninsula. *Cryptogamie, Bryologie* 28(2): 109-143.
- MEDINA N.G., DRAPER I. & LARA F., 2011 — Biogeography of mosses and allies: does size matter? In: Fontaneto D. (ed.), *Biogeography of Microscopic Organisms: Is Everything Small Everywhere?* Cambridge, Cambridge University Press and The Systematics Association, pp. 209-233.
- RODRÍGUEZ-OUBIÑA J., IZCO J. & RAMIL P. 2001 — Phytosociological characterization of *Sphagnum pylaesii* Brid. communities in Northwest Spain. *Acta botanica Gallica* 148(3): 201-213.
- ROS R.M., MAZIMPAKA V., ABOU-SALAMA U., ALEFFI M., BLOCKEEL T.L., BRUGUÉS M., CANO M.J., CROS R.M., DIA M.G., DIRKSE G.M., EL SAADA-WI W., ERDAĞ A., GANEVA A., GONZÁLEZ-MANCEBO J.M., HERRNSTADT I., KHALIL K., KÜRSCHNER H., LANFRANCO E., LOSADA-LIMA A., REFAI M.S., RODRÍGUEZ-NUÑEZ S., SABOVLJEVIĆ M., SÉRGIO C., SHABBARA H., SIMSIM M. & SÖDERSTRÖM L., 2007 — Hepatics and Anthocerotales of the Mediterranean, an annotated checklist. *Cryptogamie, Bryologie* 28: 351-437.
- ROS R.M., MAZIMPAKA V., ABOU-SALAMA U., ALEFFI M., BLOCKEEL T.L., BRUGUÉS M., CROS R.M., DIA M.G., DIRKSE G.M., DRAPER I., ELSAADA-WI W., ERDAĞ A., GANEVA A., GABRIEL R., GÓNZALEZMANCEBO J.M., GRANGER C., HERRNSTADT I., HUGONNOT V., KHALIL K., KÜRSCHNER H., LOSADA-LIMA A., LUÍS L., MIFSUD S., PRIVITERA M., PUGLISI M., SABOVLJEVIĆ M., SÉRGIO C., SHABBARA H.M., SIM-SIM M., SOTIAUX A., TACCHI R., VANDERPOORTEN A. & WERNER O., 2013 — Mosses of the Mediterranean, an Annotated Checklist. *Cryptogamie, Bryologie* 34: 99-283.
- SEGARRA-MORAGUES J.G., PUCHE F., SABOVLJEVIĆ M., INFANTE M. & HERAS P., 2014 — Taxonomic revision of *Riella* subgenus *Trabutiella* (Riellaceae, Sphaerocarpaceae). *Phytotaxa* 159(3): 131-174.
- SÉRGIO C., CASAS C., BRUGUÉS M. & CROS R.M., 1994 — *Lista Vermelha dos Briófitos da Península Ibérica/Red List of Bryophytes of the Iberian Peninsula*. Lisboa, Instituto da Conservação da Natureza, Universidade de Lisboa, 45 p.
- SÉRGIO C., BRUGUÉS M., CROS R.M., CASAS C. & GARCIA C., 2007 — The 2006 Red List and an updated Checklist of bryophytes of the Iberian Peninsula (Portugal, Spain and Andorra). *Lindbergia* 31: 109-125.
- SÉRGIO C., BRUGUÉS M. & RUIZ E., 2015 — *Campylopus* Brid.. In: Brugués M. & Guerra J. (eds.), *Flora Briofítica Ibérica Vol. II: Archidiales, Dicranales, Fissidentales, Seligeriales, Grimmiales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 125-138.
- TAN B.C. & PÓCS T., 2000 — Bryogeography and conservation of bryophytes. In: Shaw A.J. & Goffinet B. (eds.), *Bryophyte Biology*. Cambridge, Cambridge University Press, pp. 403-448.
- VANDERPOORTEN A. & GOFFINET B., 2009 — *Introduction to bryophytes*. Cambridge, Cambridge University Press, 303 p.

Annex 1. Species considered Regionally Extinct (RE) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, original and equivalent IUCN categories are offered in the last two columns

LIVERWORTS	2014	2006	1994	1994 IUCN
<i>Haplomitrium hookeri</i> (Sm.) Nees	RE	DD	E	EN
<i>Jungermannia handelii</i> (Schiffn.) Amakawa	CR	RE	V	VU
<i>Scapania verrucosa</i> Heeg	RE	CR	V	VU
MOSESSES	2014	2006	1994	1994 IUCN
<i>Anoetangium aestivum</i> (Hedw.) Mitt.	DD	RE	R	
<i>Bryum arcticum</i> (R. Br.) Bruch & Schimp.	RE	RE	K	DD
<i>Callicladium haldanianum</i> (Grev.) H.A. Crum	Excluded	RE	E	EN
<i>Campyliadelphus elodes</i> (Lindb.) Kande	RE	DD-n		
<i>Campylopus setifolius</i> Wilson	RE	DD-va	R	
<i>Disclium nudum</i> (Dicks.) Brid.	RE	DD-va		
<i>Entodon cladorrhizans</i> (Hedw.) Müll. Hal.	VU	VU	Ex	RE
<i>Fissidens viridulus</i> complex (<i>F. kosaninii</i> Latzel)	Synonymized		Ex	RE
<i>Hennediella heimii</i> (Hedw.) Mitt.	RE	CR	K	DD
<i>Homalia webbiana</i> (Mont.) Schimp.	RE			
<i>Hygrohypnum cochlearifolium</i> (Venturi) Broth.	RE	RE	V	VU
<i>Hygrohypnum polare</i> (Lindb.) Loeske	Excluded		Ex	RE
<i>Hypnum hamulosum</i> Schimp.	RE	DD	R	
<i>Isopterygium bottinii</i> (Breidl.) Kindb.	RE	EN	E	EN
<i>Meesia triquetra</i> (Richter) Ångstr.	CR	CR	Ex	RE
<i>Orthodontium pellucens</i> (Hook.) Schimp.	RE	RE	V	VU
<i>Orthotrichum rogeri</i> Brid.	LC	DD	Ex	RE
<i>Pohlia atropurpurea</i> (Wahlenb.) Lindb.	Excluded	DD	Ex	RE
<i>Ptychomitrium incurvum</i> (Schwägr.) Spruce	RE	RE	Ex	RE
<i>Tetrastichium virens</i> (Cardot) S.P. Churchill	CR	VU	Ex	RE
<i>Tortula solmsii</i> (Schimp.) Limpr.	RE	VU	K	DD
<i>Zygodon conoideus</i> (Dicks.) Hook. & Taylor	DD	VU	Ex	RE

Annex 2. Taxa considered Critically Endangered (CR) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1

HORNWORTS	2014	2006	1994	1994 IUCN
<i>Anthoceros caucasicus</i> Steph.	CR	LC	V	VU
LIVERWORTS	2014	2006	1994	1994 IUCN
<i>Anastrophyllum hellerianum</i> (Nees ex Lindenb.) R.M. Schust.	CR	EN	R	
<i>Barbilophozia binsteadii</i> (Kaal.) Loeske	CR	CR	V	VU
<i>Cephalozia loitlesbergeri</i> Schiffn.	CR	DD-n		
<i>Cephaloziella integerrima</i> (Lindb.) Warnst.	CR	DD	R	
<i>Fossombronia crozalsii</i> Corb.	CR	VU	R	
<i>Geocalyx graveolens</i> (Schrad.) Nees	CR	DD	R	
<i>Gymnomitrium corallioides</i> Nees	CR	NT	R	
<i>Gymnomitrium crenulatum</i> Gottsche ex Carrington	CR	NT	R	
<i>Jungermannia handelii</i> (Schiffn.) Amakawa	CR	RE	V	VU
<i>Mannia fragrans</i> (Balbis) Frye & L. Clark	CR	CR	R	
<i>Marsupella sprucei</i> (Limpr.) Bernet	CR	LC		
<i>Nardia breidleri</i> (Limpr.) Lindb.	CR			
<i>Plagiochasma appendiculatum</i> Lehm. & Lindenb.	CR			
<i>Radula holtii</i> Spruce	CR	VU	R	
<i>Scapania gymnostomophila</i> Kaal.	CR	VU	R	
<i>Scapania subalpina</i> (Nees ex Lindenb.) Dumort.	CR	NT		
<i>Scapania verrucosa</i> Heeg	RE	CR	V	VU
MOSESSES	2014	2006	1994	1994 IUCN
<i>Arctoa fulvella</i> (Dicks.) Bruch & Schimp.	CR	VU	K	DD
<i>Brachythecium cirrosum</i> (Schwägr.) Schimp.	CR		R	
<i>Breutelia chrysocoma</i> (Hedw.) Lindb.	CR	VU	V	VU
<i>Cinclidotus vivesii</i> Eder & J. Guerra	CR	DD-n		
<i>Dichelyma falcatum</i> (Hedw.) Myrin	CR	CR	E	EN
<i>Dicranodontium asperulum</i> (Mitt.) Broth.	CR	DD-n		
<i>Dicranodontium uncinatum</i> (Harv.) A. Jaeger	CR	VU	R	
<i>Ephemerum cohaerens</i> (Hedw.) Hampe	CR	DD-n		
<i>Ephemerum spinulosum</i> Bruch & Schimp.	CR	DD-n		
<i>Fontinalis dalecarlica</i> Bruch & Schimp.	Excluded	CR	E	EN
<i>Grimmia arenaria</i> Hampe	CR	VU		
<i>Henediella heimii</i> (Hedw.) Mitt.	RE	CR	K	DD
<i>Hypnum imponens</i> Hedw.	CR	EN	R	
<i>Hypnum pallescens</i> (Hedw.) P. Beauv.	CR	VU	R	

MOSSES	2014	2006	1994	1994 IUCN
<i>Hypnum uncinulatum</i> Jur.	CR	EN		
<i>Meesia triquetra</i> (Richter) Ångstr.	CR	CR	Ex	RE
<i>Meesia uliginosa</i> Hedw.	CR	CR	V	VU
<i>Oncophorus wahlenbergii</i> Brid.	CR	VU	R	
<i>Orthotrichum casasianum</i> F. Lara, Garilleti & Mazimpaka	CR	DD-n		
<i>Orthotrichum consobrinum</i> Cardot	CR			
<i>Orthotrichum patens</i> Brid.	CR	DD	R	
<i>Polytrichastrum longisetum</i> (Sw. ex Brid.) G.L. Sm.	CR	CR	E	EN
<i>Schistidium occidentale</i> (E. Lawton) Churchill	CR	DD-n		
<i>Seligeria patula</i> (Lindb.) I. Hagen	CR	VU		
<i>Sphagnum centrale</i> C.E.O. Jensen	EN	CR	V	VU
<i>Sphagnum fuscum</i> (Schimp.) H. Klinggr.	CR	CR	E	EN
<i>Tetrastichium fontanum</i> (Mitt.) Cardot	CR	DD-n		
<i>Tetrastichium virens</i> (Cardot) S.P. Churchill	CR	VU	Ex	RE
<i>Timmia megapolitana</i> Hedw.	CR		R	
<i>Timmiella anomala</i> (Bruch & Schimp.) Limpr.	CR	CR		
<i>Ulota phyllantha</i> Brid.	CR	DD	VU	
<i>Zygodon stirtonii</i> Schimp. ex Stirt.	CR			

Annex 3. Taxa considered Endangered (E) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1

LIVERWORTS	2014	2006	1994	1994 IUCN
<i>Anastrepta orcadensis</i> (Hook.) Schiffn.	EN	DD-n		
<i>Anastrophyllum hellerianum</i> (Nees ex Lindenb.) R.M. Schust.	CR	EN	R	
<i>Aphanolejeunea microscopica</i> (Taylor) A. Evans	EN	EN	R	
<i>Asterella africana</i> (Mont.) A. Evans	EN	DD-n		
<i>Calypogeia integristipula</i> Steph.	EN	VU	R	
<i>Calypogeia suecica</i> (Arnell & J. Perss.) Müll. Frib.	EN	EN	R	
<i>Cephalozia crassifolia</i> (Lindenb. & Gottsche) Fulford	VU	EN	V	VU
<i>Cephaloziella calyculata</i> (Durieu & Mont.) Müll. Frib.	EN	NT	V	VU
<i>Cladopodiella fluitans</i> (Nees) H. Buch	VU	EN	R	
<i>Frullania oakesiana</i> Austin	EN	VU	V	VU
<i>Haplomitrium hookeri</i> (Sm.) Nees	RE	DD	E	EN
<i>Harpanthus scutatus</i> (F. Weber & D. Mohr) Spruce	EN	VU	E	EN
<i>Jungermannia confertissima</i> Nees	EN	EN	V	VU

Annex 3. Taxa considered Endangered (E) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

LIVERWORTS	2014	2006	1994	1994 IUCN
<i>Kurzia sylvatica</i> (A. Evans) Grolle	EN	EN	R	
<i>Lepidozia cupressina</i> (Sw.) Lindenb.	EN	VU	V	VU
<i>Lophozia ascendens</i> (Warnst.) R.M. Schust.	EN	VU	V	VU
<i>Mylia anomala</i> (Hook.) Gray	VU	EN	R	
<i>Pleurocladula albescens</i> (Hook.) Grolle	VU	VU	E	EN
<i>Porella pinnata</i> L.	EN	NT	R	
<i>Ptilidium pulcherrimum</i> (F. Weber) Vain.	EN	EN	R	
<i>Ricciocarpos natans</i> (L.) Corda	EN	EN	E	EN
<i>Riella cossoniana</i> Trab.	EN	EN	E	EN
<i>Riella helicophylla</i> (Bory & Mont.) Mont.	EN	VU	E	EN
<i>Riella notarisii</i> (Mont.) Mont.	VU	VU	E	EN
<i>Scapania mucronata</i> H. Buch	DD	DD	E	EN
<i>Scapania umbrosa</i> (Schrad.) Dumort.	VU	EN	R	
<i>Tetralophozia filiformis</i> (Steph.) Urmi	EN	VU	R	
MOSESSES	2014	2006	1994	1994 IUCN
<i>Brachydontium trichodes</i> (F. Weber) Milde	EN	EN	E	EN
<i>Brachythecium laetum</i> (Brid.) Schimp.	EN			
<i>Bruchia vogesiaca</i> Schwäger.	EN	VU	V	VU
<i>Bryoerythrophyllum inaequalifolium</i> (Taylor) R.H. Zander	EN	EN	V	VU
<i>Bryum tenuisetum</i> Limpr.	EN	VU		
<i>Buxbaumia aphylla</i> Hedw.	EN	EN	E	EN
<i>Buxbaumia viridis</i> (DC.) Moug. & Nestl.	VU	EN	R	
<i>Callicladium haldanianum</i> (Grev.) H.A. Crum	Excluded	RE	E	EN
<i>Calliergon giganteum</i> (Schimp.) Kindb.	EN	EN	V	VU
<i>Catoscopium nigratum</i> (Hedw.) Brid.	EN	EN	V	VU
<i>Clasmatodon parvulus</i> (Hampe) Sull.	Excluded		E	EN
<i>Cleistocarpidium palustre</i> (Bruch & Schimp.) Ochyra & Bednarek-Ochyra	DD-va	DD-va	E	EN
<i>Cratoneuron curvicaule</i> (Jur.) G. Roth	Excluded	DD-va	E	EN
<i>Cyclodictyon laete-virens</i> (Hook. & Taylor) Mitt.	EN	VU	V	VU
<i>Cynodontium strumiferum</i> (Hedw.) Lindb.	EN	EN	R	
<i>Dichelyma falcatum</i> (Hedw.) Myrin	CR	CR	E	EN
<i>Dicranum spadiceum</i> J.E. Zetterst.	EN	EN		
<i>Didymodon erosus</i> J.A. Jiménez & J. Guerra	EN	DD-n		
<i>Ditrichum lineare</i> (Sw.) Lindb.	EN	EN	E	EN

MOSSES	2014	2006	1994	1994 IUCN
<i>Fontinalis dalecarlica</i> Bruch & Schimp.	Excluded	CR	E	EN
<i>Goniomitrium seroi</i> Casas	EN	EN	R	
<i>Grimmia pilosissima</i> Herzog	Synonymised			EN
<i>Hamatocaulis vernicosus</i> (Mitt.) Hedenäs	EN	EN	V	VU
<i>Herzogiella striatella</i> (Brid.) Z. Iwats.	EN	EN	R	
<i>Hygrohypnum smithii</i> (Sw.) Broth.	VU	EN	R	
<i>Hypnum imponens</i> Hedw.	CR	EN	R	
<i>Hypnum recurvatum</i> (Lindb. & Arnell) Kindb.	EN	VU		
<i>Hypnum uncinulatum</i> Jur.	CR	EN		
<i>Isopterygium bottinii</i> (Breidl.) Kindb.	RE	EN	E	EN
<i>Kiaeria blyttii</i> (Bruch & Schimp.)	EN			
<i>Leptodontium flexifolium</i> (With.) Hampe	EN	EN	V	VU
<i>Micromitrium tenerum</i> (Bruch & Schimp.) Crosby	EN	DD-n		
<i>Pohlia flexuosa</i> Hook.	EN	DD-n		
<i>Pohlia longicolla</i> (Hedw.) Lindb.	VU	VU	E	EN
<i>Pohlia ludwigii</i> (Schwägr.) Broth.	VU	DD	E	EN
<i>Pohlia obtusifolia</i> (Brid.) L. Koch	VU	DD	E	EN
<i>Polytrichastrum longisetum</i> (Sw. ex Brid.) G.L. Sm.	CR	CR	E	EN
<i>Ptilium crista-castrensis</i> (Hedw.) De Not.	EN	VU	R	
<i>Ptychostomum cyclophyllum</i> (Schwägr.) J.R.Spence	Excluded	EN	V	VU
<i>Rhizomnium magnifolium</i> (Horik.) T.J. Kop.	LC	LC		EN
<i>Rhynchostegiella durieui</i> (Mont.) P. Allorge & Perss.	EN	VU	R	
<i>Scorpidium revolvens</i> (Sw.) Rubens	DD	EN	R	
<i>Scorpidium scorpioides</i> (Hedw.) Limpr.	EN	EN	E	EN
<i>Sphagnum centrale</i> C.E.O. Jensen	EN	CR	V	VU
<i>Sphagnum fuscum</i> (Schimp.) H. Klinggr.	CR	CR	E	EN
<i>Sphagnum magellanicum</i> Brid.	VU	EN	V	VU
<i>Sphagnum majus</i> (Russow) C.E.O. Jensen	EN	DD-n		
<i>Sphagnum subtile</i> (Russow) Warnst.	EN	DD-n		
<i>Splachnum ampullaceum</i> Hedw.	VU	VU	E	EN
<i>Syntrichia handelii</i> (Schiffn.) Agnew & Vondr.	EN	DD		
<i>Tayloria froehlichiana</i> (Hedw.) Broth.	EN	EN	E	EN
<i>Timmia norvegica</i> Zetterst.	EN	EN	R	
<i>Tomentypnum nitens</i> (Hedw.) Loeske	VU	VU	E	EN
<i>Tortella alpicola</i> Dixon	EN	DD-n		
<i>Tortula freibergii</i> Dixon & Loeske	EN	VU		EN
<i>Warnstorfia sarmentosa</i> (Wahlenb.) Hedenäs	EN	EN	V	VU

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1

HORNWORTS	2014	2006	1994	1994 IUCN
<i>Anthoceros caucasicus</i> Steph.	CR	LC	V	VU
<i>Phaeoceros carolinianus</i> (Michx.) Prosk.	VU	LC		
LIVERWORTS	2014	2006	1994	1994 IUCN
<i>Adelanthus decipiens</i> (Hook.) Mitt.	VU	VU	R	
<i>Asterella gracilis</i> (F. Weber) Underw.	VU	NT	R	
<i>Barbilophozia atlantica</i> (Kaal.) Müll. Frib.	VU	VU	R	
<i>Barbilophozia attenuata</i> (Mart.) Loeske	VU	VU	R	
<i>Barbilophozia binsteadii</i> (Kaal.) Loeske	CR	CR	V	VU
<i>Barbilophozia kunzeana</i> (Huebener) Müll. Frib.	VU	NT		
<i>Bazzania tricrenata</i> (Wahlenb.) Lindb.	VU	LC		
<i>Blasia pusilla</i> L.	VU	VU	R	
<i>Calypogeia integristipula</i> Steph.	EN	VU	R	
<i>Calypogeia neesiana</i> (C. Massal. & Carestia) Müll. Frib.	VU	LC		
<i>Cephalozia ambigua</i> C. Massal.	VU	DD	R	
<i>Cephalozia crassifolia</i> (Lindenb. & Gottsche) Fulford	VU	EN	V	VU
<i>Cephalozia pleniceps</i> (Austin) Lindb.	VU	LC	R	
<i>Cephaloziella calyculata</i> (Durieu & Mont.) Müll. Frib.	EN	NT	V	VU
<i>Cephaloziella grimsulana</i> (J.B. Jack ex Gottsche & Rabenh.) Lacout.	DD	VU	R	
<i>Cephaloziella massalongi</i> (Spruce) Müll. Frib.	VU	VU	R	
<i>Cladopodiella fluitans</i> (Nees) H. Buch	VU	EN	R	
<i>Cladopodiella francisci</i> (Hook.) Jörg.	VU	VU	R	
<i>Fossombronia crozalsii</i> Corb.	CR	VU	R	
<i>Frullania oakesiana</i> Austin	EN	VU	V	VU
<i>Frullania riparia</i> Hampe ex Lehm	DD	DD	K	DD
<i>Frullania teneriffae</i> (F. Weber) Nees	VU	VU	R	
<i>Harpanthus scutatus</i> (F. Weber & D. Mohr) Spruce	EN	VU	E	EN
<i>Jamesoniella autumnalis</i> (DC.) Steph.	VU	VU	R	
<i>Jungermannia confertissima</i> Nees	EN	EN	V	VU
<i>Jungermannia handelii</i> (Schiffn.) Amakawa	CR	RE	V	VU
<i>Kurzia trichoclados</i> (Müll. Frib.) Grolle	VU	VU	R	
<i>Lejeunea eckloniana</i> Lindenb. (= <i>L. holtii</i> Spruce)	VU	DD-n		
<i>Lejeunea mandonii</i> (Steph.) Müll. Frib.	VU	DD	R	
<i>Lepidozia cupressina</i> (Sw.) Lindenb.	EN	VU	V	VU

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

LIVERWORTS	2014	2006	1994	1994 IUCN
<i>Lophocolea fragrans</i> (Moris & De Not.) Gottsche <i>et al.</i>	VU	VU	R	
<i>Lophozia ascendens</i> (Warnst.) R.M. Schust.	EN	VU	V	VU
<i>Lophozia heterocolpos</i> (Thed. <i>ex</i> Hartm.) M. Howe	VU	LC	R	
<i>Lophozia incisa</i> (Schrad.) Dumort.	VU	LC	R	
<i>Lophozia obtusa</i> (Lindb.) A. Evans	VU	VU		
<i>Lophozia opacifolia</i> Culm. <i>ex</i> Meyl.	VU	NT	R	
<i>Lophozia wenzelii</i> (Nees) Steph.	VU	LC	R	
<i>Marsupella brevissima</i> (Dumort.) Grolle	VU	VU	R	
<i>Metzgeria temperata</i> Kuwah.	LC-att	VU	V	VU
<i>Mylia anomala</i> (Hook.) Gray	VU	EN	R	
<i>Odontoschisma denudatum</i> (Mart.) Dumort.	VU	VU	R	
<i>Petalophyllum ralfsii</i> (Wilson) Nees & Gottsche	VU	VU	V	VU
<i>Plagiochila exigua</i> (Taylor) Taylor	VU	NT	R	
<i>Plagiochila punctata</i> (Taylor) Taylor	VU	DD	R	
<i>Pleurocladula albescens</i> (Hook.) Grolle	VU	VU	E	EN
<i>Radula holtii</i> Spruce	CR	VU	R	
<i>Riccardia incurvata</i> Lindb.	VU	VU	R	
<i>Riccia fluitans</i> L.	VU	NT	N	LC
<i>Riccia frostii</i> Austin	DD	DD	V	VU
<i>Riccia huebeneriana</i> Lindenb.	VU	VU	R	
<i>Riella helicophylla</i> (Bory & Mont.) Mont.	EN	VU	E	EN
<i>Riella notarisii</i> (Mont.) Mont.	VU	VU	E	EN
<i>Scapania gymnostomophila</i> Kaal.	CR	VU	R	
<i>Scapania umbrosa</i> (Schrad.) Dumort.	VU	EN	R	
<i>Scapania verrucosa</i> Heeg	RE	CR	V	VU
<i>Telaranea europaea</i> J.J. Engel & G.L. Sm.	VU	VU	R	
<i>Tetralophozia filiformis</i> (Steph.) Urmi	EN	VU	R	
MOSESSES	2014	2006	1994	1994 IUCN
<i>Acaulon fontiquerianum</i> Casas & Sérgio	VU	VU	R	
<i>Aloina brevisrostris</i> (Hook & Grev.) Kindb.	VU			
<i>Amblyodon dealbatus</i> (Hedw.) Bruch & Schimp.	VU	VU	V	VU
<i>Amphidium lapponicum</i> (Hedw.) Schimp.	VU	LC	R	
<i>Andreaea heinemannii</i> Hampe & Müll. Hal. subsp. <i>heinemannii</i>	VU	VU		

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

MOSSES	2014	2006	1994	1994 IUCN
<i>Andreaea heinemannii</i> subsp. <i>crassifolia</i> (Luisier) Sérgio	VU	LC-att		
<i>Andreaea megistospora</i> B.M. Murray	VU	LC		
<i>Andreaea mutabilis</i> Hook.f. & Wilson	VU	LC	R	
<i>Andreaea nivalis</i> Hook.	VU	LC		
<i>Anomobryum lusitanicum</i> (I. Hagen ex Luisier) Thér.	VU	LC-att	R	
<i>Anomodon longifolius</i> (Schleich. ex Brid.) C. Hartm.	VU	LC	R	
<i>Anomodon rostratus</i> (Hedw.) Schimp.	VU	LC		
<i>Arctoa fulvella</i> (Dicks.) Bruch & Schimp.	CR	VU	K	DD
<i>Aschisma carniolicum</i> (F. Weber & D. Mohr) Lindb.	VU	LC-att		
<i>Aschisma cuynetii</i> (Bizot & R.B. Pierrot) J. Guerra & M.J. Cano	VU	VU	R	
<i>Barbula crocea</i> (Brid.) F. Weber & D. Mohr	VU	VU	R	
<i>Brachythecium mildeanum</i> (Schimp.) Milde	VU	DD	R	
<i>Brachythecium turgidum</i> (Hartm.) Kindb.	VU	DD-n		
<i>Breutelia chrysocoma</i> (Hedw.) Lindb.	CR	VU	V	VU
<i>Bruchia vogesiaca</i> Schwägr.	EN	VU	V	VU
<i>Bryoerythrophyllum ferruginascens</i> (Stirt.) Giacom.	VU	VU	V	VU
<i>Bryoerythrophyllum inaequalifolium</i> (Taylor) R.H. Zander	EN	EN	V	VU
<i>Bryum intermedium</i> (Brid.) Blandow	VU	DD		
<i>Bryum mildeanum</i> Jur.	VU	LC	N	LC
<i>Bryum minii</i> Podp.	VU			
<i>Bryum sauteri</i> Bruch & Schimp.	VU	DD	R	
<i>Bryum subapiculatum</i> Hampe	VU	LC	R	
<i>Bryum tenuisetum</i> Limpr.	EN	VU		
<i>Bryum uliginosum</i> (Brid.) Bruch & Schimp.	VU	DD	R	
<i>Buxbaumia viridis</i> (Moug. ex Lam & DC.) Brid. ex Moug. & Nestl.	VU	EN	R	
<i>Calliergon cordifolium</i> (Hedw.) Kindb.	VU	VU	V	VU
<i>Calliergon giganteum</i> (Schimp.) Kindb.	EN	EN	V	VU
<i>Calliergonella lindbergii</i> (Mitt.) Hedenäs	LC	LC	V	VU
<i>Campylopus oerstedianus</i> (Müll. Hal.) Mitt.	Excluded	VU	R	
<i>Campylopus schimperi</i> Milde	VU	VU	R	
<i>Campylostelium saxicola</i> (F. Weber & D. Mohr) Bruch & Schimp.	VU	VU	R	

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

MOSSES	2014	2006	1994	1994 IUCN
<i>Catoscopium nigratum</i> (Hedw.) Brid.	EN	EN	V	VU
<i>Codonoblepharon forsteri</i> (Dicks.) Goffinet		VU		
<i>Conardia compacta</i> (Müll. Hal.) H. Rob.	VU	NT	R	
<i>Cyclodictyon laete-virens</i> (Hook. & Taylor) Mitt.	EN	VU	V	VU
<i>Dendrocryphaea lamyana</i> (Mont.) P. Rao	VU	LC-att	V	VU
<i>Dicranella grevilleana</i> (Brid.) Schimp.	VU	VU	R	
<i>Dicranella schreberiana</i> (Hedw.) H.A. Crum & L.E. Anderson	DD	VU	R	
<i>Dicranella staphylina</i> H. Whitehouse	DD	VU	R	
<i>Dicranodontium uncinatum</i> (Harv.) A. Jaeger	CR	VU	R	
<i>Dicranum brevifolium</i> (Lindb.) Lindb.	DD	VU		
<i>Dicranum flagellare</i> Hedw.	VU	VU	R	
<i>Dicranum leioneuron</i> Kindb.	DD	DD	V	VU
<i>Dicranum viride</i> (Sull. & Lesq.) Lindb.	VU			
<i>Didymodon asperifolius</i> (Mitt.) H.A. Crum, Steere & L.E. Anderson	VU	VU	R	
<i>Didymodon bistratosus</i> Hebr. & R.B. Pierrot	VU	DD-n		
<i>Didymodon eckeliae</i> R.H. Zander	VU	DD-n		
<i>Distichium inclinatum</i> (Hedw.) Bruch & Schimp.	VU	NT	R	
<i>Ditrichum pallidum</i> (Hedw.) Hampe	Excluded	VU	R	
<i>Ditrichum pusillum</i> (Hedw.) Hampe	VU	VU	R	
<i>Drepanocladus polygamus</i> (Schimp.) Hedenäs	VU	LC-att	R	
<i>Encalypta affinis</i> Hedw.	VU	VU	R	
<i>Encalypta microstoma</i> Bals.-Criv. & De Not.	VU	DD		
<i>Entodon cladorrhizans</i> (Hedw.) Müll. Hal.	VU	VU	Ex	RE
<i>Entosthodon hungaricus</i> (Boros) Loeske		VU	V	VU
<i>Entosthodon mouretii</i> (Corb.) Jelenc	VU	DD-n		
<i>Entosthodon muhlenbergii</i> (Turner) Fife	VU	VU≠	R	
<i>Entosthodon schimperii</i> Brugués	VU	DD-n		
<i>Eurhynchium angustirete</i> (Broth.) T.J. Kop.	VU	LC	R	
<i>Exsertotheca baetica</i> (J. Guerra) Draper <i>et al.</i>	VU	VU		
<i>Funariella curviseta</i> (Schwägr.) Sérgio	LC	LC	V	VU
<i>Gigaspermum mouretii</i> Corb.	LC-att	VU	R	
<i>Grimmia arenaria</i> Hampe	CR	VU		
<i>Grimmia atrata</i> Hornsch.	VU	LC		
<i>Grimmia capillata</i> De Not	VU	DD-n		
<i>Grimmia mollis</i> Bruch & Schimp.	VU	VU	V	VU

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

MOSSES	2014	2006	1994	1994 IUCN
<i>Grimmia muehlenbeckii</i> Schimp.	VU	VU		
<i>Grimmia poecilostoma</i> Cardot & Sébille	DD	VU		
<i>Grimmia unicolor</i> Hook.	DD	VU	R	
<i>Hamatocaulis vernicosus</i> (Mitt.) Hedenäs	EN	EN	V	VU
<i>Hygrohypnum cochlearifolium</i> (Venturi) Broth.	RE	RE	V	VU
<i>Hygrohypnum eugyrium</i> (Schimp.) Broth.	DD		V	VU
<i>Hygrohypnum molle</i> (Hedw.) Loeske	VU	VU	V	VU
<i>Hygrohypnum smithii</i> (Sw.) Broth.	VU	EN	R	
<i>Hylocomiastrum pyrenaicum</i> (Spruce) M. Fleisch.	VU	VU	V	VU
<i>Hylocomiastrum umbratum</i> (Hedw.) M. Fleisch.	VU	VU	V	VU
<i>Hypnum callichroum</i> Brid.	VU	LC	V	VU
<i>Hypnum pallescens</i> (Hedw.) P. Beauv.	CR	VU	R	
<i>Hypnum procerrimum</i> Molendo	VU	LC	R	
<i>Hypnum recurvatum</i> (Lindb. & Arnell) Kindb.	EN	VU		
<i>Isothecium algarvicum</i> W.E. Nicholson & Dixon	VU	VU	R	VU
<i>Isothecium holtii</i> Kindb.	VU	LC		
<i>Leptobarbula berica</i> (De Not.) Schimp.	LC	LC	V	VU
<i>Leptodontium flexifolium</i> (With.) Hampe	EN	EN	V	VU
<i>Meesia uliginosa</i> Hedw.	CR	CR	V	VU
<i>Microbryum fosbergii</i> (E.B. Bartram) Ros, O. Werner & Rams	VU	DD-n		
<i>Microbryum longipes</i> (J. Guerra, J.J. Martínez & Ros) R.H. Zander	VU	VU	R	
<i>Mielichhoferia elongata</i> (Hope & Hornsch.) Nees & Hornsch.	VU	VU	R	
<i>Neckera cephalonica</i> Jur. & Unger	VU	VU	R	
<i>Oedipodiella australis</i> (Wager & Dixon) Dixon	VU	VU	R	
<i>Oncophorus wahlenbergii</i> Brid.	CR	VU	R	
<i>Orthodontium pellucens</i> (Hook.) Schimp.	RE	RE	V	VU
<i>Orthotrichum hispanicum</i> F. Lara, Garilleti & Mazimpaka	VU	DD-n		
<i>Orthotrichum philibertii</i> Venturi	VU	DD-n		
<i>Orthotrichum pulchellum</i> Brunt.	VU	LC	R	
<i>Orthotrichum scanicum</i> Grönv.	VU	DD-n		
<i>Orthotrichum shawii</i> Wilson	VU	DD-n		
<i>Orthotrichum sprucei</i> Mont.	VU	DD-n		
<i>Paraleucobryum enerve</i> (Thed.) Loeske	VU	VU	R	

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

MOSSES	2014	2006	1994	1994 IUCN
<i>Paraleucobryum sauteri</i> (Bruch & Schimp.) Loeske	VU	VU	R	
<i>Plagiobryum zierii</i> (Hedw.) Lindb.	VU	LC	R	
<i>Plagiothecium platyphyllum</i> Mönk.	VU	VU	R	
<i>Platygyrium repens</i> (Brid.) Schimp.	LC	LC	V	VU
<i>Pohlia andalusica</i> (Höhn.) Broth.	VU	DD	R	
<i>Pohlia bolanderi</i> (Lesq.) Broth.	VU	DD-n		
<i>Pohlia drummondii</i> (Müll. Hal.) A.L. Andrews	VU	LC		
<i>Pohlia filum</i> (Schimp.) Martensson	VU	DD-n		
<i>Pohlia lescuriana</i> (Sull.) Ochi	VU	DD	R	
<i>Pohlia longicolla</i> (Hedw.) Lindb.	VU	VU	E	EN
<i>Pohlia ludwigii</i> (Schwägr.) Broth.	VU	DD	E	EN
<i>Pohlia obtusifolia</i> (Brid.) L. Koch	VU	DD	E	EN
<i>Polytrichastrum sexangulare</i> (Flörke ex Brid.) G.L. Sm.	VU	LC		
<i>Pseudotaxiphyllum laetevirens</i> (Dixon & Luisier ex F. Koppe & Düll) Hedenäs	VU	DD-n		
<i>Pterygoneurum lamellatum</i> (Lindb.) Jur.	LC	LC	V	VU
<i>Pterygoneurum subsessile</i> (Brid.) Jur.	LC	LC	V	VU
<i>Ptilium crista-castrensis</i> (Hedw.) De Not.	EN	VU	R	
<i>Ptychostomum cyclophyllum</i> (Schwägr.) J.R.Spence	Excluded	EN	V	VU
<i>Pyramidula tetragona</i> (Brid.) Brid.	VU	VU	R	
<i>Racomitrium macounii</i> Kindb. subsp. <i>macounii</i>	VU	LC	N	LC
<i>Rhabdoweisia crenulata</i> (Mitt.) Jameson	Excluded	VU	R	
<i>Rhabdoweisia crispata</i> (With.) Lindb.	VU	DD-n		
<i>Rhynchostegiella durieui</i> (Mont.) P. Allorge & Perss.	EN	VU	R	
<i>Schistidium agassizii</i> Sull. & Lesq.	LC	LC	V	VU
<i>Schistostega pennata</i> (Hedw.) F. Weber & D. Mohr	VU	LC	V	VU
<i>Schizymenium pontevedrensis</i> (Luisier) Sérgio, Casas, Cros & Brugués	VU	LC-att		
<i>Sciuro-hypnum glaciale</i> (Schimp.) Ignatov & Huttunen	VU	DD		
<i>Sciuro-hypnum starkei</i> (Brid.) Ignatov & Huttunen	VU	LC	R	
<i>Scopelophila cataractae</i> (Mitt.) Broth.	VU	VU	V	VU
<i>Seligeria patula</i> (Lindb.) I. Hagen	CR	VU		
<i>Seligeria calcarea</i> (Hedw.) Bruch & Schimp.	VU	VU	R	

Annex 4. Taxa considered Vulnerable (VU) in any of the three Spanish Red Lists published in Peninsular and Balearic Spain. For the 1994 list, data are given as in Annex 1 (*continued*)

MOSSES	2014	2006	1994	1994 IUCN
<i>Seligeria donniana</i> (Sm.) Müll.Hal.	LC	VU		
<i>Seligeria trifaria</i> (Brid.) Lindb.	VU	VU	R	
<i>Sphagnum angustifolium</i> (Russow) C.E.O. Jensen	LC	LC	V	VU
<i>Sphagnum centrale</i> C.E.O. Jensen	EN	CR	V	VU
<i>Sphagnum contortum</i> Schultz	VU	VU	R	
<i>Sphagnum magellanicum</i> Brid.	VU	EN	V	VU
<i>Sphagnum molle</i> Sull.	VU	VU	V	VU
<i>Sphagnum squarrosum</i> Crome	VU	VU	V	VU
<i>Sphagnum warnstorffii</i> Russow	VU	NT	R	
<i>Splachnum ampullaceum</i> Hedw.	VU	VU	E	EN
<i>Stegonia latifolia</i> (Schwägr.) Broth.	VU	VU	R	
<i>Syntrichia fragilis</i> (Taylor) Ochyra	VU	VU	R	
<i>Syntrichia minor</i> (Bizot) M.T. Gallego, J. Guerra, M.J. Cano & Ros	VU			
<i>Syntrichia sinensis</i> (Müll. Hal.) Ochyra	VU	VU	R	
<i>Tayloria tenuis</i> (With.) Schimp.	VU	VU	V	VU
<i>Tetrastichium virens</i> (Cardot) S.P. Churchill	CR	VU	Ex	RE
<i>Tetradontium brownianum</i> (Dicks.) Schwägr.	VU	VU	V	VU
<i>Timmia austriaca</i> Hedw.	VU	NT	R	
<i>Tomentypnum nitens</i> (Hedw.) Loeske	VU	VU	E	EN
<i>Tortula freibergii</i> Dixon & Loeske	EN	VU		
<i>Tortula guepinii</i> (Bruch & Schimp.) Broth.	VU	DD	K	DD
<i>Tortula pallida</i> (Lindb.) R.H.Zander	LC	LC	V	VU
<i>Tortula solmsii</i> (Schimp.) Limpr.	RE	VU	K	DD
<i>Tortula viridifolia</i> (Mitt.) Blockeel & A.J.E. Sm.	VU	DD	R	
<i>Tortula vlassovii</i> (Laz.) Ros & Herrnst.	VU	VU		
<i>Trematodon ambiguus</i> Hornsch.	VU	VU	V	VU
<i>Trichodon cylindricus</i> (Hedw.) Schimp.	VU	VU	R	
<i>Ulota calvescens</i> Wilson	VU	VU	V	VU
<i>Ulota coarctata</i> (P. Beauv.) Hammar	VU	DD	V	VU
<i>Ulota phyllantha</i> Brid.	RE	DD	V	VU
<i>Warnstorffia sarmentosa</i> (Wahlenb.) Hedenäs	EN	EN	V	VU
<i>Weissia perssonii</i> Kindb.	VU	VU	R	
<i>Weissia rutilans</i> (Hedw.) Lindb.	VU	LC	V	VU
<i>Weissia wimmeriana</i> (Sendtn.) Bruch & Schimp.	VU	LC	N	LC
<i>Zygodon conoideus</i> (Dicks.) Hook. & Taylor	DD	VU	Ex	RE