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THREATENED BRYOPHYTES IN EUROPE

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RESUMEN

Las briofitas europeas son probablemente las mejor conocidas del mundo por la concentración de briólogos profesionales y aficionados residentes y por una larga tradición de estudio que se remonta a Linneo y Hedwig. Las briofitas de Europa son muy diversas y están amenazadas porque éste es el continente más desarrollado y tiene una densidad de población alta. Tal vez otros puedan aprender de nuestros errores (y éxitos). Europa es muy variada y contiene una biodiversidad alta; la mayoría de los hábitats templados están representados. De un total de 1687 especies, 406 (24.1%) se consideran amenazados. El nivel de endemismo es aparentemente bajo, aunque no se puede decir si es más bajo que en otras regiones menos conocidas. De las 219 (13%) especies endémicas a Europa, 133 (60%) se consideran en peligro. Los centros de diversidad incluyen Macaronesia, el Mediterráneo, los Alpes y áreas boreales/árticas, con Noruega como el centro de diversidad de *Sphagnum*. En general, el clima sin variaciones extremas y con humedad más o menos constante permite una alta diversidad de briofitas. Sin embargo, las briofitas especializadas aparecen en regiones áridas o en regiones extremosas en números reducidos. Las amenazas para las briofitas europeas son muchas. Debido a su densidad de población casi todas las áreas vírgenes han sido reemplazadas. Los paisajes post-industriales y de la revolución agrícola han reemplazado a las áreas naturales y sólo quedan áreas seminaturales con vestigios de la vegetación original. Cerca de 279 (73.2%) especies amenazadas se encuentran en sitios identificados en el Registro de Sitios. Siendo la parte del mundo mejor conocida y a pesar de que todavía se describen nuevos taxa, varios países han producido Listas Rojas de briofitas. El Comité Europeo para la Conservación de Briofitas (ECCB) fue formado en 1990. El reciente Symposium on Endangered Bryophytes in Europe culminó con resoluciones para la conservación de briofitas. Varias especies forman ahora parte de convenciones internacionales.

Palabras clave: Europa, briofitas, conservación.

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ABSTRACT

The bryophytes of Europe are probably the most well-studied in the world because of the concentration of professional and amateur bryologists living there and the long historical tradition of study, going back to Linnaeus and Hedwig. They are also very diverse and very threatened. Europe is the most developed continent the world and has a high population density. Perhaps other areas in the world can learn from our mistakes (and successes). Europe is extremely varied and contains a wide range of biodiversity. Most temperate habitats are represented. Out of a total of 1687 species, 406 (24.1%) are considered to be threatened. The level of endemism is apparently low, but whether it is lower than that of other, lesser known, region is difficult to say. There is a total of 219 (13%) species endemic to Europe. Of these, 133 (60%) are considered threatened. There are several centres of diversity, notably Macaronesia, the Mediterranean, the Alps and Boreal/Arctic areas, with Norway as the centre of diversity for *Sphagnum*. In general, climate with few extremes of temperature and a more or less constant humidity, support a high diversity of bryophytes. However, smaller numbers of more specialist bryophytes occur in arid or in more extreme regions. Threats to bryophytes in Europe are many; because It is densely populated, nearly all virgin nature has been replaced. Post-industrial and agricultural revolution landscapes have replaced natural areas and we are left with semi-natural areas that contain vestiges of natural vegetation. About 279 (73.2%) of threatened species occur in sites identified in the Site Register. It is also the best-known part of the world, with several countries having produced Red Lists of bryophytes. However, new species are still being described. The European Committee for the Conservation of Bryophytes (ECCB) was formed in 1990. The recent Symposium on Endangered Bryophytes in Europe culminated in a number of resolutions for the conservation of bryophytes. Several species are now listed on international conventions.

Key words: Europe, bryophytes, conservation.

INTRODUCTION

The bryophytes of Europe are probably the most well-studied in the world, because of the concentration of professional and amateur bryologists living there and the long historical tradition of study, going back to Linnaeus and Hedwig. They are also very diverse and very threatened. Europe is the most 'developed' continent in the world, and has a high population density. Now that nearly all natural habitat in Europe has been replaced, conservation consists largely of a rearguard action. Perhaps other regions of the world can learn from the European experience. For the purposes of this paper, Europe is defined as the area covered by the recent Red Data Book, which includes the Canary Islands, the Azores and Madeira, and the northern Caucasus.

BIODIVERSITY

Europe is extremely varied and contains a wide range of biodiversity. Most temperate habitat types are represented. Some habitats are important on an international scale, *e.g.*, bogs, oceanic woodlands, boreal forest. Out of a total of 1687 bryophyte species in Europe (in a total of *ca.* 340 genera and *ca.* 100 families), 406 (24.1%) are considered threatened (ECCB,1995).

ENDEMISM AND/OR UNIQUENESS

The level of endemism of bryophytes in Europe is rather low, but whether it is significantly lower than that of some other lesser known regions is difficult to be sure of.

The total number of bryophyte species endemic to Europe is 219 (13% of the total flora), of which 133 (60%) are threatened (ECCB, in press). There are no bryophyte families endemic to Europe, and only seven endemic genera: *Alophosia, Andoa, Nobregaea, Ochyraea, Pictus, Trochobryum* and *Saccogyna.*

There are four monotypic families represented in Europe, none of which is endemic: Catascopiaceae, Disceliaceae, Oedipodiaceae and Schistostegaceae. There are about 50 monotypic genera.

The basic references for these figures were Corley *et al.* (1981), Corley and Crundwell (1991) and Grolle (1983), with some modifications from more recent literature.

In general, levels of endemism in bryophytes tend to be lower than in vascular plants for two reasons. Firstly, their dispersal mechanisms are, at least potentially, very effective. Secondly, they tend to grow in microhabitats and microclimates, which may occur in a wide range of macrohabitats and macroclimates. This means there is more potential for wider geographical ranges in bryophytes than there is in many vascular plants and, therefore, disjunctions are common. There are many examples of disjunctions, both intra-European and extra-European. An example of the former might be *Jamesoniella undulifolia,* a plant that exhibits a typical distribution pattern for a threatened but widespread species. This corresponds to one of the 'forms of rarity' listed by Rabinowitz (1981): large range, narrow habitat specificity and small local populations. It is recorded from 11 countries in Europe, and is on the Red Lists of all of them.

Many examples of the latter type of disjunction can be found in oceanic-montane species such as *Pleurozia purpurea* and *Plagiochila carringtonii.* These may be a result of relict distribution patterns or more recent dispersal.

CENTRES OF DIVERSITY

While the main centres of diversity for bryophytes must be considered to be in the tropics, there are several distinct areas in Europe that can be regarded as such.

Firstly, because of their isolation, the Macaronesian islands. Although these contain strong elements from Europe and Africa, they also have an important endemic flora. Of the 'European' endemics, 60 are Macaronesian endemics. Some genera, most notably *Echinodium*, have the islands as their centre of speciation.

The Mediterranean area can also be regarded as a centre of diversity because its semi-arid habitats are isolated to the north by increasing competition from vegetation used to a more amenable climate, and to the south by the extreme aridity of the Sahara desert. Therefore there is a great diversity of taxa such as *Riccia* species that are unique to the Mediterranean area.

The Alps may be regarded as a centre of diversity, as there are some genera which are apparently proliferating here (*e.g.*, in the Leskeaceae). There are outlying alpine habitats to the north and west in Britain and Scandinavia and to the east in the Carpathians. However, many alpine species are widespread on a global scale and occur again in the Himalayas, for example.

Boreal/Arctic/Atlantic areas are additional centres of diversity. Most notably Scandinavia, and especially Norway, isolated from other boreal/arctic zones by more extreme arctic vegetation and sea, is a centre of diversity for *Sphagnum*, with Britain and Ireland also important.

ECOLOGY/HABITAT REQUIREMENTS

In general, climates with few extremes of temperature and more or less constant humidity support a high diversity of bryophytes. However, smaller numbers of more specialist bryophytes occur in arid or more extreme regions. Bryophytes are, however, often capable of occupying small niches in otherwise unfavourable areas (*e.g.*, oceanic species in deep ravines in non-oceanic areas). Many species are also opportunists, colonising readily wherever the habitat is available.

WHAT KIND OF BRYOPHYTES ARE THE MOST THREATENED?

Table 1 shows numbers of species in the European Red Data Book (ECCB, 1995) arranged according to broad habitat types. Note that the threat categories used are the old IUCN categories. New threat categories have not yet been applied to species on a Europe-wide scale. Many species have been scored as occurring in more than one habitat, so the sum of the totals is considerably more than the total number of threatened species in Europe.

Several interesting points can be drawn from this table. Montane rock habitats support the largest number of threatened species. This reflects the fact that bryologically important areas, such as high-altitude base-rich rocks, have a rather restricted distribution in the mountains and that, although many areas are relatively remote and inaccessible, many of the richest bryological areas are under threat. It

Table 1. Number of species in each threat category according to habitat

Habitat	Number of species				
	E	V	R	EX	Total
Montane cliffs, rocks & grassland (basic)	3	22	43	1	69
Macaronesian laurel & juniper forest	2	23	41	-	66
Non-Atlantic woodland	7	14	23	-	44
Montane cliffs, rocks & grassland (non-basic)	2	11	22	-	35
Rotting wood	6	10	18	-	34
Arctic tundra, rocks, waste ground, soil, fens & swamps	-	10	24	-	34
Epiphytic (not necessarily woodland)	6	9	15	2	32
Atlantic forest & ravine woodland (non-Macaronesian)	1	7	24	-	32
Lowland rock exposures (basic)	2	8	12	-	22
Lowland rock exposures (non-basic)	1	10	11	-	22
Lowland grassland, quarries, waste ground & soil (basic)	3	6	11	-	20
Lowland riverine & aquatic	4	3	12	-	19
Coastal grassland, rocks & thin turf	1	3	14	1	19
Margins of lowland pools & reservoirs	6	1	8	-	15
Lowland grassland, quarries, waste ground & soil (non-basic)	2	5	8	-	15
Boreal forest	3	3	8	-	14
Epiphyllous	-	7	7	-	14
Upland flushes & mountain streams	2	3	8	-	13
Upland heath & bog	3	2	7	-	12
Xeric mediterranean terrestrial habitats	-	2	10	-	12
Lowland heath & bog	2	3	6	-	11
Cultivated fields	3	1	5	-	9
Lowland fen	1	2	6	-	9
Snow patch	1	2	6	-	9
Heavy metal rich rocks & mine waste	1	1	2	-	4
Woodland rides (non-basic soil)	1	1	2	-	4
Steppe	-	1	2	-	3
Sea caves and dripping gullies in coastal cliffs	-	1	1	-	2
Thatch	-	1	1	-	2
Fumaroles (non-atlantic only)	-	1	1	-	2
Dunes	-	1	1	-	2
Unknown	-	3	6	1	10

is also striking that a very large number of threatened bryophytes occur in woodland habitats (including epiphytes and those growing on rotting wood). The importance of Macaronesian forests is emphasised.

A high proportion of endangered and extinct species is particularly noticeable for epiphytes, species of reservoir and pool margins, riverine and aquatic species and species of cultivated fields. However, not too much should be read into these figures, because the higher figures tend to apply to habitats that are naturally species-rich, and so would be expected to have a higher number of both threatened and non-threatened species.

Table 2 (based on a study of life strategies applied to threatened species in the United Kingdom (Hodgetts and Stark, in press)), applies the life strategies devised and developed by During (1979, 1992) to threatened species in the UK, using the new IUCN threat categories (IUCN, 1994). As pointed out by González-Mancebo *et al.* (1991), some bryophytes are capable of exploiting more than one life strategy according to their habitat and the prevailing conditions. Where this is the case, species have been counted more than once in the table. Some species seldom produce spores but it is possible to allocate a life strategy to them on the basis of the nature and behaviour of their vegetative propagules (*e.g., Cephaloziella* spp.). A full list of bryophyte species on the British Red List, with their life strategies, is provided in Appendix 1.

The main conclusions to be drawn from this are as follows. Of threatened species in the UK, most perennial stayers (61%) are Vulnerable, with relatively few (27%) Endangered and Critically Endangered species. A high proportion (53%) of the shuttle species are either Endangered or Critically Endangered, with only 35% Vulnerable. This reflects the fact that species with a restricted habitat that are not very mobile are relatively highly threatened.

Table 2. Life strategy of threatened bryophytes in the UK

Life strategy	Status				
	VU	EN	CR	EX	Total
F	2	0	0	0	2 (1.5%)
AS	6	6	2	0	14 (10.2%)
C	26	12	10	6	54 (39.4%)
SS	13	11	10	5	39 (28.5%)
P	31	12	2	6	51 (37.2%)
LS	7	5	5	4	21 (15.3%)
D	0	1	0	1	2 (1.5%)
Total	62 (45.3%)	40 (29.2%)	20 (14.6%)	15 (10.9%)	

F = fugitive; AS = annual shuttle; C = colonist; SS = short-lived shuttle; P = perennial stayer; LS = long-lived shuttle; D = dominant (after During, 1992).

MAIN THREATS

The threats to bryophytes in Europe are many. Europe is one of the most densely populated areas of the world. Nearly all 'virgin' natural habitat has disappeared, to be replaced by post-agricultural and industrial revolution landscapes. Areas of 'semi-natural' vegetation remain, which, although usually essentially anthropogenic, contain vesitiges of natural habitats. Organisms requiring large tracts of natural wilderness for their survival, such as large predators, are therefore either extinct or severely threatened. However, as far as we can tell, few bryophytes have become extinct. This is because the species and communities are at a small scale: although many species have declined markedly because of habitat destruction, it would be much more difficult to eradicate all possible sites for a bryophyte than for a wolf or bear. On the contrary, most species are capable of surviving in microhabitats in otherwise inhospitable surroundings, unlike many vascular plants or animals, many of which require large areas of natural or semi-natural vegetation. Some species are, however, so restricted in their habitat and range that they are under severe threat (*e.g.*, rich fen species in central and southern Europe).

Historically, habitat destruction has been the most important threat. This is still a threat, through building programmes, afforestation with non-indigenous species, deforestation of natural and semi-natural woodland, tourist developments, etc., but there are now wide areas of protected semi-natural vegeation in Europe, and any attempt to encroach on these further is always fought very hard. However, attitudes vary widely between countries, and some European governments still do little more than pay lip-service to the conservation of their natural heritage.

Within the conservation movement, ignorance is sometimes a threat to bryophytes. For example, it has been known for nature reserve managers to dig up bryophyte-rich dune slacks to create ponds for natterjack toads. More usually, it is ignorance of correct management procedures for bryophytes that is the problem, and many valuable bryophyte sites have been lost by being allowed to fall victim to scrub invasion or over- or under- grazing. It is the duty of bryologists to disseminate their specialist knowledge to the conservation authorities, so that bryophytes may be integrated into conservation programmes effectively.

Pollution is perhaps the most insidious and therefore the most serious threat to bryophytes in Europe because it can reach and destroy even the microhabitats. There are good examples in northern Russia, in particular, of large scale pollution that has dramatically diminished the biodiversity over large areas (*e.g.*, the effects of the aluminium smelter in the Kola Peninsula). Eutrophication because of excessive use of fertilisers and slurry and over-stocking is an important threat throughout Europe, threatening freshwater systems and wetlands.

CURRENT STATE OF KNOWLEDGE

Europe is the best-known part of the world for bryophytes. Most countries have checklists and many now have Red Lists. The ones listed in the European Red Data Book (ECCB, in press) are:

Austria: Grims (1986, mosses), Saukel (1986, hepatics); **Belgium:** Demaret and Lambinon (1969); **Czech Republic and Slovakia:** Váňa (1992, 1993); **Finland:** Kemppainen (1985), Rassi and Väisänen (1992); **Germany:** Benkert (1978), Berg and Wiehle (1992), Düll (1987), Düll and Koppe (1978), Hübschmann (1982), Klawitter and Schaepe (1985), Koperski (1991), Müller and Borsdorf (1991), Pankow (1985), Philippi (1984) and Walsemann (1982); **Hungary:** Rajczy (1990); **Italy:** Cortini and Aleffi (1993); **Luxembourg:** Werner (1987); **The Netherlands:** Siebel *et al.* (1992); **Norway:** Frisvoll and Blom (1992a, including a list of rare bryophytes in Svalbard); **Poland:** Szweykowski (1986, hepatics), Ochyra (1986, mosses); **Slovakia:** Peciar (1987); **Slovenia:** Martincic (1992, mosses); **Spain and Portugal:** Sérgio *et al.* (1994); **Sweden:** Databanken för hotade ater och Naturvårdsverket (1991); **Switzerland:** Urmi *et al.* (1992). There are Red Lists published for parts of the former USSR, including the **Ukraine** (Anon., 1991), **Kazakhstan** (Bykov, 1981), **Lithuania** (Nature Conservation State Committee of the Lithuanian SSR, 1989) and **Tadzhikistan** (Anon., 1988); other lists for the former USSR include Anon. (1975, 1982), Bardunov *et al.* (1984), Druzhinina (1984), Garushjants *et al.* (1989) and Konstantinova (1990).

Manuscripts or draft versions of Red Lists exist for the following countries: Belgium, Czech Republic, Estonia, France, Great Britain, Ireland, Portugal, Slovakia and Spain.

However, the state of knowledge is very variable, and new species are still being described. Britain is very well known (though new species continue to be found), while Greece is probably more poorly known than many tropical countries, having no resident bryologists and few visiting ones, except on holiday.

There are many species in Europe whose status remains obscure for various reasons. The Red Data Book contains a long list of Insufficiently Known (K) species, which are thought to qualify for inclusion in the Red List status but are too poorly known to be sure. Newly described species must also often be considered insufficiently known. Their distribution can often only be worked out after a period following their description during which bryologists have the opportunity to look for them away from their type locality.

ACTION

[Much of the text on legislation is taken directly from the European bryophyte Red Data Book (ECCB, in press).]

Many countries have some form of legislation relating to wildlife protection. In

general these take two forms; site protection and species protection. Site protection usually involves the identification of areas of importance, such as nature reserves, and provides for the management of these areas for their wildlife interest.

Species protection is usually based on a selected list of species that are protected from collection. Bryophytes are included on the lists of a few countries (Germany, The Netherlands, Belgium, Luxembourg, United Kingdom, Switzerland (part), Hungary and the former Soviet Union) and several other countries are considering the addition of bryophytes to their lists of protected species. In some cases the bryophytes that have been given protection are highly endangered species, but more usually they are widespread species that are exploited commercially (*e.g., Sphagnum*).

The habitats of protected species are also protected in some countries, such as Poland, Hungary, Spain and part of Austria. In several Swiss cantons, planning permission is required before the habitat of protected species can be altered. Many important bryophyte sites have been protected incidentally through designation of protected areas for other, usually habitat-related, reasons.

Species may also be given protection under international law. As mentioned above, it is incumbent on bryologists to ensure that bryophyte conservation is integrated into mainstream conservation programmes, and that bryophyte communities are taken into account when habitat conservation is considered. It is important to include species and bryophyte-rich habitats onto appendices of international conventions, if only to raise their profile.

Table 3. Species accepted for addition to Appendix 1 of the convention on the Conservation of European Wildlife and Natural Habitats

*Notothylas orbicularis**	*Buxbaumia viridis**
Cephalozia macounii	*Cynodontium suecicum*
*Frullania parvistipula**	*Dichelyma capillaceum**
*Jungermannia handelii**	*Dicranum viride**
*Mannia triandra**	*Distichophyllum carinatum**
*Marsupella profunda**	*Echinodium spinosum**
*Petalophyllum ralfsii**	*Hamatocaulis vernicosus (= Drepanocladus v.)* *
*Riccia breidleri**	*Meesia longiseta**
*Riella helicophylla**	*Orthotrichum rogeri**
*Scapania massalongi**	*Pyramidula tetragona**
	*Sphagnum pylaisii**
*Atractylocarpus alpinus**	*Tayloria rudolphiana**
*Bruchia vogesiaca**	*Thamnobryum fernandesii**
*Bryoerythrophyllum machadoanum**	

*Species also added to the list of protected species in the European Community Directive on the conservation of natural habitats and of wild fauna and flora (*i.e.*, those occurring in member states of the European Union).

The European Committee for the Conservation of Bryophytes (ECCB) was formed in 1990 to address bryophyte conservation in Europe. Its first act was to recommend the addition of a selection of species to Appendix 1 of The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). The species accepted for addition are shown in Table 3.

These were the first lower plants to be listed under any international treaty or law. A panel of experts has been set up to review this list periodically.

The European Community Directive was ratified in May 1992 and has several important aspects. Firstly, it seeks to ensure the protection of important sites for selected threatened species as well as protection for the species themselves. As far as bryophytes are concerned, all the species listed on the Bern Convention that occur within the European Community area require 'Special Areas of Conservation' to be designated for their protection.

Another article in the European Community Directive deals with the commercial exploitation of species. This article now means that the exploitation of all *Sphagnum* species and *Leucobryum glaucum* should be monitored by member states and measures should be taken to prevent exploitation from adversely affecting the status of these species.

However, blanket protection for species is not necessarily the best way of protecting bryophytes, as it can be counter-productive and stifle professional and amateur research. Action plans for species protection appear to offer a much more positive way forward, as they can be tailored to the requirements of individual species. Bryophyte conservation should go forward as an integrated part of an overall biodiversity conservation strategy rather than being marginalised. This is now widely recognised. For example, in the UK, bryophytes and other lower plants are taken into consideration in the Plant Conservation Strategy (Palmer, 1995), along with vascular plants, and action plans for lower plant species are being produced in response to the Rio Biodiversity Convention.

The ECCB has just produced a Red Data Book of European bryophytes (ECCB, 1995). This includes an introductory section, the European bryophyte Red List, and a site register, which incorporates a selection of important bryophyte sites in Europe. 279 (73.2%) of threatened species occur in sites identified in the Site Register.

The recent Symposium on Endangered Bryophytes in Europe, held in Zürich in 1994, culminated in a number of resolutions for the conservation of bryophytes. These are listed in Appendix 2.

The IUCN/IAB Bryophyte Specialist Group was also established in 1990. The main task of this group is to produce an action plan for bryophyte conservation worldwide.

Because there are currently relatively many bryologists in Europe and relatively few in the tropics, European bryologists have an important role in the conservation of tropical bryophytes. European bryologists can enthuse botanists in tropical universities to study bryophytes and impart their knowledge to them. Systems such as the Darwin Initiative, now starting in Britain as a result of the Biodiversity Con-

vention in Rio, can be important in this respect. Far from bryophyte study being a handicap in obtaining funding, one of the criteria for Darwin initiative funding is that of studying 'little-known' groups. This demonstrates that bryologists should be confident in applying for funding that will address conservation of what others might think of as obscure organisms.

Although the process will rarely be straightforward, because of economic and social pressures, tropical countries, many of which still have extensive tracts of virgin habitat, have an opportunity to improve on the record of temperate ones. Some countries, such as Costa Rica, are clearly aware of the great intrinsic and economic value of their natural resource and take its conservation very seriously. Ecotourism is now a major money-earner for this country. Others, such as Malaysia, appear to be oblivious to their natural heritage, often ruthlessly exploiting and destroying it for short-term gain. This will surely prove to be suicidal in the long term.

The situation in Europe is therefore both a warning to less 'developed' countries as to what can go wrong and also an example of what may be done about it.

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Appendix 1. Bryophytes on the British Red Data List, with new IUCN threat categories and life strategies

Key: F = fugitive; AS = annual shuttle; C = colonist; SS = short-lived shuttle; P = perennial stayer; LS = long-lived shuttle; D = dominant (after During 1992).

Species	Status	Life strategy
Adelanthus lindenbergianus	VU	P (relict)
Cephaloziella baumgartneri	VU	C
Cephaloziella dentata	EN	C
Cephaloziella integerrima	EN	C
Cephaloziella massalongi	VU	C/SS
Cephaloziella turneri	VU	C/SS
Fossombronia crozalsii	CR	AS
Geocalyx graveolens	VU	C/P
Gymnocolea acutiloba	VU	C/P
Herbertus borealis	VU	P (relict)
Jamesoniella undulifolia	EN	C/P
Jungermannia leiantha	EN	SS/LS
Lejeunea eckloniana (=*L. holtii*)	VU	P?
Lejeunea mandonii	EN	P?
Lophozia rutheana	CR	P
Marsupella arctica	VU	P
Marsupella profunda	CR	C
Marsupella sparsifolia	VU	C/P
Pallavicinia lyellii	VU	LS
Petalophyllum ralfsii	VU	LS
Phaeoceros carolinianus	EN	SS
Riccia bifurca	VU	AS/SS
Riccia canaliculata	VU	AS
Riccia crystallina	VU	AS
Riccia huebeneriana	VU	AS
Scapania paludicola	EN	P/LS?
Scapania praetervisa	VU	C/P?
Southbya nigrella	EN	C/P
Sphaerocarpos texanus	VU	AS/SS
Telaranea nematodes	VU	P
Acaulon triquetrum	EN	AS
Amblystegium saxatileV	UC	
Andreaea frigida	VU	SS/LS
Anomodon attenuatus	EX	LS?

Appendix 1. *continued*

Species	Status	Life strategy
Anomodon longifolius	EN	LS?
Aplodon wormskjoldii	VU	F
Atrichum angustatum	EN	C
Bartramia stricta	EN	SS
Blindia caespiticia	VU	P
Brachythecium erythrorrhizon	EN	P
Brachythecium starkei	VU	P
Bryum calophyllum	VU	SS
Bryum cyclophyllum	EN	AS/SS
Bryum gemmiparum	EN	SS/LS
Bryum knowltonii	VU	SS
Bryum lawersianum	EX	SS
Bryum mamillatum	CR	SS
Bryum marratii	EN	SS
Bryum neodamense	EN	C
Bryum schleicheri var. *latifolium*	CR	LS
Bryum stirtonii	VU	C
Bryum turbinatum	CR	C
Bryum uliginosum	CR	SS
Bryum warneum	VU	SS
Buxbaumia viridis	CR	C
Campylium halleri	VU	P
Ceratodon conicus	EN	C
Cryphaea lamyana	VU	P/LS
Ctenidium procerrimum	VU	P
Cyclodictyon laetevirens	VU	P
Cynodontium fallax	EX	C/SS?
Daltonia splachnoides	EN	C
Desmatodon cernuus	EN	AS/SS
Desmatodon leucostoma	VU	SS
Dicranum bergeri (=*D. undulatum*)	VU	LS
Dicranum elongatum	EN	SS
Didymodon cordatus	CR	C/SS
Didymodon glaucus	CR	C/SS
Ditrichum cornubicum	CR	C/SS
Encalypta brevicollis	EX	SS
Ephemerum cohaerens	CR	AS

Appendix 1. *continued*

Species	Status	Life strategy
Ephemerum stellatum	EN	AS
Eurhynchium meridionale	VU	P
Eurhynchium pulchellum	EN	P
Fissidens serrulatus	VU	P
Grimmia alpestris	VU	C/P
Grimmia anodon	EN	C/P
Grimmia elatior	EX	C/P
Grimmia ovalis	VU	C/P
Grimmia unicolor	VU	C/P
Gyroweisia reflexa	EX	C/P/LS
Habrodon perpusillus	EN	C
Helodium blandowii	EX	P
Homomallium incurvatum	EN	P
Hygrohypnum molle	VU	P
Hygrohypnum polare	VU	P
Hygrohypnum styriacum	EN	P
Hypnum revolutum	VU	P?
Hypnum vaucheri	VU	P?
Leptodontium gemmascens	EN	LS
Lescuraea saxicola	EX	P?
Micromitrium tenerum	EN	AS
Mielichhoferia mielichhoferiana	VU	C/SS
Myurella tenerrima	VU	C/P
Neckera pennata	EX	LS
Orthodontium gracile	EN	C
Orthotrichum gymnostomum	CR	C/SS/LS
Orthotrichum obtusifolium	CR	C/SS/LS
Orthotrichum pallens	CR	C/SS/LS
Paludella squarrosa	EX	P/LS
Philonotis cernua (=*Bartramidula wilsonii*)	EN	SS
Philonotis marchica	CR	LS
Physcomitrium eurystomum	VU	AS
Plagiothecium piliferum	EN	C/P
Pohlia crudoides	VU	C/SS?
Pseudoleskeella nervosa	VU	LS
Pterygoneurum lamellatum	EX	C
Rhynchostegium rotundifolium	CR	P

Appendix 1. *continued*

Species	Status	Life strategy
Saelania glaucescens	VU	C/P
Schistidium atrofuscum	VU	C/P
Schistidium boreale	VU	C/P
Scorpidium turgescens	EN	P
Seligeria brevifolia	VU	C/P/SS/LS
Seligeria diversifolia	VU	C
Sematophyllum demissum	EN	P
Sphagnum balticum	EN	D
Sphagnum obtusum	EX	D
Splachnum vasculosum	VU	F
Tayloria lingulata	EN	SS
Tayloria tenuis (=*T. longicollis*)	EN	C
Tetrodontium repandum	CR	C/SS
Thamnobryum angustifolium	CR	P
Thamnobryum cataractarum	VU	P
Timmia austriaca	VU	P?
Tortella limosella	EX	C/P?
Tortula cuneifolia	VU	C
Tortula norvegica	VU	C/P?
Trematodon ambiguus	EX	SS
Trochobryum carniolicum	CR	SS
Weissia condensa (=*W. tortilis*)	VU	C
Weissia levieri	VU	C/SS
Weissia mittenii	EX	C/SS
Weissia multicapsularis	VU	C/SS
Weissia squarrosa	EN	AS/SS
Weissia wimmerana	VU	C
Zygodon forsteri	EN	C
Zygodon gracilis	EN	P

Appendix 2. Resolutions made by the ECCB following the Conservation of Bryophytes in Europe Symposium held in Zürich, 4-8 September 1994

1. ECCB should request national authorities to include the sites listed in the European Bryophyte Site Register in the list of sites representing natural habitat types cited in Annex I of the Habitat and Species Directive, insofar as the 'important bryophyte sites' are covered by Annex I habitat types and are within the EU territory. National authorities should be requested to designate these sites as Special Areas of Conservation.

2. ECCB should ask the scientific community to propose a strategy to promote the interests of plant conservation to be undertaken through the Cohesion Fund and the Structural Fund of the EU.

3. ECCB urges that all EU and national environmental legislation concerned, for example, with maintaining the quality of air, soil and water, and with disposal of waste, should make appropriate provision for the conservation of bryophytes and other plants and that such legislation should be implemented through sectorial policies concerned with matters such as energy, agriculture, industry, transport and tourism.

4. ECCB should seek to ensure that bryophytes and other non-vascular plants are given equal weight with vascular plants and animals in conservation legislation throughout Europe and elsewhere.

5. ECCB should collaborate with the IUCN legal programme to develop strategies aimed at ensuring that the judiciary and other authorities involved in enforcing environmental legislation are adequately trained in conservation biology, with particular attention to plant conservation.

6. a). ECCB and the IUCN Specialist Group for Eastern Europe should offer to collaborate with administrative authorities, the Academies of Science in eastern European countries and other relevant bodies, with the objective of developing the structures necessary to strengthen and enforce legislation aimed at conserving bryophytes and other plants.

   b). ECCB recommends that funding agencies such as the World Bank and the EU Commission through its PHARE programme, should allocate a significant percentage of their development aid to nature conservation within their environmental programmes. It is recommended that the governments of all European countries should recognise the need to make adequate financial provision for measures designed to conserve bryophytes and other plants.

   c). ECCB should collaborate with scientists from throughout Europe within its Action Plans for bryophyte conservation by offering to share expertise and in other appropriate ways.

Supplementary resolution on the protection of Kutsa area, Russia.

The ECCB Symposium, held in 1994 in Zürich on the conservation of threatened bryophytes in Europe, requests the competent authorities to give legal protection to the territory of Kutsa area (Murmansk Province, Russia).