

Red List of Liverworts and Hornworts of Poland (4th edition, 2018)

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Abstract – The fourth edition of the Red List of Liverworts and Hornworts of Poland was prepared using the rules presented in the 2nd edition of the International Union for Conservation of Nature Red List Categories and Criteria (version 3.1). Altogether, 240 liverwort and four hornwort species that are currently found in Poland are included. Seventy-two species (71 liverworts and one hornwort) are classified as threatened, which comprises 30% and 25% of the liverwort and hornwort flora, respectively. The critically endangered (CR) category is assigned to 11 liverworts and one hornwort, the endangered (EN) category is assigned to 21 liverworts, and the vulnerable (VU) category is assigned to 39 liverworts. Two liverwort species, *Anastrophyllum donnianum* and *Biantheridion undulifolium*, are considered regionally extinct. Data concerning the distribution, abundance and population state of 21 species (20 liverworts and one hornwort) fall within the data deficient (DD) category; in this category, the data are insufficient for the established criteria to be used to determine the endangerment category. One liverwort is included in the not applicable (NA) category.

Red lists / threatened liverworts and hornworts / extinct species / bryophytes / Poland

INTRODUCTION

Three editions of the Red List of Threatened Liverworts and Hornworts (Szweykowski, 1986, 1992; Klama, 2006) have been published during the last 30 years of bryological research in Poland. The publication of the three editions occurred in response to vanishing species of bryophytes and their associated environments (see, for example, Szweykowski & Tobolewski, 1959; Klama 2003, 2005; Górski & Urbański 2006). Field data provide information about current bryophyte distribution, and combining that data with historical data allows for an analysis of the important changes that influence the endangerment of these plants. After the first edition of the Red List (Szweykowski, 1986), a large amount of research has been undertaken to document the occurrence of Polish liverworts and hornworts. Regional monographs have been published from areas that are rich in bryophyte species richness, such as the Carpathians (for example, Mierzeńska, 1994; Klama, 1996, 2004a; Szweykowski

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& Buczkowska, 1996; Ochyra & Cykowska, 2008; Górski & Váňa, 2014; Górski 2016), northeastern Poland (Klama, 2002a) and Western Pomerania (Szweykowski & Buczkowska, 2000; Górski, 2013b). After the third edition of the Red List (Klama, 2006), six new liverwort species has been reported in Poland (Buczkowska & Bączkiewicz, 2006; Klama *in Ellis et al.*, 2011; Górski & Váňa 2011; Górski & Váňa 2013; Górski & Váňa *in Ellis et al.*, 2013a; Váňa & Górski *in Ellis et al.*, 2013b). Other important findings in recent years include new data about the rarest species of Polish flora, which was previously reported in one or two localities (Klama, 2004a; Cykowska, 2011; Górski & Romański, 2016), and liverworts that were considered extinct (Górski, 2013a). Many times, studies in Poland that aimed to find species ended up confirming their extinction. The most recent attempt to assess the endangerment of local liverworts was the creation of a new and extended list of liverworts that are subject to legal species protection (Kapel *et al.*, 2012; Anonymous, 2014). However, it is worth noting that the criteria applied by local legal protection differs substantially from those employed by the *International Union for Conservation of Nature (IUCN)*. For those reasons, we were inspired to gain new insight into changes that happen in the local bryoflora.

The aim of this work is to present the current state of endangerment of liverworts and hornworts in Poland. For the first time in the history of Polish bryological Red Lists, we based our categorisation of species on the commonly accepted IUCN criteria (IUCN, 2012). The present edition of the Red List not only follows the IUCN guidelines with regard to updating the list every couple of years, but it also aligns with the efforts of the European Committee for the Conservation of Bryophytes, started in Zurich in 2011, with regard to the preparation of the new Red Data Book of European Bryophytes (Hodgetts, 2015).

Factors that are associated with a reduction in the number of liverworts in Poland are well characterised (see, for example, Szweykowski & Tobolewski, 1959; Klama, 2003, 2004b, 2005; Górski & Urbański, 2006). The most influential human activities that cause the degradation and fragmentation of bryophyte environments are forestry, agriculture and the regulation of hydrographic conditions of swamp ecosystems. Due to the hemerophobic nature of most liverworts, all threats to natural ecosystems are of concern to the preservation of this group. Hornworts have different distribution characteristics. Because it is a plant that grows primarily within anthropogenic habitats (mostly fields), they are exposed to changes in their use.

METHODS

General assumptions

All liverwort and hornwort species that have been recorded in Poland up to the end of 2016 were taken into consideration. The taxonomic depiction and nomenclature of liverworts and hornworts follows Söderström *et al.* (2016). At present, the liverwort flora of Poland consists of 240 species, and the hornwort flora consists of four species. The Red List that describes the liverworts of Poland was established on the basis of the categories and criteria of IUCN (2012). Species were categorised using methods described in the Guidelines for Using the IUCN Red List Categories and Criteria, version 12 (IUCN Standards and Petitions Subcommittee,

2016) and in the Guidelines for Application of IUCN Red List Criteria at Regional and National Levels, version 4.0 (IUCN Species Survival Commission, 2012).

Red List categories

On the basis of IUCN (2012) and IUCN Species Survival Commission (2012), eight categories were used to describe species, depending on their degree of endangerment. Those definitions are as follows:

1. Regionally extinct (RE): The taxon is considered to be regionally extinct if its local environment has been destroyed or if studies conducted since 1985 have not confirmed its presence in regional environments. It cannot be excluded that the taxon could be found in future research.
2. Critically endangered (CR): Includes species that meet the criteria for this category and are at extreme risk of extinction in their current local environment.
3. Endangered (EN): A taxon is endangered if meets the criteria for this category and is at a high risk of extinction in its current local environment.
4. Vulnerable (VU): This includes taxa that meet the criteria for this category and are at a high risk of extinction in their current local environment.
5. Near threatened (NT): This category includes species that do not meet the criteria for being CR, EN or VU; however, they may be classified in one of those categories in the near future.
6. Least concern (LC): A taxon is considered to be of least concern if it does not meet the criteria for being CR, EN or VU, and it would not be classified in one of those categories in the near future.
7. Data deficient (DD): Includes taxa for which there is not enough data on the distribution, abundance or population state to allow for the classification on the basis of the criteria.
8. Not Applicable (NA): Category for a taxon deemed to be ineligible for assessment at a regional level. A taxon is NA because it is not within its natural range in the region.

Criteria

Currently, reliable data does not exist about the quantity and dynamics of the liverwort and hornwort population in Poland, including observations confirming a decrease in population during the last 10 years. For that reason, only B and D IUCN criteria (IUCN, 2012; IUCN Standards and Petitions Subcommittee, 2016) were applied for the categorisation and evaluation of species endangerment.

The IUCN B criterion is the criterion that was most frequently used during the evaluation of the Red List in Poland. In this case, the extent of occurrence (EOO; subcriterion B1) or the area of occupancy (AOO; subcriterion B2) are applied for the determination of species threat category. In the case of subcriterion B1, a species could be categorised as CR if its EOO is less than 100 km², as EN if the EOO is less than 5,000 km² and as VU if the EOO is lower than 20 000 km². In the case of subcriterion B2, a species could be categorised as CR if its AOO is lower than 10 km², as EN if the AOO is lower 500 km² and as VU if the AOO is lower than 2,000 km². Additionally, for both subcriteria, the species would have to meet two of the three of the following requirements for criterion B:

1. A population that is critically fragmented or known to be from one locality (CR), less than five localities (EN) or less than 10 localities (VU).
2. There is an observed, evaluated or predicted constant decrease in any of the following: (i) the extent of occurrence, (ii) the area of occupancy, (iii) the area, range or quality of habitat, (iv) number of localities or subpopulations and (v) the number of mature individuals.
3. There are extreme fluctuations in the (i) extent of occurrence, (ii) area of occupancy, (iii) number of localities or subpopulations or (iv) number of mature individuals.

Criterion D identifies species with very small or restricted populations. During the establishment of the Polish Red List, the subcriterion D2 was used, which applies only to the VU category. A taxon is considered to be VU if its area of occupancy is highly restricted (less than 20 km²), or if it is present in up to five localities and there is a likely (either natural or anthropogenic) threat to its occurrence.

EVALUATION OF THE CURRENT STATE OF ENDANGERMENT OF THE LIVERWORT AND HORNWORT FLORA IN POLAND

General data

In Poland, the list of threatened species comprises 71 liverworts and one hornwort; 39 species of liverworts (16% of the liverwort flora of Poland) are categorised as VU, 21 (9%) are categorised as EN and 11 (5%) are categorised as CR, while one species of hornwort is categorised as CR. These 71 species of liverworts and one species of hornwort make up to 29% and 25% of their flora, respectively. Two species of liverworts (3%) are categorised as RE. Twenty-one species (20 liverworts and one hornwort) are categorised as DD, which means there is lack of data for estimating threat and they need further observation. Twelve species of liverworts are categorised as NT. One liverwort is categorised as NA (Tables 1 and 3).

Characteristics of selected groups of species

The species that are extinct in Poland (RE) are *Biantheridion undulifolium* (*Jamesoniella undulifolia*) and *Anastrophyllum donnianum*. *Biantheridion undulifolium* was recorded in 11 localities, mostly during the 19th century (Szweykowski, 1971). The last record was reported from Sudety Mountains (southwestern Poland; Szweykowski, 1953). However, the locality was destroyed later (Szweykowski, 2006). A search for *B. undulifolium* in its sole locality in the Tatra Mountains (Krupa, 1882) has not confirmed that it is still present (Górski & Váňa, 2014). The species has a high level of threat in Europe (E category sensu Schumacker & Martiny, 1995; Schumacker & Váňa, 2005). The other liverwort that is extinct in Poland, *A. donnianum*, was reported in Poland in 1958 in one locality in the Western Tatra Mountains (Szweykowski, 1960). Subsequent searches for the plant at that site (H. Klama in 1985, 1986 and 1987; P. Górski in 2008 and 2016) have not located this species. However, it is worth noting that in the Slovakian Tatra Mountains, the plant was found in 2008 (Górski, 2009) near the historical

locality described by Krupa (1888). In the 2006 edition of the Red List (Klama, 2006), *Frullania fragilifolia* moved from extinct category to the CR group after being found in 2005 in the Western Tatra Mountains (Górski, 2013a). Most recently, in 2013, the plant was found in the same area, but in the Slovakian part of the massif (Górski & Váňa, 2014).

Of the 12 species in the CR category, as many as six are known to be from one or two localities that have not been confirmed during at least the past 50 years. Those six liverwort species are *Frullania jackii*, *Metzgeria simplex*, *Oxymitra incrassata*, *Scapania carinthiaca*, *Sphenobolus saxicola* and *Tritomaria scitula*; only one, *Sphenobolus saxicola*, has been found since 2000 in the Slovakian Tatra Mountains, near the Polish border (Górski, 2009). The remaining CR species have been recently found in single localities, for example, *Metzgeria violacea* (Armata 2009; Górski, 2013b; Górski & Váňa, 2014), *Odontoschisma francisci* (Górski & Váňa, 2014) and *Scapania apiculata* (Szweykowski & Buczkowska, 1996). The species with the highest risk of extinction is *Scapania carinthiaca*. This plant is known from only one location in Poland, which is in the Tatra Mountains (Szweykowski, 1960). This area is located at relatively low elevation (1,100 m a.s.l.), and in an area that is under extensive tourist pressure. The nearest locality in the Slovakian side of the Tatra Mountains no longer exists (P. Górski, unpublished).

A large group of 21 species in the EN category consists of with six liverworts that are only present in the Tatra Mountains (*Arnellia fennica*, *Jungermannia borealis*, *Kurzia trichoclados*, *Marsupella apiculata*, *Marsupella sparsifolia*, *Nardia breidlerii*). Of those, only *Arnellia fennica*, *Nardia breidlerii* (Górski & Váňa, 2014) and *Marsupella apiculata* (P. Górski, unpublished) are still present in their historical localities. The threats to *A. fennica* is very high due to its location on lower mountain sites (1,040–1,360 m a.s.l.) near the large urban agglomeration of Zakopane. For lowland and lowland-montane species within the EN category, detailed searches of historical localities have not been carried out. Some of them have been recently found in new localities many years after their previous observations. Examples include *Reboulia hemisphaerica* (Klama in Szweykowski & Klama, 2010), *Haplomitrium hookeri* (Bączkiewicz & Szweykowski, 2001; Klama, 2004a), *Fuscocephaloziopsis loitlesbergeri* (Górski & Pawlikowski in Ellis *et al.*, 2014; Górski & Váňa, 2014), *Liochlaena subulata* (Górski & Romański, 2016), *Heterogemma laxa* (Górski *et al.* in Górski *et al.*, 2015) and *Riccardia chamedryfolia* (Rosadziński & Rusińska, 2010). *Crossocalyx hellerianus* has been found several times recently (see, for example, Stebel *et al.*, 2013; Pawlikowski & Górski in Górski *et al.*, 2014; Górski & Romański in Górski *et al.*, 2016c), but always in areas that have a high degree of naturalness that results from long-term, strict preservation. Similarly, several new localities have been reported recently for *Pallavicinia lyelii* (Rosadziński & Rusińska, 2010; Górski, 2013b; Klama, 2014; Rosadziński in Górski *et al.*, 2014; Stebel & Krawczyk, 2016).

The VU category comprises 39 liverworts. Besides species that are rare on a country scale (D2 criterion), this group includes plants with a diverse level of threats, depending on the region. Examples are epixylic liverworts (for example, *Anastrophyllum michauxii*, *Calypogeia suecica*, *Fuscocephaloziopsis catenulata*, *Lophoziopsis longidens* and *Lophozia ascendens*), which are rare in lowlands and which indicate the presence of a forest complex that is primeval in character (see Cieśliński *et al.*, 1996). In comparison, mountain areas in the south (Carpathians, the Sudety Mountains) have a relatively high number of localities. *Metzgeria conjugata*, *Frullania tamarisci* and *M. pubescens* are found frequently (for example, the Tatra Mountains); however, at the country scale, their localities decrease,

particularly in epiphytic habitats (Zubel & Stebel, 2008; Zubel *et al.*, 2011). There are two groups of species that fall within the D2 criterion. One subgroup comprises liverworts with a limited geographical range (one to two localities in Poland) that are growing in habitats that are not affected by human activity, but that are likely very rare and are therefore endangered (*Jungermannia borealis*, *J. exsertifolia* subsp. *cordifolia*, *Cephaloziella varians* and *C. massalongi*). The other subgroup comprises rare liverworts that are found in a few localities (up to twelve); they would likely be found in other localities if research were to intensify (for example, *Cephaloziella spinigera*, *Eremonotus myriocarpus*, *Fossombronia foveolata*, *Gymnomitrium adustum*, *Neoorthocaulis binsteadii*, *Orthocaulis atlanticus*, *Scapania crassiretis* and *Schljakovianthus quadrilobus*).

Habitat characteristics of threatened species

The most numerous group of threatened species occurs in different habitats of the subalpine and alpine belt of mountain areas. In the rock shelves of the Tatra Mountains, a liverwort (*Anastrophyllum donnianum*) was found that was previously considered to be regionally extinct. *Sphenobolus saxicola*, *Frullania jackii* and *Tritomaria scitula* (all categorised as CR), last found in Poland in the 1950s (Szweykowski, 1953, 1960), occupy alpine rock habitats. A group of 20 liverwort species within the VU category grow in mountain habitats. These are species that grow on wet rock walls (*Gymnomitrium adustum* and *G. alpinum*), in earth-based habitats (including snow beds; *Marsupella condensata* and *Cephaloziella varians*) and in rock crevasses that have complex chemical compositions (*Eremonotus myriocarpus* and *Cephaloziella massalongi*). Liverworts that are found in calciferous rock shelves or low, dense grassland communities (for example, *Scapania brevicaulis*, *S. praetervisa*, *Schljakovianthus quadrilobus*, *Asterella lindenbergiana*, *Clevea hyalina* or *Peltolepis quadrata*) are also numerous. Those habitats are also occupied by *Mesoptychia badensis*. In recent years, it has been noted that, on one hand, *M. badensis* can remain for a long time in the same locality (for example, more than 100 years in parts of northwestern Poland; Wilhelm *et al.*, 2015), whereas, on the other hand, it has been shown to grow also on anthropogenic habitats (see, for example, Stebel, 1999; Armata, 2011).

A large group of threatened liverworts is connected with peatbog communities. This includes the regionally extinct *Biantheridion undulifolium*. These habitats are especially endangered, in addition to mountain areas. In lowlands, *Odontoschisma francisci* (CR category) was last recorded in 1950 (Szweykowski & Koźlicka, 1969), *Scapania paludicola* (EN category) in 1949 (Hausbrandt, 1949), *Schljakovia kunzeana* (NT category) in 1966 (Szweykowski & Koźlicka, 1969) and *Mesoptychia rutheana* (CR category) in 1978 (Ochyra *et al.*, 1988). Peatbogs in the Sudety Mountains and the Carpathians are better maintained; in recent years, threatened peatbog liverworts — that is, *Fuscocephaloziopsis loitlesbergerii*, *Cephaloziella spinigera*, *Scapania paludosa*, *Neoorthocaulis binsteadii*, *Schljakovia kunzeana* and *Odontoschisma elongatum* — have been recorded in those areas in single localities (see, for example, Klama, 1996, 2004a; Cykowska, 2011; Górski & Váňa, 2014; Górski *in* Górski *et al.*, 2016a).

Other groups of threatened liverworts are epixylic (12) and epiphytic (8) species. Like those of peatbog ecosystems, these groups are especially threatened in lowlands. Lowland localities of *Frullania fragilifolia* (CR category) likely do not exist anymore (Górski, 2013a). The most rare epixylic liverworts (for example, *Anastrophyllum michauxii*, *Lophoziopsis longidens*, *Calypogeia suecica* and

Crossocalyx hellerianus) have their mainstay in “old forests” in northeastern Poland, especially in Białowiecki National Park (Klama, 2002a, b).

Liverworts growing in habitats of semi-natural character (xerothermic grasslands) are also noteworthy because their use has changed in recent years and require active preservation. *Mannia fragrans*, for example, has been observed to vanish from many localities. However, it has also been found in new localities (Piwowarczyk & Stebel, 2012; Stebel *et al.*, 2013). For *Riccia cilifera* or *R. crinita*, there is lack of new data from the last 40–50 years (Szweykowski, 2006).

Relatively low numbers of species typically grow in anthropogenic habitats. *Anthoceros neesii* (CR category) and *Fossombronia wondraczekii* (NT category) grow in moderately used forest ground roads, wet fields, stubble fields and fallow fields. Limited persistence of those localities, even in a few years perspective, is specific for such sites. *Anthoceros neesii* was last recorded in Poland in 1987 in three localities in the Dolny Śląsk region (Koła & Turzańska, 1993), and it has also been found more recently in the Czech Republic near the Polish border (Koval & Zmrhalová, 2010). *Fossombronia wondraczekii* is a more common species than originally thought based on the observations carried out in recent years, and it has been recorded mostly in Western Poland (Górski, 2010, 2013b; Smoczyk *in* Górski *et al.*, 2016b).

COMPARISON OF THE CURRENT AND PREVIOUS VERSIONS OF THE RED LIST

In the three previous editions of the Red List of Liverworts and Hornworts in Poland (Szweykowski, 1986, 1992; Klama, 2006), species were categorised according to the IUCN criteria from 1978. The Red Lists from 1986 and 1992 are identical — that is, they contain the same species with the same threat categories. They include 50 species: three hornworts and 47 liverworts. However, three species from the list proposed by Szweykowski (1986, 1992) — that is, *Notothylas orbicularis* and *Scapania verrucosa*, which do not occur in Poland (see Szweykowski, 2006), and *Porella platyphylloidea*, which is conspecific with *Porella platyphylla* (Therrien *et al.*, 1998), had to be excluded. Keeping this in mind, the lists from 1986 and 1992 actually contained 47 species (two hornworts and 45 liverworts): 25 in category E (endangered taxa), five in category V (vulnerable taxa), 13 in category R (rare taxa) and four in category I (indeterminate taxa).

The third edition of the Red List, published in 2006, had significant changes compared to previous editions (Klama, 2006). It retained 46 species from the Szweykowski's lists (1986, 1992). The threat categories was changed for seven species: *Frullania fragilifolia* and *Biantheridium undulifolium* were categorised as extinct (Ex) in Poland, *Haplomitrium hookeri* was categorised as vulnerable (V) and the remaining four (*Arnellia fennica*, *Mesoptychia rutheana*, *Neorthocaulis binsteadii*, and *Riccia beyrichiana*) were moved to the R category. This list did not include the hornwort *Phaeoceros carolinianus* because it appeared that this species is common in Poland and, thus, is not threatened. The third edition of the Red List also included 46 new species (50%). The group of taxa with small populations that are not currently considered to be endangered or vulnerable but are at risk (rare taxa – R category) were expanded (for example, *Clevea hyalina*, *Eremonotus myriocarpus*, *Frullania jackii*, *Gymnomitrium obtusum*, *Liochlaena subulata*, *Marsupella apiculata*,

Peltolepis quadrata, *Scapania gymnostomophila* and *Tritomaria scitula*). The group of vulnerable species was also expanded, particularly for epixylic liverworts (for example, *Anastrophyllum michauxii*, *Calypogeia suecica*, *Crossocalyx hellerianus*, *Fuscocephaloziopsis catenulata*, *F. leucantha*, *Harpanthus scutatus* and *Nowellia curvifolia*). Moreover, the number of species in the indeterminate category (I category) increased. In summary, the third edition of the Red List (Klama, 2006) is comprised of 92 species (two hornworts and 90 liverworts): two categorised as Ex, 21 as E, 16 as V, 38 as R and 15 as I.

The presented fourth edition of the Red List differs from the previous editions primarily in terms of the different categories and criteria applied during the determination of the threat level of species (IUCN, 2012). A comparison of the present list with the third edition from 2006 is presented in Tables 1 and 3. *Neoorthocaulis hyperboreus* (= *Barbilophozia hyperborea*) from the 2006 list was excluded from the liverwort flora of Poland (Górski & Váňa, 2014). *Frullania fragilifolia*, categorised as Ex in 2006, is currently considered critically endangered. In 2006, 50 years after its last record, this species was found at the foot of the Western Tatra Mountains (Górski, 2013a). On the other hand, the status of *Biantheridium udulifolium* did not change since the previous edition and is still considered regionally extinct. Sixty-one species included in the 2006 list are currently considered threatened and have been categorised as CR, EN or VU (Table 1). The remaining 28 taxa are moved to the NT (8 species), LC (4 species), DD (15 species) or NA (1 species) categories. Of 38 species that were in the R category in the 2006 list, one is currently considered regionally extinct (*Anastrophyllum donnianum*), whereas 31 species were categorised as threatened (CR, EN or VU categories). In the case of species within the I category (that is, taxa known to be extinct, endangered, vulnerable or rare but for which there is not enough information to say which of the four categories is appropriate), five are currently considered threatened, whereas the remaining 10 were assigned to the DD (9) or NA (1) categories. Some species previously categorised in the E or V categories had their threat level lowered and moved to the NT or LC categories (Tables 1 and 3). Those changes were (i) from E to NT — *Fossombronia wondraczekii* and *Porella platyphylla*; (ii) from E to LC — *Anthoceros agrestis*; (iii) from V to NT —

Table 1. Comparison of the number of redlist-evaluated liverworts and hornworts between the current version and the Red List of 2006. Abbreviations of categories: see text.

Current version of Red List		Red List of 2006 (number of species)				
categories	number of species	Ex	E	V	R	I
RE	2	1			1	
CR	12	1	4		7	
EN	21		6	3	7	3
VU	39		4	7	17	2
NT	12		2	5	1	
LC	136		1	1	2	
DD	21		3		3	9
NA	1					1
Total	244	2	20	16	38	15

Fuscocephaloziopsis leucantha, *Geocalyx graveolens*, *Nowellia curvifolia*, *Odontoschisma fluitans* and *Schljakovia kunzeana*; and (iv) from V to LC — *Marsupella emarginata*.

CONSERVATION OF ENDANGERED LIVERWORTS AND HORNWORTS IN POLAND

The most important forms of conservation for plant species in Poland include legal plants protection and reservation of plant populations in nature reserves and national parks. According to the Act on Nature Conservation (the Journal of Laws; Dziennik Ustaw, 2016; item 2134), the aim of species conservation is to ensure survival and provide adequate protection for rare, endemic, conservation-reliant and threatened species of plants, animals and fungi found in the wild in Poland or other EU countries; to protect species, including their habitats and refuges, based on international agreements signed by Poland; and to preserve species and genetic diversity. On the basis of that act, the Minister for the Environment issues regulations to protect plant species. Pursuant to the currently binding regulation of 6 October 2014 (the Journal of Laws; Dziennik Ustaw, 2014; item 1348) strict protection covers 37 species of liverworts, and 16 liverwort species are covered by partial protection. According to that act, strict species protection is the all-year protection regime that covers all representatives and developmental phases of the species. In contrast, the partial protection of species admits the possibility that there has been a reduction in the population size and collection of representatives of a species or its parts.

Among 72 liverworts and hornworts that are threatened in Poland, 29 (40%) are the subject of strict or partial legal conservation (Table 2). In the group of 53 liverworts legally protected in Poland, the threatened species make up to 55%.

An analysis of the distribution of liverworts and hornworts in Poland indicates that the populations of 64 threatened species (89%) occurs in the area of 17 of 23 national parks in the country. Only eight threatened species grows outside of national parks: *Anthoceros neesii*, *Asterella saccata*, *Mesoptychia rutheana*, *Metzgeria simplex*, *Odontoschisma sphagni*, *Oxymitra incrassata*, *Pallavicinia lyellii* and *Riccia ciliifera*. It is worth noting that 24 threatened species (34%) occur only in the Tatra National Park.

Table 2. Conservation of threatened liverworts and hornworts in Poland.

Categories	Number of species				
	total	legally protected		occurring in national parks	legally protected and occurring in national parks
		strictly	partially		
CR	12	6	-	8	10
EN	21	12	-	18	21
VU	39	8	3	38	39
Total	72	26	3	64	70

Table 3. Summary of the Red List of Polish liverworts and hornworts.

Current version of Red List		
species	criteria	Red List of 2006 (categories)
Category RE		
<i>Anastrophyllum donnianum</i>		R
<i>Biantheridium undulifolium</i>		Ex
Category CR		
<i>Anthoceros neesii</i>	B2ab(iii, iv), c(iii)	R
<i>Frullania fragilifolia</i>	B1ab(iii), B2ab(iii)	Ex
<i>Frullania jackii</i>	B2ab(iii)	R
<i>Mesoptychia rutheana</i>	B1ab(iii, iv), B2ab(iii, iv)	E
<i>Metzgeria simplex</i>	B1ab(iii), B2ab(iii)	R
<i>Metzgeria violacea</i>	B1ab(iii, iv), B2ab(iii, iv)	E
<i>Odontoschisma francisci</i>	B1ab(iii, iv), B2ab(iii, iv)	E
<i>Oxymitra incrassata</i>	B1ab(i, ii, iii), B2ab(i, ii, iii)	E
<i>Scapania apiculata</i>	B1ab(iii, iv), B2ab(iii, iv)	E
<i>Scapania carinthiaca</i>	B2ab(iii)	R
<i>Sphenolobus saxicola</i>	B2ab(iii, iv)	R
<i>Tritomaria scitula</i>	B2ab(iii)	R
Category EN		
<i>Arnellia fennica</i>	B2ab(iii)	R
<i>Asterella saccata</i>	B2ab(iii, iv)	E
<i>Crossocalyx hellerianus</i>	B2ab(iii, iv)	V
<i>Fuscocephalozioipsis loitlesbergeri</i>	B2ab(iii, iv)	R
<i>Haplomitrium hookeri</i>	B1ab(i, ii, iii), B2ab(i,ii,iii)	V
<i>Harpanthus scutatus</i>	B2ab(ii, iii)	V
<i>Heterogemma laxa</i>	B2ab(ii, iii)	I
<i>Jungermannia borealis</i>	B2ab(iii)	
<i>Kurzia sylvatica</i>	B1ab(iii), B2ab(iii)	E
<i>Kurzia trichoclados</i>	B2ab(iii)	R
<i>Liochlaena subulata</i>	B2ab(iii)	R
<i>Mannia fragrans</i>	B1b(iii, iv)c(iii), B2b(iii, iv)c(iii)	E
<i>Marsupella apiculata</i>	B2ab(iii)	R
<i>Marsupella sparsifolia</i>	B1ab(iii)	R
<i>Nardia breidlerii</i>	B2ab(iii)	
<i>Pallavicinia lyellii</i>	B1ab(iii), B2ab(iii)	E
<i>Reboulia hemisphaerica</i>	B1ab(iii)	R
<i>Riccardia chamedryfolia</i>	B1ab(iii), B2ab(iii)	E
<i>Riccia ciliifera</i>	B1ab(iii), B2ab(iii)	E

<i>Scapania paludicola</i>	B2ab(iii, iv)	I
<i>Scapania paludosa</i>	B1ab(iii), B2ab(iii)	I
Category VU		
<i>Anastrophyllum michauxii</i>	B2ab(iii)	V
<i>Asterella lindenbergiana</i>	D2	
<i>Bazzania flaccida</i>	B2ab(iii)	
<i>Calypogeia suecica</i>	B2ab(iii)	V
<i>Cephaloziella massalongi</i>	D2	
<i>Cephaloziella spinigera</i>	D2	I
<i>Cephaloziella varians</i>	D2	
<i>Clevea hyalina</i>	D2	R
<i>Cololejeunea rossettiana</i>	D2	R
<i>Eremonotus myriocarpus</i>	D2	R
<i>Fossombronina foveolata</i>	B2ab(iii)	E
<i>Frullania tamarisci</i>	B1ab(ii, iii, iv), B2ab(ii, iii, iv)	E
<i>Fuscocephaloziopsis catenulata</i>	B2ab(ii,iii)	V
<i>Gymnomitrium adustum</i>	D2	I
<i>Gymnomitrium alpinum</i>	D2	
<i>Gymnomitrium obtusum</i>	D2	R
<i>Heterogemma capitata</i>	B2ab(iii)	E
<i>Jungermannia exsertifolia</i> subsp. <i>cordifolia</i>	D2	
<i>Lophozia ascendens</i>	B2ab(iii)	
<i>Lophozia savicziae</i>	D2	
<i>Lophozia longidens</i>	B2ab(iii)	
<i>Mannia pilosa</i>	D2	R
<i>Marsupella boeckii</i>	D2	R
<i>Marsupella condensata</i>	D2	R
<i>Mesoptychia badensis</i>	B2ab(iii)	R
<i>Metzgeria conjugata</i>	B2b(iii)c(ii, iii)	V
<i>Metzgeria pubescens</i>	B2b(iii)c(ii, iii)	V
<i>Neoorthocaulis binsteadii</i>	D2	R
<i>Odontoschisma elongatum</i>	D2	R
<i>Odontoschisma sphagni</i>	B2ab(iii)	V
<i>Orthocaulis atlanticus</i>	D2	R
<i>Peltolepis quadrata</i>	D2	R
<i>Porella arboris-vitae</i>	B1ab(iii), B2ab(iii)	E
<i>Riccardia incurvata</i>	B1ab(iii), B2ab(iii)	V
<i>Scapania aspera</i>	D2	R
<i>Scapania brevicaulis</i>	D2	R
<i>Scapania crassiretis</i>	D2	R

Table 3. Summary of the Red List of Polish liverworts and hornworts. (continued)

Current version of Red List		
species	criteria	Red List of 2006 (categories)
<i>Scapania praetervisa</i>	D2	R
<i>Schljakovianthus quadrilobus</i>	D2	R
Category NT		
<i>Endogemma caespiticia</i>	B2ab(iii)	
<i>Fossombronia wondraczekii</i>	B2ab(iii, iv)	E
<i>Fuscocephaloziopsis leucantha</i>	B2ab(iii, iv)	V
<i>Fuscocephaloziopsis macrostachya</i>	B2b(ii, iii, iv)	
<i>Geocalyx graveolens</i>	B2b(ii, iii, iv)	V
<i>Nowellia curvifolia</i>	B2ab(iii, iv)	V
<i>Odontoschisma denudatum</i>	B2ab(ii, iii, iv)	
<i>Odontoschisma fluitans</i>	B2ab(iii, iv)	V
<i>Porella platyphylla</i>	B2ab(ii, iii, iv)	E
<i>Scapania calcicola</i>	B2ab(iii, iv)	
<i>Scapania gymnostomophila</i>	D2	R
<i>Schljakovia kunzeana</i>	B2ab(ii, iii, iv)	V
Category LC		
<i>Anastrepta orcadensis</i>		
<i>Aneura maxima</i>		
<i>Aneura pinguis</i>		
<i>Anthelia julacea</i>		R
<i>Anthelia juratzkana</i>		
<i>Anthoceros agrestis</i>		E
<i>Barbilophozia barbata</i>		
<i>Barbilophozia hatcheri</i>		
<i>Barbilophozia lycopodioides</i>		
<i>Barbilophozia sudetica</i>		
<i>Bazzania tricrenata</i>		
<i>Bazzania trilobata</i>		
<i>Blasia pusilla</i>		
<i>Blepharostoma trichophyllum</i>		
<i>Bucegia romanica</i>		
<i>Calypogeia azurea</i>		
<i>Calypogeia fissa</i>		I
<i>Calypogeia integristipula</i>		
<i>Calypogeia muelleriana</i>		
<i>Calypogeia neesiana</i>		

Calypogeia sphagnicola
Cephalozia ambigua
Cephalozia bicuspidata
Cephaloziella divaricata
Cephaloziella elachista
Cephaloziella hampeana
Cephaloziella rubella
Chiloscyphus pallescens
Chiloscyphus polyanthos
Cololejeunea calcarea
Conocephalum conicum
Conocephalum salebrosum
Diplophyllum albicans
Diplophyllum obtusifolium
Diplophyllum taxifolium
Frullania dilatata
Fuscocephaloziopsis albescens
Fuscocephaloziopsis connivens
Fuscocephaloziopsis lunulifolia
Fuscocephaloziopsis pleniceps
Gymnocolea inflata
Gymnomitrium brevissimum
Gymnomitrium commutatum
Gymnomitrium concinnatum
Gymnomitrium corallioides
Harpanthus flotovianus
Isopaches bicrenatus
Jungermannia atrovirens
Jungermannia polaris
Jungermannia pumila
Kurzia pauciflora
Lejeunea cavifolia
Lepidozia reptans
Liochlaena lanceolata
Lophocolea bidentata
Lophocolea heterophylla
Lophocolea minor
Lophozia guttulata
Lophozia silvicola
Lophozia ventricosa

Table 3. Summary of the Red List of Polish liverworts and hornworts.(continued)

Current version of Red List		
species	criteria	Red List of 2006 (categories)
<i>Lophozia wenzelii</i>		
<i>Lophozia excisa</i>		
<i>Lunularia cruciata</i>		
<i>Marchantia polymorpha</i>		
<i>Marsupella aquatica</i>		
<i>Marsupella emarginata</i>		V
<i>Marsupella funkii</i>		
<i>Marsupella sphacelata</i>		
<i>Marsupella sprucei</i>		
<i>Mesoptychia bantriensis</i>		
<i>Mesoptychia collaris</i>		
<i>Mesoptychia heterocolpos</i>		
<i>Metzgeria furcata</i>		
<i>Moerckia blyttii</i>		
<i>Mylia anomala</i>		
<i>Mylia taylorii</i>		
<i>Nardia geoscyphus</i>		
<i>Nardia scalaris</i>		
<i>Neoorthocaulis attenuatus</i>		
<i>Neoorthocaulis floerkei</i>		
<i>Obtusifolium obtusum</i>		
<i>Pedinophyllum interruptum</i>		
<i>Pellia endiviifolia</i>		
<i>Pellia epiphylla</i>		
<i>Pellia neesiana</i>		
<i>Phaeoceros carolinianus</i>		
<i>Plagiochila asplenioides</i>		
<i>Plagiochila porelloides</i>		
<i>Porella cordaeana</i>		
<i>Preissia quadrata</i>		
<i>Ptilidium ciliare</i>		
<i>Ptilidium pulcherrimum</i>		
<i>Radula complanata</i>		
<i>Radula lindenbergiana</i>		
<i>Riccardia latifrons</i>		
<i>Riccardia multifida</i>		

Riccardia palmata
Riccia bifurca
Riccia canaliculata
Riccia cavernosa
Riccia ciliata
Riccia fluitans
Riccia glauca
Riccia rhenana
Riccia sorocarpa
Riccia warnstorffii
Ricciocarpos natans
Saccobasis polita
Sauteria alpina
Scapania aequiloba
Scapania curta
Scapania cuspiduligera
Scapania helvetica
Scapania irrigua
Scapania mucronata
Scapania nemorea
Scapania parvifolia
Scapania scandica
Scapania subalpina
Scapania uliginosa
Scapania umbrosa
Scapania undulata
Schistochilopsis incisa
Schistochilopsis opacifolia
Solenostoma confertissimum
Solenostoma gracillimum
Solenostoma hyalinum
Solenostoma obovatum
Solenostoma sphaerocarpum
Sphenolobus minutus
Syzygiella autumnalis
Tetralophozia setiformis
Trichocolea tomentella
Trilophozia quinquedentata
Tritomaria exsecta
Tritomaria exsectiformis

Table 3. Summary of the Red List of Polish liverworts and hornworts.(continued)

Current version of Red List		
species	criteria	Red List of 2006 (categories)
Category DD		
<i>Anastrophyllum assimile</i>		I
<i>Cephalozia lacunculata</i>		I
<i>Cephaloziella elegans</i>		
<i>Cephaloziella integerrima</i>		I
<i>Cephaloziella stellulifera</i>		I
<i>Fossombronia incurva</i>		E
<i>Fossombronia pusilla</i>		I
<i>Mannia gracilis</i>		I
<i>Mannia triandra</i>		I
<i>Moerckia flotoviana</i>		
<i>Moerckia hibernica</i>		E
<i>Phaeoceros laevis</i>		
<i>Porella baueri</i>		E
<i>Riccia beyrichiana</i>		R
<i>Riccia crinita</i>		R
<i>Riccia crystallina</i>		
<i>Riccia duplex</i>		
<i>Riccia huebeneriana</i>		I
<i>Scapania compacta</i>		
<i>Scapania lingulata</i>		R
<i>Scapania scapanioides</i>		I
Category NA		
<i>Sphaerocarpos michelii</i>		

Keeping in mind legal species conservation and preservation of liverwort populations in national parks, it can be assumed that 70 threatened species (97%) are subjected to one of two forms of conservation (Table 2). Only two threatened species (the hornwort *Anthoceros neesii* and the liverwort *Metzgeria simplex*) are not subjected to any form of conservation. *Anthoceros neesii* is present in Poland in a few localities in Lower Silesia (southwestern Poland) and Wałeczek Lakeland (northwestern Poland). This hornwort grows in arable fields and stubble fields, which hampers its conservation (Koła & Turzańska, 1993). *Metzgeria simplex* is known only from a single locality in the Kaczawskie Mountains (southwestern Poland) where it grows in forests on wet calciferous rocks (Szweykowski, 1958). That locality is highly endangered due to the close presence of two quarries.

RED LIST

Liverworts

- Anastrepta orcadensis* (Hook.) Schiffn. – LC
Anastrophyllum assimile (Mitt.) Steph. – DD
Anastrophyllum donnianum (Hook.) Steph. – RE
Anastrophyllum hellerianum (Nees ex Lindenb.) R.M.Schust. ⇒ see under *Crossocalyx hellerianus*
Anastrophyllum michauxii (F. Weber) H.Buch – VU [B2ab(iii)]
Anastrophyllum minutum (Schreb.) R.M.Schust. ⇒ see under *Sphenolobus minutus*
Anastrophyllum saxicola (Schrad.) R.M.Schust. ⇒ see under *Sphenolobus saxicola*
Aneura maxima (Schiffn.) Steph. – LC
Aneura pinguis (L.) Dumort. – LC
Anthelia julacea (L.) Dumort. – LC
Anthelia juratzkana (Limpr.) Trevis. – LC
Apometzgeria pubescens (Schränk) Kuwah. ⇒ see under *Metzgeria pubescens*
Arnellia fennica (Gottsche & Rabenh.) Lindb. – EN [B2ab(iii)]
Asterella gracilis (F. Weber) Underw. ⇒ see under *Mannia gracilis*
Asterella lindenberghiana (Corda ex Nees) Lindb. ex Arnell – VU [D2]
Asterella saccata (Wahlenb.) A.Evans – EN [B2ab(iii, iv)]
Athalamia hyalina (Sommerf.) S.Hatt. ⇒ see under *Clevea hyalina*
Barbilophozia atlantica (Kaal.) Müll.Frib. ⇒ see under *Orthocaulis atlanticus*
Barbilophozia attenuata (Mart.) Loeske ⇒ see under *Neoorthocaulis attenuatus*
Barbilophozia barbata (Schmidel ex Schreb.) Loeske – LC
Barbilophozia binsteadii (Kaal.) Loeske ⇒ see under *Neoorthocaulis binsteadii*
Barbilophozia floerkei (F. Weber & D.Mohr) Loeske ⇒ see under *Neoorthocaulis floerkei*
Barbilophozia hatcheri (A.Evans) Loeske – LC
Barbilophozia kunzeana (Huebener) Müll.Frib. ⇒ see under *Schljakovia kunzeana*
Barbilophozia lycopodioides (Wallr.) Loeske – LC
Barbilophozia quadriloba (Lindb.) Loeske ⇒ see under *Schljakovianthus quadrilobus*
Barbilophozia sudetica (Nees ex Huebener) L.Söderstr., De Roo & Hedd. (= *Lophozia sudetica*) – LC
Bazzania flaccida (Dumort.) Grolle – VU [B2ab(iii)]
Bazzania tricrenata (Wahlenb.) Lindb. – LC
Bazzania trilobata (L.) Gray – LC
Biantheridion undulifolium (Nees) Konstant. & Vilnet (= *Jamesoniella undulifolia*) – RE
Blasia pusilla L. – LC
Blepharostoma trichophyllum (L.) Dumort. – LC
Bucegia romanica Radian – LC
Calypogeia azurea Stotler & Crotz – LC
Calypogeia fissa (L.) Raddi – LC
Calypogeia integristipula Steph. – LC
Calypogeia muelleriana (Schiffn.) Müll.Frib. – LC
Calypogeia neesiana (C.Massal. & Carestia) Müll.Frib. – LC
Calypogeia sphagnicola (Arnell & J.Perss.) Warnst. & Loeske – LC
Calypogeia suecica (Arnell & J.Perss.) Müll.Frib. – VU [B2ab(iii)]
Cephalozia ambigua C.Massal. – LC

- Cephalozia bicuspidata*** (L.) Dumort. – LC
Cephalozia catenulata (Huebener) Lindb. ⇒ see under *Fuscocephaloziopsis catenulata*
Cephalozia connivens (Dicks.) Lindb. ⇒ see under *Fuscocephaloziopsis connivens*
Cephalozia lacinulata (J.B.Jack ex Gottsche & Rabenh.) Spruce – DD
Cephalozia leucantha Spruce ⇒ see under *Fuscocephaloziopsis leucantha*
Cephalozia loitlesbergeri Schiffn. ⇒ see under *Fuscocephaloziopsis loitlesbergeri*
Cephalozia lunulifolia (Dumort.) Dumort. ⇒ see under *Fuscocephaloziopsis lunulifolia*
Cephalozia macrostachya Kaal. ⇒ see under *Fuscocephaloziopsis macrostachya*
Cephalozia pleniceps (Austin) Lindb. ⇒ see under *Fuscocephaloziopsis pleniceps*
Cephaloziella divaricata (Sm.) Schiffn. – LC
Cephaloziella elachista (J.B.Jack ex Gottsche & Rabenh.) Schiffn. – LC
Cephaloziella elegans (Heeg) Schiffn. – DD
Cephaloziella hampeana (Nees) Schiffn. ex Loeske – LC
Cephaloziella integerrima (Lindb.) Warnst. – DD
Cephaloziella massalongi (Spruce) Müll.Frib. – VU [D2]
Cephaloziella rubella (Nees) Warnst. – LC
Cephaloziella spinigera (Lindb.) Jörg. – VU [D2]
Cephaloziella stellulifera (Taylor ex Carrington & Pearson) Schiffn. – DD
Cephaloziella varians (Gottsche) Steph. – VU [D2]
Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort. – LC
Chiloscyphus polyanthos (L.) Corda – LC
Cladopodiella fluitans (Nees) H.Buch ⇒ see under *Odontoschisma fluitans*
Cladopodiella francisci (Hook) Jörg. ⇒ see under *Odontoschisma francisci*
Clevea hyalina (Sommerf.) Lindb. (= *Athalamia hyalina*) – VU [D2]
Cololejeunea calcarea (Lib.) Schiffn. – LC
Cololejeunea rossettiana (C.Massal.) Schiffn. – VU [D2]
Conocephalum conicum (L.) Dumort. – LC
Conocephalum salebrosum Szweyk., Buczk. & Odrzyk. – LC
Crossocalyx hellerianus (Nees ex Lindenb.) Meyl. (= *Anastrophyllum hellerianum*) – EN [B2ab(iii, iv)]
Diplophyllum albicans (L.) Dumort. – LC
Diplophyllum obtusifolium (Hook.) Dumort. – LC
Diplophyllum taxifolium (Wahlenb.) Dumort. – LC
Endogemma caespiticia (Lindenb.) Konstant., A.Vilnet & A.V.Troitsky (= *Jungermannia caespiticia*) – NT [B2ab(iii)]
Eremonotus myriocarpus (Carrington) Lindb. & Kaal. ex Pearson – VU [D2]
Fossombronina foveolata Lindb. – VU [B2ab(iii)]
Fossombronina incurva Lindb. – DD
Fossombronina pusilla (L.) Nees – DD
Fossombronina wondraczekii (Corda) Dumort. ex Lindb. – NT [B2ab(iii, iv)]
Frullania dilatata (L.) Dumort. – LC
Frullania fragilifolia (Taylor) Taylor ex Gottsche, Lindenb. & Nees – CR [B1ab(iii), B2ab(iii)]
Frullania jackii Gottsche – CR [B2ab(iii)]
Frullania tamarisci (L.) Dumort. – VU [B1ab(ii, iii, iv), B2ab(ii, iii, iv)]
Fuscocephaloziopsis albescens (Hook.) Váňa & L.Söderstr. (= *Pleurocladula albescens*) – LC
Fuscocephaloziopsis catenulata (Huebener) Váňa & L.Söderstr. (= *Cephalozia catenulata*) – VU [B2ab(ii,iii)]

- Fuscocephaloziopsis connivens* (Dicks.) Lindb. (= *Cephalozia connivens*) – LC
Fuscocephaloziopsis leucantha (Spruce) Váňa & L.Söderstr. (= *Cephalozia leucantha*) – NT [B2ab(iii, iv)]
Fuscocephaloziopsis loitlesbergeri (Schiffn.) Váňa & L.Söderstr. (= *Cephalozia loitlesbergeri*) – EN [B2ab(iii, iv)]
Fuscocephaloziopsis lunulifolia (Dumort.) Váňa & L.Söderstr. (= *Cephalozia lunulifolia*) – LC
Fuscocephaloziopsis macrostachya (Kaal.) Váňa & L.Söderstr. (= *Cephalozia macrostachya*) – NT [B2b(ii, iii, iv)]
Fuscocephaloziopsis pleniceps (Austin) Váňa & L.Söderstr. (= *Cephalozia pleniceps*) – LC
Geocalyx graveolens (Schrad.) Nees – NT [B2b(ii, iii, iv)]
Gymnocolea inflata (Huds.) Dumort. – LC
Gymnomitrium adustum Nees (= *Marsupella adusta*) – VU [D2]
Gymnomitrium alpinum (Gottsche ex Husn.) Schiffn. (= *Marsupella alpina*) – VU [D2]
Gymnomitrium brevissimum (Dumort.) Warnst. (= *Marsupella brevissima*) – LC
Gymnomitrium commutatum (Limpr.) Schiffn. (= *Marsupella commutata*) – LC
Gymnomitrium concinatum (Lightf.) Corda – LC
Gymnomitrium corallioides Nees – LC
Gymnomitrium obtusum Lindb. – VU [D2]
Haplomitrium hookeri (Lydell ex Sm.) Nees – EN [B1ab(i, ii, iii), B2ab(i,ii,iii)]
Harpanthus flotovianus (Nees) Nees – LC
Harpanthus scutatus (F.Weber & D.Mohr) Spruce – EN [B2ab(ii, iii)]
Heterogemma capitata (Hook.) Konstant. & Vilnet (= *Lophozia capitata*) – VU [B2ab(iii)]
Heterogemma laxa (Lindb.) Konstant. & Vilnet (= *Lophozia laxa*) – EN [B2ab(ii, iii)]
Isopaches bicrenatus (Schmidel ex Hoffm.) H.Buch (= *Lophozia bicrenata*) – LC
Jamesoniella autumnalis (DC.) Steph. ⇒ see under *Syzygiella autumnalis*
Jamesoniella undulifolia (Nees) Müll.Frib. ⇒ see under *Biantheridion undulifolium*
Jungermannia atrovirens Dumort. – LC
Jungermannia borealis Damsh. & Váňa – EN [B2ab(iii)]
Jungermannia caespiticia Lindenb. ⇒ see under *Endogemma caespiticia*
Jungermannia confertissima Nees ⇒ see under *Solenostoma confertissimum*
Jungermannia exsertifolia Steph. subsp. *cordifolia* (Dumort.) Váňa – VU [D2]
Jungermannia gracillima Sm. ⇒ see under *Solenostoma gracillimum*
Jungermannia hyalina Lyell ⇒ see under *Solenostoma hyalinum*
Jungermannia leiantha Grolle ⇒ see under *Liochlaena lanceolata*
Jungermannia obovata Nees ⇒ see under *Solenostoma obovatum*
Jungermannia polaris Lindb. – LC
Jungermannia pumila With. – LC
Jungermannia sphaerocarpa Hook. ⇒ see under *Solenostoma sphaerocarpum*
Jungermannia subulata A.Evans ⇒ see under *Liochlaena subulata*
Kurzia pauciflora (Dicks.) Grolle – LC
Kurzia sylvatica (A.Evans) Grolle – EN [B1ab(iii), B2ab(iii)]
Kurzia trichoclados (Müll.Frib.) Grolle – EN [B2ab(iii)]
Lejeunea cavifolia (Ehrh.) Lindb. – LC
Lepidozia reptans (L.) Dumort. – LC
Liochlaena lanceolata Nees (= *Jungermannia leiantha*) – LC

- Liochlaena subulata*** (A.Evans) Schljakov (= *Jungermannia subulata*) – EN [B2ab(iii)]
- Lophocolea bidentata*** (L.) Dumort. – LC
- Lophocolea heterophylla*** (Schrad.) Dumort. – LC
- Lophocolea minor*** Nees – LC
- Lophozia ascendens*** (Warnst.) R.M.Schust. – VU [B2ab(iii)]
- Lophozia badensis* (Gottsche) Schiffn. ⇒ see under *Mesoptychia badensis*
- Lophozia bantriensis* (Hook.) Steph. ⇒ see under *Mesoptychia bantriensis*
- Lophozia bicrenata* (Schmidel ex Hoffm.) Dumort. ⇒ see under *Isopaches bicrenatus*
- Lophozia capitata* (Hook.) Macoun ⇒ see under *Heterogemma capitata*
- Lophozia collaris* (Nees) Dumort. ⇒ see under *Mesoptychia collaris*
- Lophozia excisa* (Dicks.) Dumort. ⇒ see under *Lophozia excisa*
- Lophozia guttulata*** (Lindb. & Arnell) A.Evans (= *L. longiflora*) – LC
- Lophozia heterocolpos* (Thed. ex C.Hartm.) M.Howe ⇒ see under *Mesoptychia heterocolpos*
- Lophozia incisa* (Schrad.) Dumort. ⇒ see under *Schistochilopsis incisa*
- Lophozia laxa* (Lindb.) Grolle ⇒ see under *Heterogemma laxa*
- Lophozia longidens* (Lindb.) Macoun ⇒ see under *Lophozia longidens*
- Lophozia longiflora* auct. ⇒ see under *Lophozia guttulata*
- Lophozia obtusa* (Lindb.) A.Evans ⇒ see under *Obtusifolium obtusum*
- Lophozia opacifolia* Culm. ex Meyl. ⇒ see under *Schistochilopsis opacifolia*
- Lophozia rutheana* (Limpr.) M.Howe ⇒ see under *Mesoptychia rutheana*
- Lophozia savicziae*** Schljakov – VU [D2]
- Lophozia silvicola*** H.Buch – LC
- Lophozia sudetica* (Nees ex Huebener) Grolle ⇒ see under *Barbilophozia sudetica*
- Lophozia ventricosa*** (Dicks.) Dumort. – LC
- Lophozia wenzelii*** (Nees) Steph. – LC
- Lophozia excisa*** (Dicks.) Konstant. & Vilnet (= *Lophozia excisa*) – LC
- Lophozia longidens*** (Lindb.) Konstant. & Vilnet (= *Lophozia longidens*) – VU [B2ab(iii)]
- Lunularia cruciata*** (L.) Dumort. ex Lindb. – LC
- Mannia fragrans*** (Balb.) Frye & L.Clark – EN [B1b(iii), iv)c(iii), B2b(iii), iv)c(iii)]
- Mannia gracilis*** (F.Weber) D.B.Schill & D.G.Long (= *Asterella gracilis*) – DD
- Mannia pilosa*** (Hornem.) Frye et L.Clark – VU [D2]
- Mannia triandra*** (Scop.) Grolle – DD
- Marchantia polymorpha*** L. – LC
- Marsupella adusta* (Nees) Spruce ⇒ see under *Gymnomitrium adustum*
- Marsupella alpina* (Gottsche ex Husn.) Bernet ⇒ see under *Gymnomitrium alpinum*
- Marsupella apiculata*** Schiffn. – EN [B2ab(iii)]
- Marsupella aquatica*** (Lindenb.) Schiffn. – LC
- Marsupella boeckii*** (Austin) Lindb. ex Kaal. – VU [D2]
- Marsupella brevissima* (Dumort.) Grolle ⇒ see under *Gymnomitrium brevissimum*
- Marsupella commutata* (Limpr.) Bernet ⇒ see under *Gymnomitrium commutatum*
- Marsupella condensata*** (Ångstr. ex C.Hartm.) Lindb. ex Kaal. – VU [D2]
- Marsupella emarginata*** (Ehrh.) Dumort. – LC
- Marsupella funckii*** (F.Weber & D.Mohr) Dumort. – LC
- Marsupella sparsifolia*** (Lindb.) Dumort. – EN [B1ab(iii)]
- Marsupella sphacelata*** (Giesecke ex Lindenb.) Dumort. – LC
- Marsupella sprucei*** (Limpr.) Bernet – LC
- Mesoptychia badensis*** (Gottsche ex Rabenh.) L.Söderstr. & Váňa (= *Lophozia badensis*) – VU [B2ab(iii)]

- Mesoptychia bantriensis* (Hook.) L.Söderstr. & Váňa (= *Lophozia bantriensis*) – **LC**
Mesoptychia collaris (Nees) L.Söderstr. & Váňa (= *Lophozia collaris*) – **LC**
Mesoptychia heterocolpos (Thed. ex Hartm.) L.Söderstr. & Váňa (= *Lophozia heterocolpos*) – **LC**
Mesoptychia rutheana (Limpr.) L.Söderstr. & Váňa (= *Lophozia rutheana*) – **CR**
 [B1ab(iii, iv), B2ab(iii, iv)]
Metzgeria conjugata Lindb. – **VU** [B2b(iii)c(ii, iii)]
Metzgeria furcata (L.) Corda – **LC**
Metzgeria pubescens (Schrank) Raddi (= *Apometzgeria pubescens*) – **VU** [B2b(iii)c(ii, iii)]
Metzgeria simplex Lorb. ex Müll.Frib. – **CR** [B1ab(iii), B2ab(iii)]
Metzgeria violacea (Ach. ex F.Weber & D.Mohr) Dumort. – **CR** [B1ab(iii, iv), B2ab(iii, iv)]
Moerckia blyttii (Mörch ex Hornem.) Brockm. – **LC**
Moerckia flotoviana (Nees) Schiffn. – **DD**
Moerckia hibernica (Hook.) Gottsche – **DD**
Mylia anomala (Hook.) Gray – **LC**
Mylia taylorii (Hook.) Gray – **LC**
Nardia breidleri (Limpr.) Lindb. – **EN** [B2ab(iii)]
Nardia geoscyphus (De Not.) Lindb. – **LC**
Nardia scalaris Gray – **LC**
Neoorthocaulis attenuatus (Mart.) L.Söderstr., De Roo & Hedd. (= *Barbilophozia attenuata*) – **LC**
Neoorthocaulis binsteadii (Kaal.) L.Söderstr., De Roo & Hedd. (= *Barbilophozia binsteadii*) – **VU** [D2]
Neoorthocaulis floerkei (F.Weber & D.Mohr) L.Söderstr., De Roo & Hedd. (= *Barbilophozia floerkei*) – **LC**
Nowellia curvifolia (Dicks.) Mitt. – **NT** [B2ab(iii, iv)]
Obtusifolium obtusum (Lindb.) S.W.Arnell (= *Lophozia obtusa*) – **LC**
Odontoschisma denudatum (Mart.) Dumort. – **NT** [B2ab(ii, iii, iv)]
Odontoschisma elongatum (Lindb.) A.Evans – **VU** [D2]
Odontoschisma fluitans (Nees) L.Söderstr. et Váňa (= *Cladopodiella fluitans*) – **NT**
 [B2ab(iii, iv)]
Odontoschisma francisci (Hook.) L.Söderstr. et Váňa (= *Cladopodiella francisci*) – **CR**
 [B1ab(iii, iv), B2ab(iii, iv)]
Odontoschisma sphagni (Dicks.) Dumort. – **VU** [B2ab(iii)]
Orthocaulis atlanticus (Kaal.) H.Buch (= *Barbilophozia atlantica*) – **VU** [D2]
Oxymitra incrassata (Brot.) Sérgio & Sim-Sim – **CR** [B1ab(i, ii, iii), B2ab(i, ii, iii)]
Pallavicinia lyellii (Hook.) Carruth. – **EN** [B1ab(iii), B2ab(iii)]
Pedinophyllum interruptum (Nees) Kaal. – **LC**
Pellia endiviifolia (Dicks.) Dumort. – **LC**
Pellia epiphylla (L.) Corda – **LC**
Pellia neesiana (Gottsche) Limpr. – **LC**
Peltolepis quadrata (Saut.) Müll.Frib. – **VU** [D2]
Plagiochila asplenioides (L.) Dumort. – **LC**
Plagiochila porelloides (Torr. ex Nees) Lindenb. – **LC**
Pleurocladula albescens (Hook.) Grolle ⇒ see under *Fuscocephaloziopsis albescens*
Porella arboris-vitae (With.) Grolle – **VU** [B1ab(iii), B2ab(iii)]
Porella baueri (Schiffn.) C.E.O.Jensen – **DD**
Porella cordaeana (Huebener) Moore – **LC**
Porella platyphylla (L.) Pfeiff. – **NT** [B2ab(ii, iii, iv)]

- Preissia quadrata* (Scop.) Nees – **LC**
Ptilidium ciliare (L.) Hampe – **LC**
Ptilidium pulcherrimum (Weber) Vain. – **LC**
Radula complanata (L.) Dumort. – **LC**
Radula lindenbergiana Gottsche ex C.Hartm. – **LC**
Reboulia hemisphaerica (L.) Raddi – **EN** [B1ab(iii)]
Riccardia chamedryfolia (With.) Grolle – **EN** [B1ab(iii), B2ab(iii)]
Riccardia incurvata Lindb. – **VU** [B1ab(iii), B2ab(iii)]
Riccardia latifrons (Lindb.) Lindb. – **LC**
Riccardia multifida (L.) Gray – **LC**
Riccardia palmata (Hedw.) Carruth. – **LC**
Riccia beyrichiana Hampe ex Lehm. & Lindenb. – **DD**
Riccia bifurca Hoffm. – **LC**
Riccia canaliculata Hoffm. – **LC**
Riccia cavernosa Hoffm. – **LC**
Riccia ciliata Hoffm. – **LC**
Riccia ciliifera Link ex Lindenb. – **EN** [B1ab(iii), B2ab(iii)]
Riccia crinita Taylor – **DD**
Riccia crystallina L. – **DD**
Riccia duplex Lorb. – **DD**
Riccia fluitans L. – **LC**
Riccia glauca L. – **LC**
Riccia huebeneriana Lindenb. – **DD**
Riccia rhenana Lorb. ex Müll.Frib. – **LC**
Riccia sorocarpa Bisch. – **LC**
Riccia warnstorffii Limpr. ex Warnst. – **LC**
Ricciocarpos natans (L.) Corda – **LC**
Saccobasis polita (Nees) H.Buch (= *Tritomaria polita*) – **LC**
Sauteria alpina (Nees) Nees – **LC**
Scapania aequiloba (Schwägr.) Dumort. – **LC**
Scapania apiculata Spruce – **CR** [B1ab(iii, iv), B2ab(iii, iv)]
Scapania aspera M.Bernet & Bernet – **VU** [D2]
Scapania brevicaulis Taylor – **VU** [D2]
Scapania calcicola (Arnell & J.Perss.) Ingham – **NT** [B2ab(iii, iv)]
Scapania carinthiaca J.B.Jack ex Lindb. – **CR** [B2ab(iii)]
Scapania compacta (Roth) Dumort. – **DD**
Scapania crassiretis Bryhn – **VU** [D2]
Scapania curta (Mart.) Dumort. – **LC**
Scapania cuspiduligera (Nees) Müll.Frib. – **LC**
Scapania gymnostomophila Kaal. – **NT** [D2]
Scapania helvetica Gottsche – **LC**
Scapania irrigua (Nees) Nees – **LC**
Scapania lingulata H.Buch – **DD**
Scapania mucronata H.Buch – **LC**
Scapania nemorea (L.) Grolle – **LC**
Scapania paludicola Loeske & Müll.Frib. – **EN** [B2ab(iii, iv)]
Scapania paludosa (Müll.Frib.) Müll.Frib. – **EN** [B1ab(iii), B2ab(iii)]
Scapania parvifolia Warnst. – **LC**
Scapania praetervisa Meyl. – **VU** [D2]
Scapania scandica (Arnell & H.Buch) Macvicar – **LC**
Scapania scapanioides (C.Massal.) Grolle – **DD**

- Scapania subalpina* (Nees ex Lindenb.) Dumort. – **LC**
Scapania uliginosa (Sw. ex Lindenb.) Dumort. – **LC**
Scapania umbrosa (Schrad.) Dumort. – **LC**
Scapania undulata (L.) Dumort. – **LC**
Schistochilopsis incisa (Schrad.) Konstant. (= *Lophozia incisa*) – **LC**
Schistochilopsis opacifolia (Culm. ex Meyl.) Konstant. (= *Lophozia opacifolia*) – **LC**
Schljakovia kunzeana (Huebener) Konstant. & Vilnet (= *Barbilophozia kunzeana*) – **NT** [B2ab(ii, iii, iv)]
Schljakovianthus quadrilobus (Lindb.) Konstant. & Vilnet (= *Barbilophozia quadriloba*) – **VU** [D2]
Solenostoma confertissimum (Nees) Schljakov (= *Jungermannia confertissima*) – **LC**
Solenostoma gracillimum (Sm.) R.M.Schust. (= *Jungermannia gracillima*) – **LC**
Solenostoma hyalinum (Lyell ex Hook.) Mitt. (= *Jungermannia hyalina*) – **LC**
Solenostoma obovatum (Nees) C.Massal. (= *Jungermannia obovata*) – **LC**
Solenostoma sphaerocarpum (Hook.) Steph. (= *Jungermannia sphaerocarpa*) – **LC**
Sphaerocarpos michelii Bellardi – **NA**
Sphenolobus minutus (Schreb. ex Crantz) Berggr. (= *Anastrophyllum minutum*) – **LC**
Sphenolobus saxicola (Schrad.) Steph. (= *Anastrophyllum saxicola*) – **CR** [B2ab(iii, iv)]
Szyziella autumnalis (DC.) K.Feldberg, Váňa, Hentschel & Heinrichs (= *Jamesoniella autumnalis*) – **LC**
Tetralophozia setiformis (Ehrh.) Schljakov – **LC**
Trichocolea tomentella (Ehrh.) Dumort. – **LC**
Trilophozia quinquedentata (Huds.) Bakalin (= *Tritomaria quinquedentata*) – **LC**
Tritomaria exsecta (Schmidel ex Schrad.) Schiffn. ex Loeske – **LC**
Tritomaria exsectiformis (Breidl.) Schiffn. ex Loeske – **LC**
Tritomaria polita (Nees) Jörg. ⇒ see under *Saccobasis polita*
Tritomaria quinquedentata (Huds.) H.Buch ⇒ see under *Trilophozia quinquedentata*
Tritomaria scitula (Taylor) Jörg. – **CR** [B2ab(iii)]

Hornworts

- Anthoceros agrestis* Paton – **LC**
Anthoceros neesii Prosk. – **CR** [B2ab(iii, iv), c(iii)]
Phaeoceros carolinianus (Michx.) Prosk. – **LC**
Phaeoceros laevis (L.) Prosk. – **DD**

REFERENCES

- ANONYMOUS, 2014 — Rozporządzenie Ministra Środowiska z dnia 9 października 2014 r. w sprawie ochrony gatunkowej roślin (Dz. U. z 2014 r., poz. 1409).
 ARMATA L., 2009 — *Metzgeria violacea* (Marchantiopsida, Metzgeriaceae) in the Polish Carpathians. *Polish botanical journal* 51(4): 37-40.
 ARMATA L., 2011 — Anthropogenic occurrence of liverwort *Leiocolea badensis* (Marchantiophyta, Jungermanniaceae) in the Góry Słonne Mts (Polish Eastern Carpathians). In: Stebel A. & Ochyra R. (eds), *Bryophytes of the Polish Carpathians*. Sorus, Poznań, pp. 177-181.

- BĄCZKIEWICZ A. & Szweykowski J., 2001 — Geographic distribution of *Haplomitrium hookeri* (Hepaticae, Calobryales) in Poland. *Polish botanical journal* 46(1): 83-88.
- BUCZKOWSKA K., BĄCZKIEWICZ A., 2006 — *Aneura maxima* – a liverwort new to Poland. *Cryptogamie, Bryologie* 27(4): 453-458.
- CIEŚLIŃSKI S., CZYZEWSKA K., FALIŃSKI J. B., KLAMA H., MULENKO W. & ŻARNOWIEC J., 1996 — Relicts of the primeval (virgin) forest. Relict phenomena. In: Faliński J. B., Muleńko W. (eds), *Cryptogamous plants in the forest communities of Białowieża National Park. Functional groups analysis and general synthesis (Project Crypto 3). Phytocoenosis 8* (N. S.), *Archivum geobotanicum* 6: 197-216.
- CYKOWSKA B., 2011 — Bryophytes of *Sphagnum-Polytrichum* hummocks in the Polish Tatra Mountains. In: Stebel A. & Ochyra R. (eds), *Bryophytes of the Polish Carpathians*. Sorus, Poznań, pp. 233-259.
- ELLIS L. T., ASTHANA A. K., SAHU V., SRIVASTAVA A., BEDNAREK-UCHYRA H., OCHYRA R., CHLACHULA J., COLOTTI M. T., SCHIAVONE M. M., HRADILEK Z., JIMENEZ M. S., KLAMA H., LÉBOUVIER M., NATCHEVA R., PÓCS T., PORLEY R. D., SÉRGIO C., SIM-SIM M., SMITH V. R., SÖDERSTRÖM L., ŞTEFĂNUŢ S., SUÁREZ G. M. & VÁÑA J., 2011 — New national and regional bryophyte records 28. *Journal of bryology* 33(3): 237-247.
- ELLIS L. T., ASTHANA A. K., GUPTA R. NATH V., SAHU V., BEDNAREK-UCHYRA H., OCHYRA R., CYKOWSKA B., CALVO ARANDA S., FISCHER E., GABRIEL R., GÓRSKI P., GREMMEN N., HESPAÑHOL H., KURBATOVA L. E., LEWIS SMITH R. I., LONG D. G., BELL D., MUGRO F., SÉRGIO C., GARCIA C. A., STOW S., MARTINS A., SMITH V. R., VÁÑA J. & VANDERPOORTEN A., 2013a — New national and regional bryophyte records 34. *Journal of bryology* 35(1): 62-70.
- ELLIS L. T., BAKALIN V. A., BAIŠEVA E., BEDNAREK-UCHYRA H., OCHYRA R., BOROVICHEV E. A., CHOI S. S., SUN B.-Y., ERZBERGER P., FEDOSOV V. E., GARILLETI R., ALBERTOS B., GÓRSKI P., HÁJKOVÁ P., HODGETTS N. G., IGNATOV M., KOCZUR A., KURBATOVA L. E., LÉBOUVIER M., MEŽÁKA A., MIRAVET J., PAWLIKOWSKI P., PORLEY R. D., ROSSELLÓ J. A., SABOVLJEVIĆ M. S., PANTOVIĆ J., SABOVLJEVIĆ A., SCHRÖDER W., ŞTEFĂNUŢ S., SUÁREZ G. M., SCHIAVONE M., YAYINTAŞ Ö. T. & VÁÑA J., 2013b — New national and regional bryophyte records 36. *Journal of bryology* 35(3): 228-238.
- ELLIS L. T., AFONINA O. M., ASTHANA A. K., GUPTA R., SAHU V., NATH V., BATAN N., BEDNAREK-UCHYRA H., BENITEZ A., ERZBERGER P., FEDOSOV V. E., GÓRSKI P., GRADSTEIN S. R., GREMMEN N., HALLINGBÄCK T., HAGSTRÖM M., KÖCKINGER H., M. LÉBOUVIER M., MEINUNGER L., NÉMETH C., M. NOBIS M., NOWAK A., ÖZDEMİR T., PANTOVIĆ J., SABOVLJEVIĆ A., SABOVLJEVIĆ M. S., PAWLIKOWSKI P., PLÁŠEK V., ČÍHAL L., SAWICKI J., SÉRGIO C., MINISTRO P., GARCIA C. A., SMITH V. R., ŞTEFĂNUŢ S., STOW S., SUÁREZ G. M., FLORES J. R., L. THOUVENOT L., VÁÑA J., VAN ROOY J. & ZANDER R. H., 2014 — New national and regional bryophyte records 39. *Journal of bryology* 36(2): 134-151.
- GÓRSKI P. & URBAŃSKI P., 2006 — Ochrona mszaków. In: Gwiazdowicz D. (ed.), *Ochrona przyrody w lasach. Cz. II. Ochrona szaty roślinnej*. Polskie Towarzystwo Leśne, Poznań, pp. 35-47.
- GÓRSKI P., 2009 — The rediscovery of the liverworts *Anastrophyllum donnianum* and *A. saxicola* in Central Europe (Slovakia, Tatra Mountains). *Cryptogamie, Bryologie* 30(3): 409-414.
- GÓRSKI P., 2010 — A contribution to the liverwort flora of the Drawsko Lake district (Western Pomerania, Poland). *Roczniki Akademii Rolniczej w Poznaniu, Botanika-Steciana* 14: 19-26.
- GÓRSKI P. & VÁÑA J., 2011 — *Gymnomitrium adustum* - a liverwort new to Slovakia and Poland found in the Tatra Mts (Western Carpathians). *Cryptogamie, Bryologie* 32 (3): 279-284.
- GÓRSKI P., 2013a — Rediscovery of the liverwort *Frullania fragilifolia* in Poland. *Polish botanical journal* 58(2): 605-611.
- GÓRSKI P., 2013b — *Wątrobowce (Marchantiophyta) Leśnego Kompleksu Promocyjnego „Lasy Środkowopomorskie” (Pomorze Zachodnie)*. Sianów-Poznań, PGL Lasy Państwowe Nadleśnictwo Karnieszewice, Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, 213 p.
- GÓRSKI P. & VÁÑA J., 2013 — *Jungermannia exsertifolia* subsp. *cordifolia* – liverwort new to Poland found in the Tatra Mountains (Western Carpathians). *Cryptogamie, Bryologie* 34(3): 353-358.
- GÓRSKI P. & VÁÑA J., 2014 — A synopsis of liverworts occurring in the Tatra Mountains (Western Carpathians, Poland and Slovakia): checklist, distribution and new data. *Preslia* 86(4): 381-485.

- GÓRSKI P., PAWLIKOWSKI P., STANIASZEK-KIK M., ROSADZIŃSKI S., STEBEL A., RUSIŃSKA A., ZUBEL R., WILHELM M., FUDALI E., CYKOWSKA-MARZENCKA B. & PRZEWOŹNIK L., 2014 — New distributional data on Bryophytes of Poland, 1. *Steciana* 18(2): 77-87.
- GÓRSKI P., SMOCZYK M., PAWLIKOWSKI P., VONČINA G., STEBEL A., PACIOREK T., STANIASZEK-KIK M., ROMAŃSKI M., WIADERNY A., GĄBKAM. & WIERZCHOLSKA S., 2015 — New distributional data on Bryophytes of Poland, 2. *Steciana* 19(2): 55-65.
- GÓRSKI P., 2016 — Snowbed bryophyte vegetation of the Tatra Mountains (Western Carpathians, Poland and Slovakia). *Nova Hedwigia* 102(1–2): 9-67.
- GÓRSKI P. & ROMAŃSKI M., 2016 — Rediscovery of the rare liverwort *Liochlaena subulata* (Jungermanniaceae) in Poland. *Herzogia* 29(2): 810-813.
- GÓRSKI P., SMOCZYK M., ROSADZIŃSKI S., STANIASZEK-KIK M., KLAMA H., PAWLIKOWSKI P., WILHELM M., TOPOLSKA K. & ROMAŃSKI M., 2016a — New distributional data on bryophytes of Poland and Slovakia, 7. *Steciana* 20(3): 117-127.
- GÓRSKI P., VONČINA G., SMOCZYK M., KLAMA H., ŠOLTÉS R., WILHELM M., & RUTKOWSKA M., 2016b — New distributional data on bryophytes of Poland and Slovakia, 8. *Steciana* 20(4): 191-200.
- GÓRSKI P., RUSIŃSKA A., SMOCZYK M., DEMBICZ I., WIERZCHOLSKA S., KOZUB Ł., ROMAŃSKI M., FUDALI E., PODLASKA M. & WIADERNY A., 2016c — New distributional data on bryophytes of Poland and Slovakia, 5. *Steciana* 20(1): 33-44.
- HAUSBRANDT L., 1949 — Gatunki rodzaju *Scapania* Dum. w Polsce i krajach ościennych. *Materiały do fizjografii kraju* 16: 1-43.
- HODGETTS N.G., 2015 — Checklist and country status of European bryophytes – towards a new Red List for Europe. Irish Wildlife Manuals, No. 84. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland.
- IUCN, 2012 — IUCN Red List Categories and Criteria: Version 3.1. Second edition. IUCN, Gland, Switzerland and Cambridge, UK, IV + 32 pp.
- IUCN SPECIES SURVIVAL COMMISSION, 2012 — Guidelines for Application of IUCN Red List Criteria at Regional and National Levels. Version 4.0. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland, IV + 44 pp.
- 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.
- KEPEL A., HEISE W., PAWLACZYK P., URBAŃSKI P. & GÓRSKI P., 2012 — Aktualizacja listy gatunków roślin objętych ochroną gatunkową oraz wskazania dla ich ochrony. Polskie Towarzystwo Ochrony Przyrody SALAMANDRA, Generalna Dyrekcja Ochrony Środowiska, Poznań (mscr.).
- KLAMA H., 1996 — Wątrobowce (Hepaticae) Beskidu Żywiecko-Orawskiego (Karpaty Zachodnie). *Monographiae botanicae* 79: 1-144.
- KLAMA H., 2002a — *Distribution patterns of liverworts (Marchantiopsida) in natural forest communities (Białowieża Primeval Forest, NE Poland)*. Bielsko-Biała, University of Bielsko-Biała, 278 p.
- KLAMA H., 2002b — Relikty puszczańskie we florze wątrobowców zbiorowisk leśnych Puszczy Białowieskiej. *Zeszyty Naukowe ATH - Inżynieria Włókiennicza i Ochrona Środowiska* 7(3): 244-260.
- KLAMA H., 2003 — Różnorodność gatunkowa – wątrobowce i giewiki. In: Andrzejewski R. & Weigle A. (eds), *Różnorodność biologiczna Polski. Drugi polski raport – 10 lat po Rio*. Warszawa, Narodowa Fundacja Ochrony Środowiska, pp. 49–58.
- KLAMA H., 2004a — Wątrobowce (*Marchantiophyta*) Babiogórskiego Parku Narodowego. In: Wołoszyn B.W., Jaworski A. & Szwaagrzyk J. (eds), *Babiogórski Park Narodowy. Monografia Przyrodnicza*. Kraków, Komitet Ochrony Przyrody PAN, Babiogórski Park Narodowy, pp. 333-356.
- KLAMA H., 2004b — Zagrożenia i ochrona wątrobowców w Polsce. *Zeszyty Naukowe ATH - Inżynieria Włókiennicza i Ochrona Środowiska* 14(5): 62-80.
- KLAMA H., 2005 — Ochrona gatunkowa wątrobowców w Polsce. In: Kasza H. (ed.), *Zapobieganie zanieczyszczeniu środowiska XII. Zeszyty Naukowe Akademii Techniczno-Humanistycznej 19, Inżynieria Włókiennicza i Ochrona Środowiska* 6: 113-131.
- KLAMA H., 2006 — Red list of the liverworts and hornworts in Poland. In: Mirek Z., Zarzycki K., Wojewoda W., Szelaż Z. (eds.), *Red list of plants and fungi in Poland*. Kraków, W. Szafer Institute of Botany, Polish Academy of Sciences, pp. 21-33.

- KLAMA H., 2014 — Przyczynek do flory wątrobowców rezerwatu przyrody „Diabli Skok” (Równina Walecka, północna Polska). *Fragmenta floristica et geobotanica Polonica* 21(1): 171-173.
- KOŁA W. & TURZAŃSKA M., 1993 — Zbiorowiska mszaków pól uprawnych Dolnego Śląska. I. *Acta Universitatis Wratislaviensis 1480, Prace Botaniczne* 53: 3-12.
- KOVAL S. & ZMRHALOVÁ M., 2010 — Znovunalezení hlevíků *Amthoceros neesii* a *Notothylas orbicularis* v České Republice. *Bryonora* 46: 38-46.
- KRUPA J., 1882 — Zapiski bryjologiczne. *Sprawozdania komisji fizjograficznej* 16: 170-204.
- KRUPA J., 1888 — Zapiski bryjologiczne z Tatr i Przedtatrza. *Sprawozdania Komisji Fizjograficznej* 21: 65-94.
- MIERZEŃSKA M., 1994 — Wątrobowce Gorców. *Fragmenta floristica et geobotanica Polonica* 1: 235-346.
- OCHYRA R., CYKOWSKA B., 2008 — The liverwort flora of the Skalice Nowotarskie and Spiskie Klippen (Polish Western Carpathians). In: Stebel A. & Ochyra R. (eds), *Bryophytes of the Polish Carpathians*. Poznań, Sorus, pp. 143-167.
- OCHYRA R., SZWEJKOWSKI J., BEDNAREK-OCHYRA H., 1988 — The rediscovery of *Lophozia rutheana* (Limpr.) Howe (Hepaticae, Jungermanniaceae) in Poland and a review of its distribution. *Nova Hedwigia* 47(1-2): 56-67.
- PIWOWARCZYK R. & STEBEL A., 2012 — Stanowisko wątrobowca *Mannia fragrans* w Podgrodziu koło Ćmielowa (Wyzyna Małopolska). *Chrońmy Przyrodę Ojczyzn* 68(3): 219-224.
- ROSADZIŃSKI S., RUSIŃSKA A., 2010 — Rzadkie i zagrożone wątrobowce Polskiej części Dolnych Łużyc. *Acta societatis botanicorum Poloniae* 79, suppl. 1: 24.
- SCHUMACKER R. & MARTINY P., 1995 — *Red Data Book of European bryophytes. Part 2. Threatened bryophytes in Europe including Macaronesia*. Trondheim, The European Committee for Conservation of Bryophytes.
- SCHUMACKER R. & VÁŇA J., 2005 — *Identification keys to the liverworts and hornworts of Europe and Macaronesia (distribution and status)*. Poznań, Sorus, 209 p.
- SÖDERSTRÖM L., HAGBORG A., VON KONRAT M., BARTHOLOMEW-BEGAN S., BELL D., BRISCOE L., BROWN E., CARGILL D. C., COSTA D. P., CRANDALL-STOTLER B.J., COOPER, E.D., DAUPHIN G., ENGEL J.J., FELDBERG K., GLENNY D., GRADSTEIN S. R., HE X., HEINRICHS J., HENTSCHER J., ILKIU-BORGES A. L., KATAGIRI T., KONSTANTINOVA N. A., LARRAÍN J., LONG D. G., NEBEL M., PÓCS T., PUCHE F., REINER-DREHWALD E., RENNER M. A. M., SASS-GYARMATI A., SCHÄFER-VERWIMP A., SEGARRA-MORAGUES J. G., STOTLER R. E., SUKKHARAK P., THIERS B. M., URIBE J., VÁŇA J., VILLARREAL J. C., WIGGINTON M., ZHANG L., ZHU R.-L., 2016. — World checklist of hornworts and liverworts. *PhytoKeys* 59: 1-828. doi: 10.3897/phytokeys.59.6261.
- STEBEL A., 1999 — *Lophozia badensis* (Hepaticae, Lophoziaceae) in the Silesian Upland (Poland). *Fragmenta floristica et geobotanica* 44(1): 199-201.
- STEBEL A. & KRAWCZYK R., 2016 — Interesujące stanowisko wątrobowca *Pallavicinia lyellii* w Kotlinie Sandomierskiej (Polska południowo-wschodnia). *Fragmenta floristica et geobotanica Polonica* 23(2): 379-381.
- STEBEL A., ROSADZIŃSKI S., GÓRSKI P., FOJCIK B., RUSIŃSKA A., VONČINA G., SZCZEPAŃSKI M., WILHELM M., FUDALI E., PACIOREK T., STANIASZEK-KIK M., ZUBEL R., PIWOWARSKI B., WOLSKI G., SALACHNA A., SMOLIŃSKA D. & PIERŚCIŃSKA A. 2013 — Contribution to the bryoflora of the Świętokrzyski National Park (Central Poland). *Roczniki akademii rolniczej w Poznaniu* 392, *Botanika-Steciana* 17: 77-84.
- SZWEJKOWSKI J., 1953 — Mszaki Gór Stołowych. Cz. I. Wątrobowce (Hepaticae). *Prace komisji biologicznej poznańskiego towarzystwa przyjaciół nauk* 14(5): 1-136.
- SZWEJKOWSKI J., 1958 — Materiały do flory wątrobowców Sudetów, I. Wątrobowce zebrane w Górach Kaczawskich. *Prace komisji biologicznej poznańskiego towarzystwa przyjaciół nauk* 17(6): 1-56.
- SZWEJKOWSKI J. & TOBOLEWSKI Z., 1959 — Zagadnienie ochrony roślin zarodnikowych. *Ochrona przyrody* 26: 50-64.
- SZWEJKOWSKI J., 1960 — Materiały do flory wątrobowców Tatr. *Prace komisji biologicznej poznańskiego towarzystwa przyjaciół Nauk* 21(3): 3-92.
- SZWEJKOWSKI J. & KOŹLIKA M., 1969 — Materiały do flory wątrobowców Pomorza. *Badania fizjograficzne nad Polską zachodnią* 22: 125-49.
- SZWEJKOWSKI J., 1971 — H. 156 *Jamesoniella undulifolia* (Nees) K. M. In: Szwejkowski J., Wojterski T. (eds), *Atlas of geographical distribution of spore-plants in Poland*. Series IV. Liverworts (Hepaticae). Part VII. PWN, Poznań.

- SZWEYKOWSKI J., 1986 — Czerwona lista wątrobowców zagrożonych w Polsce. In: Zarzycki K. & Wojewoda W. (eds), *Lista roślin zagrożonych w Polsce*. PWN, Kraków, pp. 110-115.
- SZWEYKOWSKI J., 1992 — Czerwona lista wątrobowców zagrożonych w Polsce. In: Zarzycki K., Wojewoda W. & Heinrich Z. (eds), *Lista roślin zagrożonych w Polsce*. Instytut Botaniki im. W. Szafera, Polska Akademia Nauk, Kraków, pp. 75-78.
- SZWEYKOWSKI J. & BUCZKOWSKA K., 1996 — Liverworts of the Bieszczady Zachodnie Range (Polish Eastern Carpathians) – a vanishing relict boreal flora. *Fragmenta Floristica et Geobotanica* 41(2): 865-934.
- SZWEYKOWSKI J., BUCZKOWSKA K., 2000 — Wątrobowce Borów Tucholskich. In: Banaszak J. & Tobolski T. (eds), *Park Narodowy Bory Tucholskie*. Wyd. Uczelniane Akademii Bydgoskiej, Bydgoszcz, pp. 319-332.
- SZWEYKOWSKI J., 2006 — An annotated checklist of Polish liverworts. *Biodiversity of Poland*, Vol. 4. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- SZWEYKOWSKI J. & KLAMA H., 2010 — Liverworts of the Tatra National Park – a checklist. In: Mirek Z. & Ronikier M. (eds), *Biodiversity of the Tatra National Park*. Vol. 3, p. 60, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- THERRIEN J. P., CRANDALL-STÖTLER B. & STÖTLER R. E., 1998 — Morphological and genetic variation in *Porella platyphylla* and *P. platyphylloidea* and their systematic implications. *Bryologist* 101: 1-19.
- USTAWA z dnia 16 kwietnia 2004 r. o ochronie przyrody (Dz. U. Nr 92, poz. 880 ze zm.).
- WILHELM M., RUSIŃSKA A., STEBEL A., GÓRSKI P., VONČINA G., FOJCIK B., ROSADZIŃSKI S., FUDALI E., SALACHNA A. & ZUBEL R., 2015 — Contribution to the bryoflora of the Wolin Island (NW Poland). *Steciana* 19(2): 75-87.
- ZUBEL R. & STEBEL A., 2008 — Occurrence of *Frullania tamarisci* (Marchantiophyta, Frullaniaceae) in the Polish Carpathians. In: Stebel A. & Ochyra R. (eds), *Bryophytes of the Polish Carpathians*. Sorus, Poznań, pp. 257-266.
- ZUBEL R., STEBEL A. & GÓRSKI P., 2011 — *Metzgeria conjugata* (Marchantiophyta, Metzgeriaceae) in the Polish Carpathians: distribution, ecology and threats. In: Stebel A. & Ochyra R. (eds), *Bryophytes of the Polish Carpathians*. Sorus, Poznań, pp. 131-152.