Cryptogamie, Bryologie, 2012, 33 (2): 113-134

Floristic and ecological survey of bryophytes from Portuguese watercourses

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(Received 4 April 2011, accepted 1 Spetember 2011)

Abstract – A floristic and ecological survey was carried out in 187 watercourses of the Portuguese Northwest mainland and Sicó mountain regions located in the transition zone between Atlantic and Mediterranean territories. This work mainly focused on the update of the bryophyte taxa along fluvial and geologic gradients, mostly of headwater areas. Seven ecological aspects (type of river segment, micro-habitat, immersion level and water velocity, depth range, shade, lithology and altitude) were classified and used to describe taxa autoecology. This survey is the first to present a comprehensive floristic catalogue and information on Portuguese aquatic and semi-aquatic taxa distribution. A list of 140 bryophytes was established for the studied areas, with predominance of mosses (102 taxa of mosses, 37 taxa of liverworts and 1 taxon of hornworts). *Racomitrium aciculare*, *Platyhypnidium lusitanicum*, *Hyocomium armoricum*, *Scapania undulata* and *Fissidens polyphyllus* were the most common taxa and Brachytheciaceae, Grimmiaceae and Fissidentaceae were the most frequent families in the studied micro-habitats. We updated the regional distribution of 30% of the taxa to new provinces of the Portugal. Four mosses and three liverworts are European endemisms, and *Racomitrium* (*R. hespericum* and *R. lusitanicum*) are Iberian endemics. Distribution maps for selected species (Atlantic, dominant or rare species) are also presented.

Aquatic / rheophytes / hygrophilous / mountain / autoecology / Portugal

INTRODUCTION

It is generally recognized that bryophytes play a vital and sometimes dominant role in fluvial ecosystems, especially in mountain areas with high precipitation (Bowden *et al.*, 1999). The studies on fluvial bryophytes in Europe (Martínez-Abaigar & Núñez-Olivera, 1991; Muotka & Virtanen, 1995; Werner, 2001; Scarlett & O'Hare, 2006), or elsewhere (Craw, 1976; Slack & Glime, 1985; Vitt *et al.*, 1986; Suren & Ormerod, 1998), have revealed high diversity levels and potential use of these organisms in management and conservation plans of aquatic habitats.

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Due to high spatial and temporal heterogeneity of water availability, sediment erosion and transport as well as discharges, Portuguese fluvial ecosystems present diverse and rich assemblages of rheophytic algae, lichens and bryophytes together with a rich vascular plant flora, all dependent on their morphologic adaptations to resist scouring and drag forces in the generally fast-flowing watercourses (Vieira *et al.*, 2003). Additionally, the climatic transition character of the studied areas promotes the coexistence of many temperate and mediterranean taxa in the same watercourse (Costa *et al.*, 1998). These communities have an added value since they include some taxa of great phytogeograghic importance related to the colonization routes during the formation of the Iberian Peninsula (Sérgio, 1990) and to the refuge nature of this Peninsula during the last glacial age in the late-Quaternary period (Petit *et al.*, 2002).

Before this study, and despite the recent publication of a revision catalogue for Portuguese bryophytes (Sérgio & Carvalho, 2003), available information on aquatic and semi-aquatic taxa was mostly based on publications of the first half of the 20th century and some scattered publications regarding aquatic bryophytes species (Machado, 1925, 1928, 1929-1930, 1931, 1933; Allorge, 1947; Ochyra *et al.*, 1988; Ochyra & Sérgio, 1992; Sérgio *et al.*, 1995; Garcia & Sérgio, 2001). Since consistent studies on aquatic bryophytes were almost non-existent for most of the Portuguese territories, and given the levels of bryophyte diversity known for the fluvial micro-habitats, we aimed at compiling the first comprehensive bryophytic and ecologic survey in Portuguese watercourses.

MATERIALS AND METHODS

Study areas

This survey was performed on watercourses mostly included within the network of Natura 2000 Sites in two regions: (i) Northwestern region of Portugal, characterized by a strong and acid water flow over schist and granite bedrocks with temperate climate (700-3000 mm of annual precipitation; 7-16°C of mean daily temperature); and (ii) Centre-western Portugal (Sicó mountain range), characterized by limestone waterbeds with neutral water and mediterranean climate (700-1400 mm of annual precipitation; 12.6-16°C of mean daily temperature) (Fig. 1).

The majority of the localities are in mountain hills and valleys at altitudes ranging mainly from 600 to 1440 m, corresponding to the headwater areas of many water basins. Watercourses show typical features of highly sloping bedrocks, with shifting currents and a succession of pools and riffles, waterfalls and rapids. Most watercourses maintain a minimum water flow in the driest period, contrasting with the high levels of winter discharge. The influence of Mediterranean climate is particularly evident in the Sicó mountain range where lower levels of annual precipitation result in dryer watercourses.

Data collection

In total, 187 river segments (defined as 100 m length of the riverbed and its margins) of 11 river basins, were studied from May 2003 to October 2008 (Fig. 1; Appendix 1). These basins were chosen in order to survey mountain

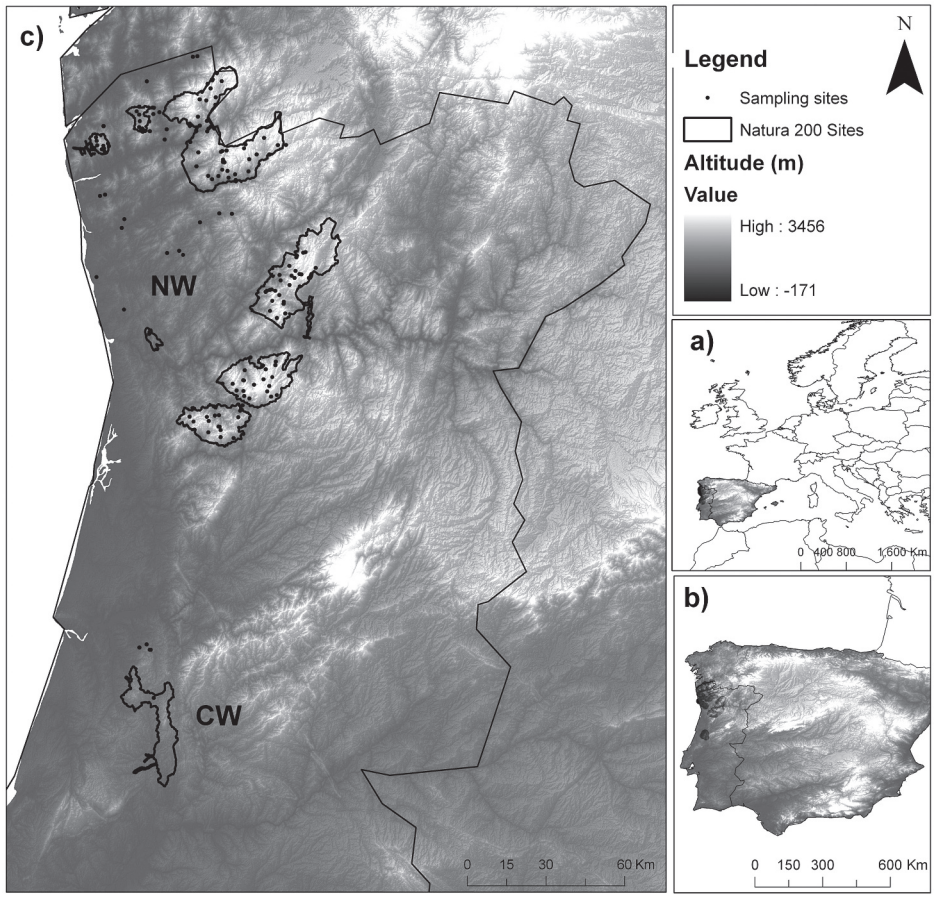


Fig. 1. Geographical location of the sampling points and Natura 2000 Network Portuguese Sites in the context of Europe (a), Iberian Peninsula (b) and Portugal (c) over a representation Digital Elevation Terrain Model. NW: Northwestern region: CW: Centre-Western region.

territories with different geomorphologic and climatic contexts, and subjected to different levels of human pressure.

This survey was performed during the lowest water discharge levels (late Spring and Summer), to access the minimum water levels. The water depth in which populations were found corresponds, therefore, to the lowest level of submersion.

Bryophytes were surveyed in all immerged or semi-immerged micro-habitats found within the 100m of riverbed and margins. This study focused mostly in the rocky substrates, although we sporadically included micro-habitats that showed some deposition of silt or sand within the bryophyte patches. Bryophyte species abundance was registered as percentage cover using 0.25 m^2 (0.5 m × 0.5 m) sample plots placed in all recognizable hydrologic zones: micro-habitats constantly or easily immerged seasonally or several times a month with discharges related to precipitation or dam releases, and micro-habitats immerged only in extended periods of rain that might show some evidences of fine substrate.

Information on bryophyte autoecology was recorded according to seven ecological aspects, namely types of watercourses, micro-habitats and five additional abiotic parameters (immersion level and water velocity, depth range, shade, lithology and altitude), all of which were classified after the recognition of the variability of the watercourses of the study area (Table 1).

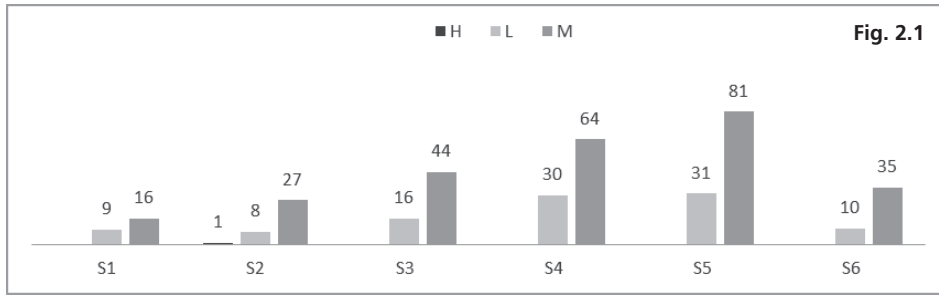
Table 1. Classes of abiotic parameters coded for the definition of the autoecology of bryophytes.

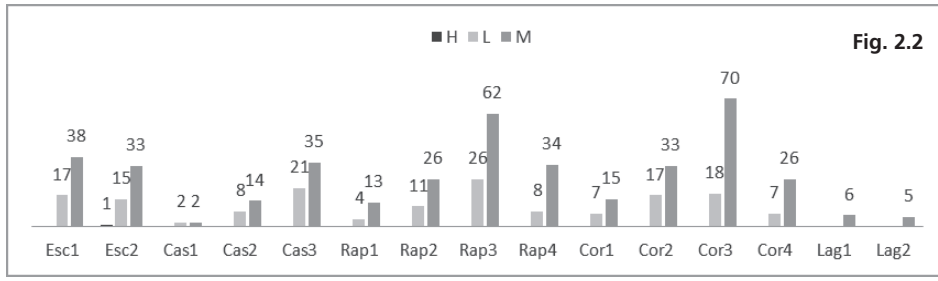
Parameter	*Description*	*Classes*
(RS) River segment	Type of watercourse segment	(**S1**) bog springs (upper mountain peaty areas); (**S2**) permanent springs (aquifer resurgence); (**S3**) mountain watercourses with temporary (mostly winter) flow; (**S4**) mountain segment with permanent flow (1st order streams); (**S5**) valley river segment with permanent flow (2nd to 3rd order streams/rivers); (**S6**) lowland river segment with permanent flow (4th to 5th order rivers).
(MH) Micro-habitat	Micro-habitat in relation to the water velocity and local slope	(**Esc**) Dripping water in a vertical surface: (**Esc1**) permanent dripping zone; (**Esc2**) temporary dripping zone. (**Cas**) Waterfall: (**Cas1**) central zone with continuous and torrential flow; (**Cas2**) surface with continuous non-turbulent current; (**Cas3**) permanent spray area. (**Cor**) Laminar waterflow: (**Cor1**) permanently submersion; (**Cor2**) seasonal submersion; (**Cor3**) high discharge submersion; (**Cor4**) extremely high discharge submersion. (**Rap**) Rapid turbulent flow: (**Rap1**) permanent submersion by turbulent flow; (**Rap2**) seasonal submersion; (**Rap3**) high discharge submersion; (**Rap4**) extreme discharge submersion. (**Lag**) Water column with imperceptible flow of lagoons or weirs: (**Lag1**) permanent submersion; (**Lag2**) high discharge submersion.
(SV) Immersion level and water velocity	Dominant and occasional (between brackets) situations in which taxon was found: (**i**) immersed; (**e**) emersed; (**s**) in spray or splashes of water); in case of immmersion, water velocity range, measured with Geopacks flowmeter ("Flowmeter 1"), is also shown (unit = m/s).	
(DR) Depth range	Range of populations' distribution in relation to water surface level (minimum to maximum in cm: negative numbers being depth under water surface, "0" (zero) the water surface level and positive numbers the height above water surface level).	
(SH) Shade	Riverbed with no direct light	unit = percentage (%) of riverbed covered by the shade of riparian vegetation
(LI) Lithology	Geologic nature of the rock substrate	(**q**) quartzit, (**co**) cornean, (**x**) schist, (**gr**) greywacke, (**ga**) alkaline granite, (**g**) non-alkaline granite, (**ca**) crystaline limestone (marble), (**cm**) limestone, (**t**) limestone tufts.
(AL) Altitude	Range of altitude (minimum and maximum) where each specific taxon has been recorded.	

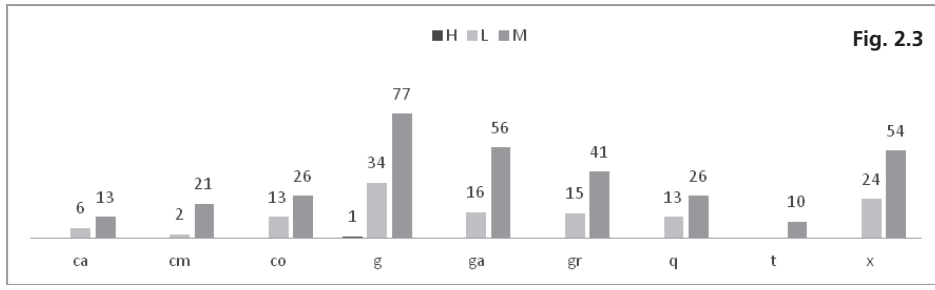
Data analysis

The three paraphyletic bryophyte phyla (mosses, liverworts and hornworts) were considered (von Konrat *et al.*, 2010). The nomenclature of mosses follows Hill *et al.* (2006), that of hornworts and liverworts follows Ros *et al.* (2007), except for the genus *Marsupella* (Söderström *et al.*, 2002). Specimens were deposited in "CIBIO collection" of Porto Herbarium (PO) with collection numbers ranging from 1221 to 10306.

Synthetic graphs (Figs 2.1 to 2.6) regarding ecological parameters used to describe taxa autoecology (Table 1) are shown to resume the trends found in







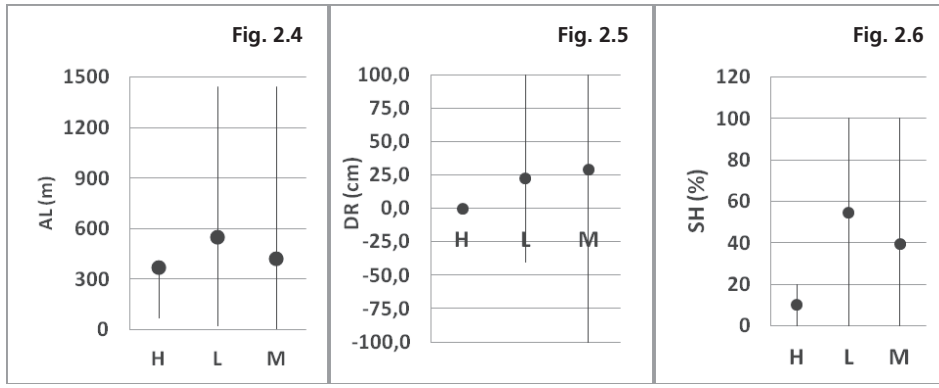


Fig. 2. Observation numbers of bryophytes in each of the ecological parameter classes (Fig. 2.1 to 2.3) and distribution of taxa and average values (represented by a black dot in the graph) in relation to the ecologic parameter (fig. 2.4 to 2.6). 2.1: River segment (RS); 2.2: Micro-habitat (MH); 2.3: Lithology (LI); 2.4: Altitude (AL); 2.5: Depth range (DR); 2.6: Shade (SH); Mosses (M), liverworts (L) and hornworts (H). See Table 1 for explanations of acronyms and classes.

niches of mosses, liverworts and hornworts. With respect to the parameter "altitude", we also explored species richness trends through the altitudinal gradient by modelling taxa richness values in each fluvial segment with "Loess Smoother" technique using the CANOCO 4.52 (Lepš & Šmilauer, 2006).

RESULTS

The total list of taxa and their autoecology is presented in Appendix 2, as well as location data represented by numbers (Appendix 1), and notes on the novelties to the national catalogue. A total of 140 bryophytes belonging to 83 genus and 57 families were recorded in potentially or actually submerged micro-habitats. Most of the taxa showed narrow niches regarding each of the ecological parameter surveyed (Appendix 2). The most common species were *Racomitrium aciculare*, *Platyhypnidium lusitanicum*, *Hyocomium armoricum*, *Scapania undulata* and *Fissidens polyphyllus* (around 250 observations each). Brachytheciaceae, Grimmiaceae and Fissidentaceae were the most frequent families in the studied micro-habitats (with more than 400 observations).

Two new species for mainland Portugal, Blindia acuta and Dichodontium pellucidum, are reported. Populations of species such as *Radula holtii*, *Porella pinnata*, *Jungermannia pumila*, *Jungermannia obovata*, *Climacium dendroides*, *Fissidens exilis*, *Thamnobryum maderense*, *Schistidium rivulare*, taxa that had remained insufficiently known or had been considered extinct in Portugal, were also found. Several European and Iberian endemisms were found, some of which were quite frequent and dominanting the communities of their micro-habitats (*Platyhypnidium lusitanicum*, *Isothecium holtii* and *Thamnobryum maderense*); others were not so frequent and nor abundant (*Racomitrium hespericum*, *Racomitrium lusitanicum*, *Saccogyna viticulosa*, *Radula holtii*, *Ptychomitrium polyphyllum* and *Gymnomytrium crenulatum*).

Bryophytes were found along the six different types of river segments typified for this study (Fig. 2.1). Mountain segments with permanent flow or valley river segments with permanent flow resulted to be the richest ones (94 taxa in 1st order streams - S4; 112 taxa in 2nd to 3th order streams/rivers - S5). Nevertheless, mountain springs (S1 or S2) or lowland segment rivers could also offer suitable micro-habitats for many taxa.

Micro-habitats located in the upper parts of rapids and currents (Rap3-4 and Cor 3-4) or lateral parts of waterfalls (Cas3) hosted a higher number of moss and liverwort species (Fig. 2.2). Also many species were found colonizing dripping zones (Esc 1-2). Only 25 taxa (80% mosses and 20% liverworts) were found growing under permanent torrential currents of rapids and waterfalls faster than 2 m/s (*e.g. Scapania undulata, Marsupella emarginata* var. *aquatica, Chiloscyphus polyanthos, Cinclidotus aquaticus, Cratoneuron filicinum, Brachythecium rivulare, Hygrohypnum ochraceum, Fissidens polyphyllus, Fontinalis squamosa* var. *dixonii, Platyhypnidium lusitanicum* and *Racomitrium aciculare*). Other taxa, known to be mainly hygrophilous, also seemed to withstand seasonal submergence (e.g.: *Hyocomium armoricum, Thamnobryum alopecurum, Bryum gemmiparum, Fissidens pusillus* and *Polytrichum commune*). Substrates submerged by slow-flowing water in lagoons or weirs (micro-habitat "Lag") were the least colonized: only taxa capable of being submerged up to 1 m, such as *Sphagnum auriculatum*, *Fontinalis antipyretica* subsp. *antipyretica* and *F. squamosa* var. *dixonii*

(Fig. 2.2). In micro-habitats submerged by everlasting water columns, although usually not deeper than 60 cm, we found species such as *Platyhypnidium lusitanicum, Fissidens polyphyllus, Marsupella emarginata* var. *aquatica, Fontinalis squamosa* var. *dixonii,* and *Nardia compressa.* Mosses were more frequently found submerged (75% of total observations) than liverworts or hornworts (25% of total observations). Although mosses seem to better tolerate conditions of deep immersion (Fig. 2.4), both liverworts and mosses can be found in micro-habitats along the entire submersion gradient.

The tolerance to light incidence in the studied habitats differred among taxa: 49% of the taxa were able to develop at any intensity of solar incidence, 23% in totally exposed or slightly shaded conditions and 28% seemed to prefer shaded segments (at least with half of the riverbed shaded by riparian vegetation). Liverworts showed a tendency to occupy more shaded micro-habitats with an average of micro-habitat shade percentage slightly higher than mosses (Fig. 2.5). Nevertheless, taxa of both groups were found thriving in each micro-habitat type, from deeply shaded to completely exposed conditions.

Most taxa of the catalogue were found developing exclusively on bedrocks in the Northwest streams. Granites (both non-alkaline and alkaline), schists and greywackes are the substrates colonized by a higher number of taxa of liverworts and mosses (Fig. 2.3). Nevertheless, some taxa were only found colonizing limestone in the Centre-western region (*e.g.: Fissidens exilis, Cinclidotus riparius, Fontinalis hypnoides* var. *duriaei, Scorpiurium deflexifolium, Eucladium verticillatum, Scorpiurium circinatum*).

As for the species distribution along the altitudinal gradient, 46% of the taxa reached 100 m, 27% were not found above 300 m and 18% were only recorded above 1000 m. Liverworts showed a slightly higher altitude range, when compared with mosses, but both groups show a wide altitude range (Fig. 2.6). Despite some variability of species richness along the studied altitudinal gradient (about 1500 m), a trend of major species richness was recognized at intermediate altitudes (around 700 m) by the "Loess Smoother" method (Fig. 3).

DISCUSSION

All taxa included in this catalogue seemed to withstand, in a variable extent, water submersion and seasonal discharge shifts. Although in the bryological floras some might not be described as aquatic, amphibians or hygrophilous, these taxa find in fluvial streams and rivers micro-habitats an alternative niche. At the same time, other taxa, commonly designated as rheophytes, were found submerged or showing a great tolerance to desiccation in the intermittently immerged zones. Nevertheless, bryophytes were not found in water depths higher than 1 m and most of the taxa were found immediately above the lowest water surface level or at the spray zones of waterfalls and rapids, being submerged as soon as precipitation occurs or during most of the winter water discharges. This distribution trend close to the water level might be related to the restricted access to CO_2 in higher depths, especially in still waters, such as in lagoon micro-habitats (Jenkins & Proctor, 1985).

Most of the acidophilous taxa were found on headwaters running on granitic or schistose bedrocks, while neutrophilous and basophilous species were found in limestone territories. This lithological segregation of taxa seemed to be

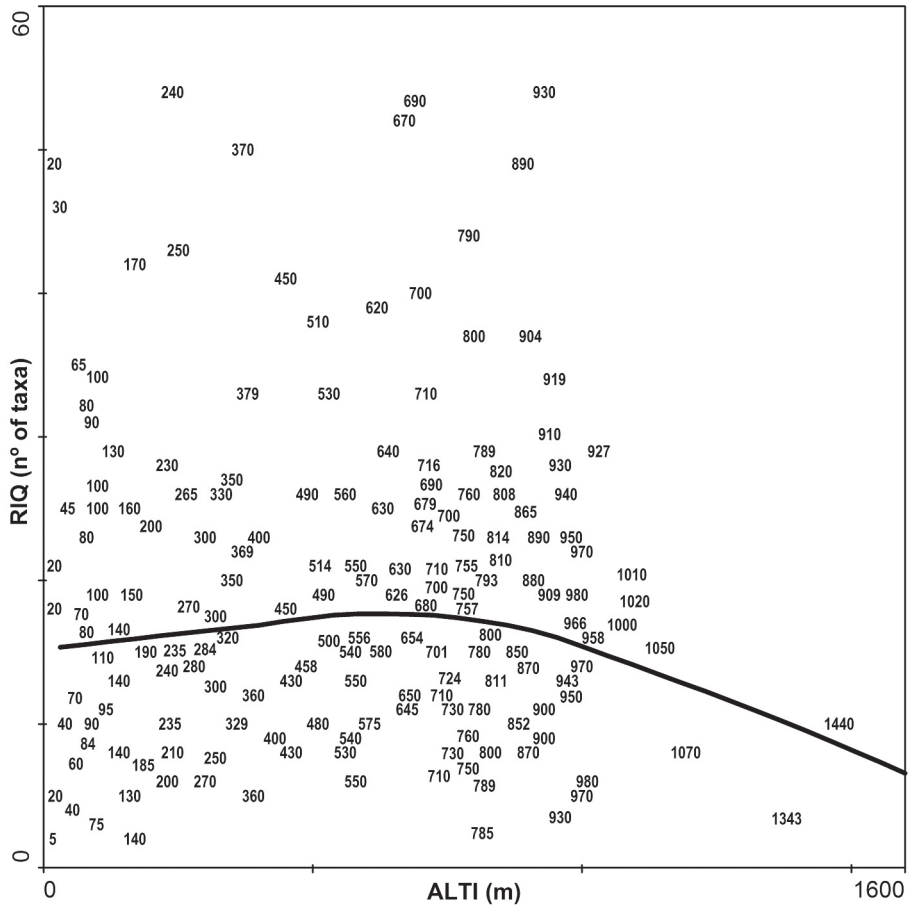


Fig. 3. "Loess Smoother" model of richness of bryophytes (RIQ: number of different taxa found in each fluvial segment). Each segment is represented by its altitude value (ALTI) in the centroid of its distribution in relation to the richness model curve.

correlated with the species tolerance to different water pH and content of dissolved minerals related to underlying lithology (Bates, 2000).

Many taxa showed tolerance to both shade and direct light incidence. Many of the populations of exposed locations presented darker pigmentation (e.g.: *Bryum alpinum, Marsupella sphacelata, Scapania undulata, Sphagnum* sp., *Platyhypnidium lusitanicum*) in exposed mountain streambeds, while many other lighted color taxa survived in conditions of minimum light availability. In both situations these bryophyte taxa dominated aquatic communities and seemed to have found a competitive advantage in relation to other macrophytes not so shade tolerant or unable to preserve chlorophyll during desiccation (Marschall & Proctor, 2004).

The taxonomic analysis of the catalogue confirms the theory of adaptive colonization of the aquatic environment by several parallel lines of development (Akiyama, 1995), with taxa from many genera and families adapting to the diversity of watercourses niches.

A larger number and occurrences of mosses than liverworts and hornworts are similar to those reported in other rivers of Northern Hemisphere (Martínez-Abaigar & Núñez-Olivera, 1991; Muotka & Virtanen, 1995; Scarlett & O'Hare, 2006). This numerical trend is probably due to the ecological exclusion of the latter two groups from fluvial conditions, due to their lower resistance to water impact and desiccation when compared to mosses (Vitt & Glime, 1984). Nevertheless, some foliose liverworts were frequently found in fast-flowing currents (*e.g. Marsupella emarginata* var. *aquatica, Marsupella sphacelata, Nardia compressa, Scapania undulata* and *Chiloscyphus polyanthos*). Most of the thallose liverworts were only found in splashed micro-habitats (*e.g. Dumortiera hirsuta, Conocephalum conicum, Lunularia cruciata, Pellia epiphylla, Riccardia* spp., *Marchantia polymorpha*).

The distribution pattern of species richness along an altitudinal gradient, with higher levels at intermediate altitudes, has been previously documented (Ormerod *et al.,* 1994; Andrew *et al.,* 2003). High physiological stress caused by wide thermal amplitudes, prolonged desiccation in the dry season or mechanical damage and elimination of populations in spate or high discharge periods in upper segments seemed the most probable causes of bryophyte exclusion/restriction in these habitats. On the other hand, in lowland streams, the instability of sandy and gravel substrates, the higher depth of water column (more than 1 m depth) and heavy anthropic disturbance (including water pollution) and competition with other macrophytes are the pressures widely recognized to cause lower coverage and richness of bryophytes (Vitt & Glime, 1984; Glime, 1992). The higher richness of bryophytes in segments located at intermediate altitudes might be supported by the higher quantity, stability and heterogeneity of micro-habitats observed in the bedrocks of hill watercourses, with low depth currents and well preserved natural watersheds (Suren & Ormerod, 1998).

This survey added two new species to national catalogue (Vieira *et al.*, 2007), and updated the distribution of 30% of the taxa for new provinces. We confirmed the presence of endemisms and some species given as extinct or doubtful for Portugal (Vieira *et al*., 2005) in the Portuguese Red Lists (Sérgio *et al.*, 1994, 2006). The taxa number found is equivalent to about 16% of all bryophyte taxa recognized in the Iberian Peninsula, and 10% of the recognized values for Europe (ECCB, 1995; Sérgio *et al.*, 2006). On the other hand, some of the taxa listed are also important because of their chorology. Many of the populations of freshwater Atlantic bryophytes recorded in the studied area (*e.g. Isothecium holtii, Fissidens polyphyllus, Heterocladium wulfsbergii, Amphidium mougeotii, Fontinalis squamosa* var. *dixonii, Grimmia lisae, Plagiothecium succulentum, Platyhypnidium lusitanicum, Hyocomium armoricum, Saccogyna viticulosa, Dumortiera hirsuta, Riccardia chamedryfolia, Racomitrium hespericum, Nardia compressa, Lejeunea lamacerina, Radula holtii*; Ratcliffe, 1968) are particularly important since (i) the northwestern streams correspond to their suitable habitat in Portugal, (ii) Atlantic taxa found in Portugal are amongst the most threatened by changes in thermal conditions and hydrological regimes, and (iii) mainland Portugal corresponds to the European southern limit of distribution of some Atlantic taxa (Fig. 4).

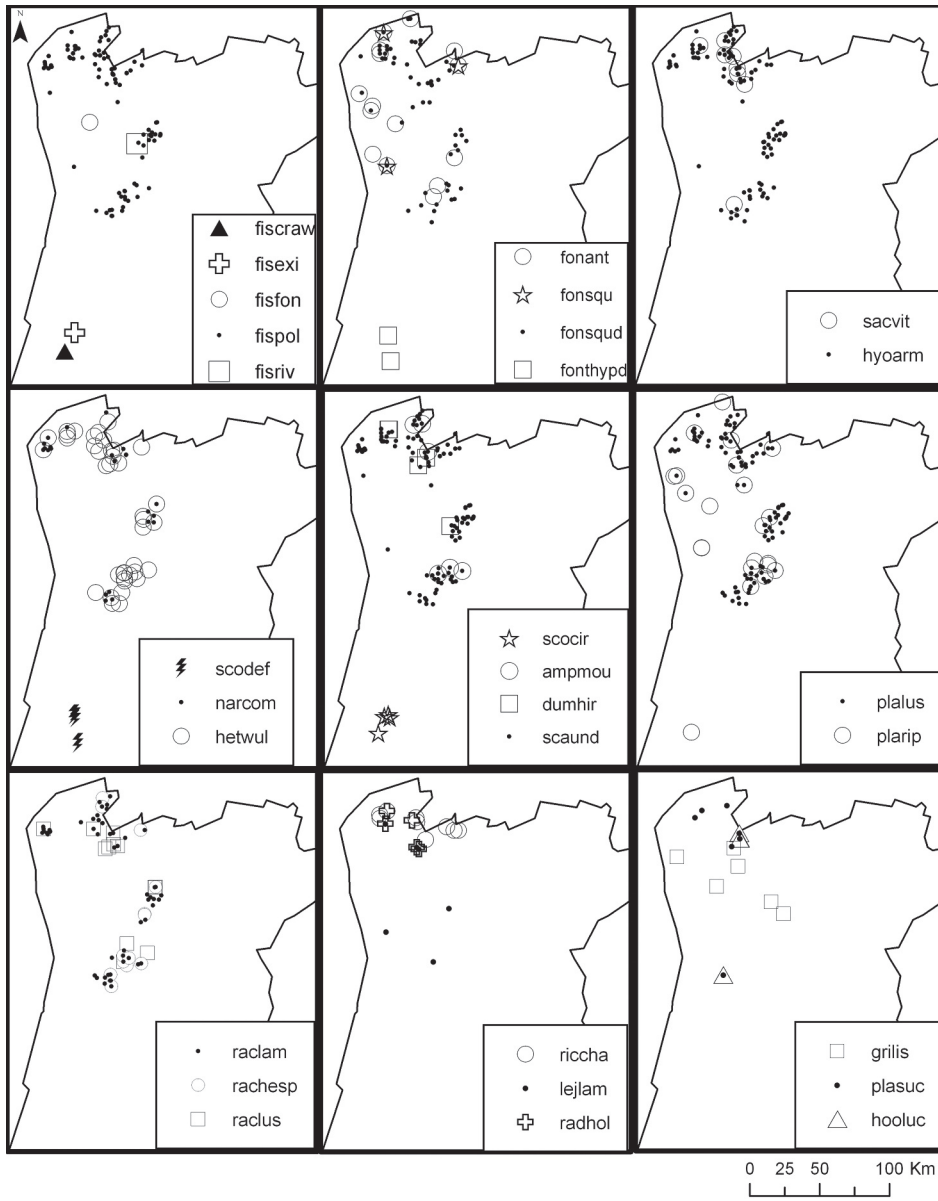


Fig. 4. Distribution maps for selected species found in the studied area (**fiscraw**: *Fissidens crassipes* subsp. *warnstorffii*; **fisexi**,: *Fissidens exilis*; **fisriv**: *Fissidens rivularis*; **fisfon**: *Fissidens fontanus*; **fispol**: *Fissidens polyphyllus*; **fonthypd**: *Fontinalis hypnoides* var. *duriaei*; **fonant**: *Fontinalis antipyretica s.l.*; **fonsqud**: *Fontinalis squamosa* var. *dixonii*; **fonsqu**: *Fontinalis squamosa* var. *squamosa;* **hyoarm**: *Hyocomium armoricum*; **sacvit**: *Saccogyna viticulosa;* **scodef**: *Scorpidium deflexifolium*; **narcom**: *Nardia compressa*; **hetwul**: *Heterocladium wulfsbergii*; **scocir**: *Scorpidium circinatum;* **ampmou**: *Amphidium mougeotii*; **dumhir**: *Dumortiera hirsuta*; **scaund**: *Scapania undulata*; **plalus**: *Platyhypnidium lusitanicum*; **plarip**: *Platyhypnidium riparioides*; **raclam**: *Racomitrium lamprocarpum*; **rachesp**: *Racomitrium hespericum*; **raclus**: *Racomitrium lusitanicum*; **riccha**: *Riccardia chamaedryfolia*; **lejlam**: *Lejeunea lamacerina*; **radhol**: *Radula holtii*; **grilis**: *Grimmia lisae*; **isohol**: *Isothecium holtii*; **plasuc**: *Plagiothecium succulentum*; **hooluc**: *Hookeria lucens*).

CONCLUSION

Bryophytes are a conspicuous part of the freshwater biodiversity in Portugal. These ecosystems display a level of bryophyte richness comparable to the river systems at similar altitude ranges of other countries of Europe. Despite the originality on the species catalogue and dominating taxa, we found similar bryophyte zonation patterns along the different micro-habitats mainly defined by hydrologic and lithologic factors.

This study also underlines the importance of conservation of different types of watercourses for the survival of the whole diversity of Portuguese bryophytic taxa, which showed a restricted distribution dependent on fluvial integrity and specific climate and geological contexts.

Acknowledgements. We thank Fundação para Ciência e Tecnologia (FCT), for providing funds through doctoral and post-doctoral grants (SFRH/BD/6969/2001; SFRH/BPD/63741/2009) to the first author.

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APPENDIX 1

List of sampled localities, with their province acronym and UTM 1×1 km coordinates (Portuguese provinces: Mi: Minho; TM: Trás-os-Montes e Alto Douro; DL: Douro Litoral; BL: Beira Litoral; BA: Beira Alta). (Obs: some localities share UTM coordinates because they correspond to different segments of the same watercourse).

1: TM, Ribeira do Arnal; PF0075
2: TM, Ribeira de Teixeira; NF9779
3: TM, Ribeira do Porto; PF0480
4: TM, Regato do Cabril; PF0480
5: TM, Regato do Cabril tributary; PF0479
6: TM, Ribeira da Cunca; PF0379
7: TM, Regato da Fraga do Raio; PF0682
8: TM, Ribeira de Teixeira tributary; NF9879
9: TM, Rio Poio; PF0288
10: TM, Rio do Sião; NF9378
11: TM, Ribeira de Azevinheiro; NF9272
12: TM, Rio Cabrão; NF9683
13: TM, Rio Olo; NF9881
14: TM, Ribeiro do Osso; NF9469
15: TM, Ribeiro dos Moinhos; NF9469
16: DL, Ribeiro da Póvoa; NF8966
17: DL, Rio Marão; NF9070
18: TM, Rio Seromelha; NF9565
19, 20: DL, Rio Teixeira; NF9163
21: TM, Rio Sôrdo; PF0269
22: TM, Rio Olo; NF9280
23: TM, Ribeira do Chão tributary; NF9174
24, 25: TM, Ribeira de Aveleiras tributary; NF9987
26: TM, Ribeira de Alvadia; PF0188
27: TM, Ribeira de Aveleiras tributary; NF9986
28: TM, Rio Olo; PF0180
29: DL, Ribeiro das Covas; NF8774
30: DL, Ribeira do Sabugueiro; NF8974
31: TM, Ribeira do Velho; NF8974
32: DL, Ribeiro das Covas tributary; NF8773
33: TM, Ribeiro de Vila Cova; NF9676
34: TM, Rio Olo; PF0080
35: Mi, Ribeira de S. João; NG2231
36: Mi, Fundo do Cavalinho; NG2629
37: Mi, Ribeiro da Cerquido; NG2728
38: Mi, Regueiro da Outra Banda tributary; NG2427
39: Mi, Regato Grande tributary; NG2427
40: Mi, Regato Grande tributary; NG2527
41: Mi, Regueiro dos Enxurros; NG2228
42: Mi, Regueiro da Fisga; NG2230
43: Mi, Ribeiro Bufo; NG2526
44: Mi, Rio Âncora; NG2127
45: Mi, Regato Grande tributary; NG2528
46: Mi, Ribeiro da Fonte da Cruz; NG2527
47: Mi, Riomao; NG3934
48: Mi, Rio Coura tributary; NG3935
49: Mi, Rio Frio tributary; NG4034
50: Mi, Ribeira da Pantanha; NG3741
51: Mi, Rio dos Cavaleiros; NG3835
52: Mi, Rio dos Cavaleiros; NG3838
53: Mi, Rio Frio tributary; NG4234
54: Mi, Ribeira do Padroso; NG4343
55: Mi, Cascata do Padroso; NG4443
56: Mi, Ribeira de Cambela; NG4440
57, 58: Mi, Rio de Codeceda; NG3843
59: Mi, Rio Coura; NG3840
60, 61: Mi, Ribeiro do Rio de Moinhos; NG4238
62: DL, Ribeiro Pequenino tributary; NF6624
63: BA, Ribeira de Paivô tributary; NF7020
64: BA, Cascata da Silha; NF6619
65: DL, Rio Arda tributary; NF5925
66: DL, Frecha da Mizarela; NF6023
67: BA, Rio Paiva; NF7930
68: BA, Ribeiro de Covas do Rio tributary; NF7828
69: BA, Ribeira de Pena; NF7725
70: BA, Ribeira de Varosa; NF7517
71: BA, Ribeira do Ninho do Corvo; NF7018
72: BA, Ribeiro Escuro; NF7022
73: BA, Ribeira de Paivô; NF7022
74: DL, Ribeira da Pena Amarela; NF6525
75: DL, Ribeira de Paivô; NF6829
76: DL, Ribeira de Frades; NF6826

77: DL, Rio Paivô; NF7026
78: Mi, Ribeiro do Forno; NG7227
79: Mi, Ribeiro de Freitas tributary; NG6517
80: Mi, Rio Caldo; NG6616
81: Mi, Ribeiro do Pedredo; NG6926
82: Mi, Ribeira da Pena Longa; NG7027
83: Mi, Cascata de Leonte; NG7023
84: Mi, Ribeira da Auguinha; NG7019
85: Mi, Ribeira da Laja; NG7122
86: TM, Rio Homem; NG7929
87: TM, Rio Homem; NG7828
88: Mi, Cascata da Laja ; NG7023
89: Mi, Ribeira da Laja; NG7022
90: Mi, Rio Gerês; NG6917
91, 92: Mi, Rio Arado; NG7219
93: Mi, Rio Ermida; NG7217
94: Mi, Rio Cávado; NG7515
95: TM, Rio Cávado; NG8826
96: Mi, Rio Conho; NG7518
97: TM, Ribeira de Cabril; NG8019
98: TM, Ribeira da Abelheira; NG8325
99: TM, Rio Cávado tributary; NG8825
100: TM, Ribeira do Beredo; NG8632
101, 102: TM, Ribeira da Ponte Pequena; NG9140
103: Ribeira do Rio Mau; NG9129
104, 105: TM, Ribeira de Cabril; NG8024
106: TM, Rio Cávado; NG7516
107: Mi, Rio Castro Laboreiro; NG6953
108: Mi, Rio Trancoso; NG6856
109: Mi, Rio Mouro; NG6653
110: Mi, Rio Mouro; NG6654
111, 112: Mi, Porto dos Lobos; NG6146
113: Mi, Rio Pomba; NG6249
114: Mi, Ribeiro da Moadoira; NG6452
115: Mi, Rio Castro Laboreiro; NG6744
116: Mi, Ribeiro dos Ossos; NG6747
117: Mi, Rio de Tieiras; NG6550
118: Mi, Rio Peneda; NG6446
119, 120: Mi, Rio Adrão; NG6136
121: Mi, Rio Bordença; NG6140
122: Mi, Ribeiro de Várzea; NG6438
123: Mi, Ribeira de João Paz; NG5737
124: Mi, Ribeira da Lapa tributary; NG5836
125: Mi, Ribeira de Cruz; NG6735
126: Mi, Ribeira de Soutelo; NG6535
127: Mi, Rio da Ponte; NG6434
128: Mi, Rio Froufe; NG5830
129: Mi, Ribeira de Germil; NG6126
130: Mi, Rio Lima tributary; NG6034
131: Mi, Rio Lima waterfall; NG6536
132: BA, Ribeiro da Moura Morta; NF9234
133: BA, Rio Balsemão; NF9041
134: BA, Ribeira do Rossão; NF8937
135: DL, Ribeira de S. Martinho; NF9147
136: DL, Ribeira de Fazamões; NF9145
137: TM, Rio das Poldras; NF9641
138: BA, Ribeira da Fraga do Meio Alqueire; NF9033
139: BA, Ribeira da Carvalhosa; NF8835
140: DL, Ribeiro da Gralheira tributary; NF8740
141: DL, Ribeiro do Taquinho; NF8744
142: DL, Rio Cabrum; NF8645
143: BA, Ribeiro das Fragas do Inferno; NF8132
144: BA, Ribeiro de Meã; NF7933
145: BA, Ribeiro Tenente; NF7935
146: BA, Ribeira das Levadas; NF7635
147: DL, Ribeiro de Bustelo; NF7538
148: DL, Rio Ardena; NF7138
149: DL, Ribeira de Covais; NF7939
150: DL, Ribeira de Tendais; NF7939
151: DL, Ribeiro de Alhões; NF8338
152: DL, Ribeira de Bestança; NF7943
153: DL, Rio Cabrum; NF8248
154: Mi, Ribeira de Frades; NG4641
155: Mi, Rio Coura; NG2536
156: Mi, Rio Coura tributary; NG2536
157: Mi, Rio Ázere; NG4935
158: Mi, Rio Vez; NG4831
159: Mi, Rio Minho; NG5862
160: Mi, Ribeiro do Porto; NG6063
161: Mi, Ribeira da Gadanha; NG4153
162: TM, Rio Cávado; NG9429
163: Mi, Rio Neiva; NG2510
164: Mi, Ribeira dos Reis Magos; NG2409
165: Mi, Rio Cávado; NF3297
166: Mi, Rio Selho; NF5587
167: Mi, Rio Ave; NF5488
168: Mi, Rio Pele; NF4988
169: DL, Rio Ave; NF2278
170: Mi, Ribeiro das Pontes; NG3300
171: DL, Ribeira do Arquinho; NF3366
172: Mi, Rio Homem; NG6021
173: Mi, Rio Ave; NG6903
174: Mi, Rio Ave; NG7403
175: Mi, Rio Pequeno; NF6299
176: BL, Ribeira de Mouros tributary; NE4037
177: BL, Ribeira de Mouros; NE4338
178: BL, Ribeira de Mouros; NE4436
179: BL, Ribeira de Mouros tributary; NE4536
180: BL, Rio Anços; NE3625
181: BL, Rio Anços; NE3526
182: BL, Rio Nabão; NE4618
183: DL, Regato da Carvoeira; NF4358
184, 185: DL, Rio Ferreira tributary; NF4357
186: DL, Rio Simão; NF4358
187: DL, Rio Ferreira; NF4358

APPENDIX 2

Catalogue of bryophytes from Portuguese watercourses. For parameter acronyms and explanations see Table 1. Data locations (L) are represented by numbers (for locations codes see Appendix 1). New records in Portuguese provinces (*) followed by the code of the province; new species to the national catalogue (**); species considered to be extinct or doubtful in the Portuguese Red Lists (Sérgio *et al.*, 1994, 2006) (●); doubtful or data deficient species by the time the most recent national catalogues were established (Sérgio and Carvalho 2003) (†); European endemism (˚); Iberian endemism (►).

MARCHANTIOPHYTA (LIVERWORTS)

***Aneura pinguis* (L.) Dumort**; **L:** 6, 52, 53, 54, 55, 65, 80, 82, 84, 88, 89, 94, 99, 120, 122, 130, 146, 161; **RS:** S2, S3, S4, S5, S6; **MH:** Esc2, Cas3, Cor2-3, Rap3; **SV:** s (i, e) (0.3 - 0.4); **DR:** 0 to 40; SD: 61-100%; **LI:** g, q, co,x; **AL**; 45-966

***Calypogeia fissa* (L.) Raddi**; **L:** 3, 4, 77, 81, 85, 162, 185; **RS:** S3, S4, S5; **MH:** Cas3, Cor2-4, Rap3-4; **SV:** s (i, e) (0.01); **DR:** 0 to 50; **SH:** 0-100%; **LI:** q, x, gr, g; **AL:** 80-940

***Cephalozia bicuspidata* (L.) Dumort**.; **L:** 78, 85, 105, 113, 155, 156, 183; **RS:** S3, S4, S5; **MH:** Cor2-3, Rap2-3; **SV:** i (e, s) (0.1); **DR:** 0 to 100; **SH:** 0-100%; **LI:** x, g, ga; **AL:** 100-970

***Chiloscyphus polyanthos* (L.) Corda**; **L:** 11, 15, 29, 52, 54, 59, 75, 79, 84, 85, 86, 88, 89, 99, 100, 101, 117, 122, 126, 135, 136, 142, 144, 146, 148, 153, 154, 157, 158, 159, 161, 162, 163, 172, 175; **RS:** S1, S3, S4, S5, S6; **MH:** Esc1, Cas2, Cor1-2, Rap2-3; **SV:** i (e, s) (0.25 - 2.9); **DR:** -10 to 50; **SH:** 0-100%; **LI:** ca, x, gr, co, ga, g; **AL:** 20-1440

***Conocephalum conicum* (L.) Dumort.**; **L:** 29, 54, 79, 126, 130, 135, 158, 170, 171, 172, 174, 175; **RS:** S2, S4, S5; **MH:** Esc2, Cas3, Cor2-3, Rap2-3; **SV:** s (i, e) (0.97); **DR:** 0 to 100; **SH:** 0-100%; **LI:** ca, ga, g; **AL:** 20-510

***Diplophyllum albicans* (L.) Dumort.**; **L:** 5, 8, 23, 26, 38, 63, 78, 81, 83, 99, 104, 113, 117, 121, 156, 185; **RS:** S1, S3, S4; **MH:** Esc2, Cas3, Cor3-4, Rap3-4; **SV:** s (e); **DR:** 0 to 100; **SH:** 0-100%; **LI:** q, x, gr, ga, g; **AL:** 80-970

***Dumortiera hirsuta* (Sw.) Nees**; **L:** 29, 54, 55, 79, 88; *DL; **RS:** S4, S5; **MH:** Esc2, Cas3, Cor2, Rap3; **SV:** s; **DR:** 0 to 30; **SH:** 41-100%; **LI:** g, ca; **AL:** 240-670

˚ ***Gymnomitrion crenulatum* Gottsche *ex* Carrington**; **L:** 92; **RS:** S5; **MH:** Cor3, Rap3; **SV:** e; **DR:** 30 to 80; **SH:** 0-20%; **LI:** g; **AL:** 700

***Jungermannia gracillima* Sm.**; **L:** 3, 24, 28, 30, 35, 37, 63, 77, 86, 92, 131, 143, 155, 172; **RS:** S1, S2, S3, S4, S5; **MH:** Esc2, Cor2-3, Rap3; **SV:** e (s, i) (0 - 1.4); **DR:** -10 to 40; **SH:** 0-40%; **LI:** co, x, q, ga, g; **AL:** 100-1440

***Jungermannia hyalina* Lyell**; **L:** 3, 5, 6, 16, 18, 19, 26, 30, 58, 68, 69, 72, 85, 93, 94, 98, 100, 103, 111, 113, 115, 122, 139, 144, 157, 162, 172, 185; **RS:** S3, S4, S5; **MH:** Esc2, Cor2-3, Rap3; **SV:** s (e, i) (0.1 - 1.5); **DR:** -10 to 90; **SH:** 0-40%; **LI:** co, x, gr, q, ga, g; **AL:** 65-970

† ***Jungermannia obovata* Nees**; **L:** 58, 117; *Mi; **RS:** S4; **MH:** Cas2, Rap2; **SV:** s; **DR:** 0 to 20; **SH:** 61-80%; **LI:** x, g; **AL:** 430-865

***Jungermannia pumila* With.**; **L:** 17, 98; *DL, *TM; **RS:** S4, S5; **MH:** Cas2, Rap2; **SV:** i (0 – 0,01); **DR:** -10 to 0; **SH:** 21-80%; **LI:** x, gr, g; **AL:** 850-852

***Jungermannia sphaerocarpa* Hook.**; **L:** 19, 103; *TM; **RS:** S4, S5; **MH:** Cor2-3, Rap3; **SV:** i (e) (0.6 - 1.5); **DR:** -10 to 10; **SH:** 61-80%; **LI:** x, gr, g; **AL:** 750-904

***Lejeunea cavifolia* (Ehrh.) Lindb.; L:** 53, 54, 56, 75, 79, 80, 82, 85, 88, 90, 126, 137, 141, 142, 144, 146, 151, 163, 177; **RS:** S4, S5, S6; **MH:** Esc2, Cas3, Cor3-4, Rap3-4; **SV:** s (e); **DR:** 0 to 80; **SH:** 0-100%; **LI:** co, q, x, gr, g, cm; **AL:** 20-950

***Lejeunea lamacerina* (Steph.) Schiffn.; L:** 29, 53, 79, 80, 146, 185; *BA, *DL; **RS:** S4, S5; **MH:** Cas3, Cor3, Rap3-4; **SV:** s (e); **DR:** 0 to 80; **SH:** 41-100%; **LI:** co, x, gr, g, ca; **AL:** 80-560

***Lunularia cruciata* (L.) Lindb.; L:** 29, 67, 80, 153, 162, 163, 168, 177; **RS:** S4, S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e (i) (0); **DR:** 0 to 100; **SH:** 0-80%; **LI:** x, gr, g, ca, cm; **AL:** 20-890

***Marchantia polymorpha* L.; L:** 18, 29, 53, 54, 89, 90, 120, 130, 162; **RS:** S2, S4, S5, S6; **MH:** Esc2, Cas3, Cor3, Rap3; **SV:** s (e); **DR:** 0 to 60; **SH:** 61-100%; **LI:** q, x, g, ca; **AL:** 70-890

***Marsupella emarginata* (Ehrh.) Dumort. subsp. *aquatica* (Lindenb.) Meyl.; L:** 8, 9, 13, 23, 26, 28, 34, 42, 45, 72, 83, 109, 113, 116, 138, 139, 156; *Mi, *BA, *TM; **RS:** S1, S3, S4, S5; **MH:** Cas2, Cor1-3, Rap1-3; **SV:** i (s, e) (0 - >3); **DR:** -30 to 90; **SH:** 0-100%; **LI:** gr, x, ga, g; **AL:** 100-1010

Marsupella emarginata* (Ehrh.) Dumort. subsp. *emarginata; **L:** 3, 9, 10, 11, 13, 19, 24, 26, 36, 38, 39, 41, 42, 43, 44, 62, 63, 71, 72, 74, 76, 78, 81, 85, 91, 92, 95, 96, 99, 103, 104, 113, 114, 116, 117, 119, 121, 123, 128, 129, 139, 149, 150, 184, 185; **RS:** S1, S3, S4, S5; **MH:** Cas3, Cor1-3, Rap1-3; **SV:** e (s, i) (0 - 1.4); **DR:** 0 to 100; **SH:** 0-100%; **LI:** q, co, x, ga, g; **AL:** 80-980

***Marsupella sphacelata* (Gieseke *ex* Lindenb.) Dumort**.; **L:** 1, 7, 34, 43, 44, 45, 46, 72, 86, 92, 110, 115, 138, 143; **RS:** S1, S3, S4, S5; **MH:** Cas2, Cor1-2, Rap2; **SV:** i (e, s) (0 - 1.3); **DR:** -20 to 60; **SH:** 0-40%; **LI:** co, x, ga, g; **AL:** 200-1440

***Nardia compressa* (Hook.) Gray**; **L:** 1, 9, 12, 33, 34, 35, 36, 37, 40, 41, 44, 58, 62, 63, 64, 76, 83, 87, 91, 92, 104, 105, 110, 156; *BA; **RS:** S1, S3, S4, S5; **MH:** Cas1-2, Cor1-2, Rap1-2; **SV:** i (s, e) (0 - >3); **DR:** -40 to 40; **SH:** 0-100%; **LI:** co, q, x, ga, g; **AL:** 100-1343

***Nardia scalaris* Gray**; **L:** 23; *TM; **RS:** S3; **MH:** Cas3; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** x; **AL:** 970

***Pellia endiviifolia* (Dicks.) Dumort.**; **L:** 136; *DL; **RS:** S4; **MH:** Rap3; **SV:** s; **DR:** 0; **SH:** 61-80%; **LI:** g; **AL:** 710

***Pellia epiphylla* (L.) Corda**; **L:** 1, 3, 4, 5, 8, 11, 18, 19, 22, 23, 24, 29, 30, 33, 35, 36, 53, 54, 59, 63, 65, 69, 78, 79, 80, 82, 83, 85, 88, 89, 92, 98, 99, 100, 103, 104, 109, 111, 113, 117, 120, 122, 124, 125, 130, 134, 137, 142, 144, 145, 146, 150, 154, 156, 157, 161, 162, 172; **RS:** S1, S2, S3, S4, S5, S6; **MH:** Esc2, Cor3-4, Rap3-4, Cas3; **SV:** s (e); **DR:** ; **SH:** ; **LI:** q, x, gr, co, ga, g; **AL:** 45-1070

***Plagiochila porelloides* (Torrey *ex* Nees) Lindenb.**; **L:** 137, 144, 151; **RS:** S4, S5; **MH:** Esc2, Rap3, Cas3; **SV:** e (s); **DR:** 0 to 20; **SH:** 41-100%; **LI:** x, gr, g; **AL:** 700

***Porella cordaeana* (Huebener) Moore**; **L:** 137; **RS:** S5; **MH:** Cas3; **SV:** e; **DR:** 0; **SH:** 61-80%; **LI:** g; **AL:** 700

• ***Porella pinnata* L.**; **L:** 54, 59, 159, 163; **RS:** S5, S6; **MH:** Rap3, Cas3; **SV:** e (s, i) (0 – 0.01); **DR:** 0 to 30; **SH:** 41-100%; **LI:** g, ga; **AL:** 20-370

• ∞ ***Radula holtii* Spruce**; **L:** 53, 54, 79, 80, 120; **RS:** S4, S5, S6; **MH:** Esc2, Cas3; **SV:** s; **DR:** 0; **SH:** 41-100%; **LI:** g; **AL:** 170-330

***Riccardia chamaedryfolia* (With.) Grolle**; **L:** 52, 54, 59, 85, 100, 103, 122, 126, 162; **RS:** Seg. S4, S5; **MH:** Cas3, Cor1-2, Rap2; **SV:** i (e, s) (0.4 - 0.97); **DR:** -10 to 50; **SH:** 41-100%; **LI:** ga, g; **AL:** 210-904

***Riccardia multifida* (L.) Gray**; **L:** 18, 54, 55, 79, 88, 89, 94, 130, 146; **RS:** S2, S4, S5; **MH:** Esc2, Cas3, Cor2, Rap3; **SV:** s (i, e) (0 – 0.01); **DR:** 0 to 80; **SH:** 61-100%; **LI:** q, co, x g; **AL:** 70-814

† ***Riccia huebeneriana* Lindenb.**; **L:** 183; *DL; **RS:** S3; **MH:** Esc2; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** x; **AL:** 110

∞ ***Saccogyna viticulosa* (L.) Dumort.**; **L:** 54, 75, 82, 88, 94, 111, 120, 125; *DL, *TM; **RS:** S2, S4, S5, S6; **MH:** Esc2, Cas3, Cor2, Rap3; **SV:** s (i, e) (0.3 - 0.4); **DR:** 0 to 40; **SH:** 41-100%; **LI:** x, g; **AL:** 235-800

***Scapania compacta* (A. Roth) Dumort.**; **L:** 3, 4, 10, 24, 27, 30, 31, 41, 44, 62, 72, 78, 92, 96, 113, 121, 128, 129, 137, 138, 145, 149, 185; **RS:** S3, S4, S5; **MH:** Cas3, Cor3-4, Rap3-4; **SV:** e (s); **DR:** 0 to 100; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 80-980

***Scapania nemorea* (L.) Grolle**; **L:** 8, 53, 61, 81, 122, 144, 156; **RS:** S4, S5; **MH:** Cas3, Cor3-4, Rap3-4; **SV:** e (s, i) (0 - 1.5); **DR:** 0 to 60; **SH:** 81-100%; **LI:** x, gr, g, ga; **AL:** 100-800

***Scapania undulata* (L.) Dumort.**; **L:** 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 14, 16, 17, 18, 19, 20, 22, 23, 24, 26, 27, 28, 30, 33, 34, 35, 36, 37, 39, 40, 41, 42, 44, 45, 46, 47, 49, 51, 52, 53, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 68, 69, 70, 71, 72, 78, 80, 81, 83, 85, 86, 87, 88, 89, 92, 93,

98, 99, 100, 101, 102, 103, 104, 105, 108, 109, 110, 111, 112, 113, 114, 116, 117, 118, 120, 122, 123, 125, 128, 129, 132, 134, 137, 138, 139, 140, 141, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 154, 155, 156, 157, 158, 162, 163, 172, 174, 185; **RS:** S1, S2, S3, S4, S5, S6; **MH:** Esc1-2, Cas1-3, Cor1-2, Rap1-3; **SV:** i (s, e) (0 - >3); **DR:** -40 to 100; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 20-1440

***Trichocolea tomentella* (Ehrh.) Dumort.**; **L:** 80; **RS:** S5; **MH:** Esc2; **SV:** s; **DR:** 0; **SH:** 41-60%; **LI:** g; **AL:** 170

***Tritomaria quinquedentata* (Huds.) H. Buch; L:** 99; *TM; **RS:** S4; **MH:** Cas3; **SV:** s; **DR:** 0; **SH:** 41-60%; **LI:** g; **AL:** 755

BRYOPHYTA (MOSSES)

***Amphidium mougeotii* (Schimp.) Schimp.**; **L:** 78, 111, 116, 137, 141, 149; *DL; **RS:** S4, S5; **MH:** Cas3, Cor3, Rap3-4; **SV:** s (e); **DR:** 0 to 60; **SH:** 0-100%; **LI:** g; **AL:** 690-880

***Andreaea rothii* F.Weber *et* D.Mohr subsp. *falcata* (Schimp.) Lindb.**; **L:** 23, 38, 43, 45, 66; *DL; **RS:** S1, S3, S4; **MH:** Cor3-4, Rap3-4, Cas3; **SV:** s (i, e) (0 - 0.01); **DR:** 0 to 80; **SH:** 0-20%; **LI:** x, ga; **AL:** 458-970

***Atrichum undulatum* (Hedw.) P.Beauv.**; **L:** 8, 26, 44, 53, 59, 65, 67, 80, 81, 85, 157, 168, 172, 173, 185, 187**RS:** S3, S4, S5; **MH:** Cas3, Cor3, Rap3; **SV:** s (e) ; **DR:** -10 to 80; **SH:** 0-80%; **LI:** co, x, gr, ga, g; **AL:** 65-910

** ***Blindia acuta* (Hedw.) Bruch & Schimp.**; **L:** 103; * TM; **RS:** S4; **MH:** Cor3; **SV:** s; **DR:** 20; **SH:** 61-80%; **LI:** g; **AL:** 904

***Brachythecium rivulare* Schimp.**; **L:** 10, 11, 14, 15, 25, 29, 32, 51, 52, 53, 54, 59, 60, 65, 67, 70, 79, 80, 82, 84, 88, 89, 94, 95, 99, 100, 101, 102, 103, 112, 130, 132, 135, 136, 137, 141, 142, 144, 146, 148, 152, 153, 154, 158, 162, 163, 165, 168, 172, 174, 177 ; *BL; **RS:** S2, S3, S4, S5, S6; **MH:** Esc1-2, Cas1-3, Cor2-3, Rap2-3; **SV:** i (e, s) (0 - >3); **DR:** -10 to 100; **SH:** 0-100%; **LI:** x, co, gr, ga, g, ca, cm; **AL:** 20-1000

***Brachythecium rutabulum* (Hedw.) Schimp.**; **L:** 154, 177, 187; **RS:** S4, S5; **MH:** Cor3; **SV:** e; **DR:** 0 to 100; **SH:** 0-60%; **LI:** x, ga, g, cm; **AL:** 80-100

***Bryum alpinum* Huds. *ex* With.**; **L:** 1, 3, 7, 15, 23, 24, 25, 27, 30, 32, 37, 38, 39, 41, 43, 44, 45, 46, 67, 68, 69, 76, 86, 93, 96, 105, 110, 115, 131, 138, 184, 185, 187; **RS:** S1, S2, S3, S4, S5; **MH:** Esc2, Cas3, Cor3, Rap3-4; **SV:** s (i, e) (0 - 0.76); **DR:** 0 to 100; **SH:** 0-60%; **LI:** q, co, x, gr, ga, g; **AL:** 80-1440

***Bryum argenteum* Hedw.**; **L:** 162, 167, 186, 187; **RS:** S5; **MH:** Cor3, Rap3; **SV:** s (e); **DR:** 0 to 60; **SH:** 0-80%; **LI:** x, g; **AL:** 70-890

***Bryum capillare* Hedw.**; **L:** 21, 80, 115, 153, 159, 162, 163, 168, 173; **RS:** S4, S5, S6; **MH:** Esc2, Cor3-4, Rap3-4; **SV:** e; **DR:** 0 to 100; **SH:** 0-80%; **LI:** ga, g; **AL:** 20-890

***Bryum gemmiferum* R.Wilczek *et* Demaret**; **L:** 158, 163, 165, 183, 186; *DL; **RS:** S3, S5, S6; **MH:** Esc2, Rap3; **SV:** s (i, e) (0.01 - 0.1); **DR:** 0 to 40; **SH:** 0-40%; **LI:** x, ga; **AL:** 20-110

***Bryum gemmiparum* De Not.**; **L:** 16, 21, 22, 32, 67, 70, 96, 107, 115, 138, 143, 148, 149, 157, 158, 159, 160, 162, 165, 167, 173, 174, 186, 187; *Mi, *BA, *DL, *TM; **RS:** S3, S4, S5, S6; **MH:** Esc2, Cor3-4, Rap3-4; **SV:** i (e, s) (0 - 2.5); **DR:** -20 to 40; **SH:** 0-80%; **LI:** co, x, gr, ga, g; **AL:** 20-943

Bryum pseudotriquetrum* (Hedw.) P.Gaertn. *et al.; **L:** 1, 2, 3, 11, 12, 14, 15, 16, 20, 22, 25, 26, 28, 29, 34, 49, 53, 67, 69, 75, 84, 89, 93, 96, 98, 99, 100, 105, 107, 111, 112, 115, 118, 120, 130, 131, 137, 143, 145, 157, 161, 163, 165, 168, 172, 174, 177, 183, 184; **RS:** S3, S4, S5, S6; **MH:** Esc2, Cor2-3, Rap2-3; **SV:** s (i, e) (0.03 - 2.7); **DR:** -10 to 70; **SH:** 0-80%; **LI:** q, x, gr, ga, g, ca, cm; **AL:** 20-1010

***Bryum torquescens* Bruch *et* Schimp.**; **L:** 177, 179, 180; **RS:** S2, S3, S5; **MH:** Cor3, Rap3; **SV:** e; **DR:** 0 to 100; **SH:** 0-80%; **LI:** cm, t; **AL:** 90-140

***Calliergonella cuspidata* (Hedw.) Loeske**; **L:** 29, 159, 172; **RS:** S4, S5, S6; **MH:** Cor3, Rap3-4; **SV:** s (i, e) (0 - 0.01); **DR:** 0 to 80; **SH:** 0-80%; **LI:** ga, g, ca; **AL:** 30-510

***Campylopus introflexus* (Hedw.) Brid.**; **L:** 14; *TM; **RS:** S3; **MH:** Cor3; **SV:** e; **DR:** 0 to 30; **SH:** 81-100%; **LI:** x, gr; **AL:** 674

***Campylopus pilifer* Brid.**; **L:** 16, 30, 32, 38, 41, 43, 44, 45, 67, 68, 96, 187; **RS:** S1, S3, S4, S5; **MH:** Cor3; **SV:** e; **DR:** 0 to 100; **SH:** 0-40%; **LI:** co, x, gr, ga, g; **AL:** 80-750

***Campylopus pyriformis* (Schultz) Brid.**; **L:** 45, 185; *DL; **RS:** S1, S4; **MH:** Cor3, Rap3; **SV:** e (s); **DR:** 0 to 30; **SH:** 0-60%; **LI:** x, gr; **AL:** 80-750

***Cinclidotus aquaticus* (Hedw.) Bruch *et* Schimp.**; **L:** 180, 181; **RS:** S2, S5; **MH:** Cas2, Cor1-2, Rap1-2; **SV:** i (e) (0 - 2.81); **DR:** -60 to 40; **SH:** 0-20%; **LI:** cm, t; **AL:** 60-90

***Cinclidotus fontinaloides* (Hedw.) P.Beauv.**; **L:** 15, 67, 90, 159, 176, 177, 178, 180, 181, 182 ; *TM; **RS:** S2, S4, S5, S6; **MH:** Cas2, Cor1-2, Rap1-2; **SV:** e (i, s) (0 - 1.4); **DR:** 0 to 100; **SH:** 0-20%; **LI:** x, gr, g, cm, t; **AL:** 30-654

***Cinclidotus riparius* (Host *ex* Brid.) Arn.**; **L:** 178; *BL; **RS:** S5; **MH:** Cor1-2, Rap1-2; **SV:** i (e) (0); **DR:** 0 to 60; **SH:** 0-20%; **LI:** cm; **AL:** 150

***Cirriphyllum crassinervium* (Taylor) Loeske *et* M.Fleisch.**; **L:** 137; *TM; **RS:** S5; **MH:** Rap3; **SV:** e; **DR:** 0; **SH:** 61-80%; **LI:** g; **AL:** 700

• ***Climacium dendroides* (Hedw.) F.Weber *et* D.Mohr**; **L:** 159; **RS:** S6; **MH:** Cor2; **SV:** i (0); **DR:** 0 to 30; **SH:** 0-20%; **LI:** g; **AL:** 30

***Cratoneuron filicinum* (Hedw.) Spruce**; **L:** 176, 180, 181; **RS:** S2, S5; **MH:** Cas2, Cor1-2, Rap1-2; **SV:** i (e, s) (0 - 2.81); **DR:** -10 to 100; **SH:** 0-20%; **LI:** t; **AL:** 40-90

***Dendrocryphaea lamyana* (Mont.) P.Rao**; **L:** 163; **RS:** S6; **MH:** Rap3; **SV:** e; **DR:** 0 to 20; **SH:** 0-20%; **LI:** g; **AL:** 20

Dialytrichia mucronata* (Brid.) Broth. var. *mucronata; **L:** 159, 162, 177, 182; **RS:** S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e (i, s) (0); **DR:** 0 to 100; **SH:** 0-80%; **LI:** g, cm; **AL:** 30-890

** ***Dichodontium pellucidum* (Hedw.) Schimp.**; **L:** 29; *DL; **RS:** S4; **MH:** Cor3; **SV:** e; **DR:** 0 to 30; **SH:** 61-80%; **LI:** ca; **AL:** 510

***Dicranella heteromalla* (Hedw.) Schimp.**; **L:** 24, 44, 76, 78, 99, 172; **RS:** S3, S4, S5; **MH:** Cas3, Cor3-4, Rap3-4; **SV:** s (e); **DR:** 0 to 100; **SH:** 0-100%; **LI:** co, q, x, ga, g; **AL:** 130-980

Didymodon luridus* Hornsch.**; **L:** 159, 176, 177, 178, 179; **RS:** S2, S3, S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e (i, s) (0 - 0.01); **DR:** 0 to 100; **SH:** 0-80%; **LI:** g, cm; **AL:** 30-150Didymodon insulanus* (De Not.) M.O.Hill**; **L:** 14, 21, 29, 75, 135, 136, 158, 159, 162, 163, 168, 170, 177, 178, 180, 182; **RS:** S2, S3, S4, S5, S6; **MH:** Esc2, Cor3-4, Rap3-4; **SV:** e (i) (0 - 0.01); **DR:** 0 to 100; **SH:** 0-80%; **LI:** q, x, gr, ga, g, ca; **AL:** 20-890

***Diphyscium foliosum* (Hedw.) D.Mohr; L:** 5, 38, 71, 78, 85, 116, 117, 129, 150; **RS:** S3, S4; **MH:** Cas3, Cor3-4, Rap3-4; **SV:** s (e); **DR:** 0 to 100; **SH:** 0-100%; **LI:** q, ga, g; **AL:** 580-958

***Drepanocladus aduncus* (Hedw.) Warnst.**; **L:** 180; **RS:** S2; **MH:** Cor2, Rap2; **SV:** i (e) (0 - 0.9); **DR:** -60 to 40; **SH:** 0-20%; **LI:** t; **AL:** 90

***Eucladium verticillatum* (With.) Bruch *et* Schimp.**; **L:** 177, 180; **RS:** S2, S5; **MH:** Esc2, Rap3; **SV:** e, s; **DR:** 0; **SH:** 0-80%; **LI:** cm, t; **AL:** 90-100

Fissidens bryoides* Hedw. var. *bryoides; **L:** 51, 165; **RS:** S4, S5; **MH:** Cor3, Rap3; **SV:** i (e) (0 - 0.01); **DR:** 0 to 40; **SH:** 0-41%; **LI:** ga, g; **AL:** 20-570

***Fissidens bryoides* Hedw. var. *caespitans* Schimp.**; **L:** 3, 4, 9, 10, 14, 15, 16, 17, 18, 28, 29, 30, 31, 51, 59, 61, 65, 69, 75, 77, 80, 88, 90, 100, 105, 107, 111, 126, 128, 130, 140, 144, 151, 155, 158, 161, 162, 163, 165, 172, 174, 183, 185; **RS:** S2, S3, S4, S5, S6; **MH:** Esc2, Cas3, Cor2-3, Rap2-3; **SV:** e (i, s) (0.01 - 1.3); **DR:** -10 to 80; **SH:** 0-100%; **LI:** q, x, gr, ga, g, ca; **AL:** 20-1050

***Fissidens crassipes* Wilson *ex* Bruch *et* Schimp. subsp. *warnstorffii* (M.Fleisch.) Brugg.-Nann.**; **L:** 180; **RS:** S2; **MH:** Rap3; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** t; **AL:** 90

***Fissidens dubius* P.Beauv.**; **L:** 14, 80, 90, 141, 144, 146, 163; *DL; **RS:** S2, S3, S4, S5, S6; **MH:** Esc2, Cor3, Rap3; **SV:** e (s); **DR:** 0 to 60; **SH:** 0-100%; **LI:** co, x, gr, g; **AL:** 20-880

† ***Fissidens exilis* Hedw.**; **L:** 177; **RS:** S5; **MH:** Cor3; **SV:** e; **DR:** 0 to 30; **SH:** 61-80%; **LI:** cm; **AL:** 100

***Fissidens fontanus* (Bach.Pyl.) Steud.**; **L:** 167; *Mi; **RS:** S5; **MH:** Cor2; **SV:** i (1.2); **DR:** -20 to 0; **SH:** 41-60%; **LI:** g; **AL:** 90

***Fissidens polyphyllus* Wilson *ex* Bruch *et* Schimp.**; **L:** 1, 2, 3, 4, 5, 8, 9, 11, 12, 13, 19, 22, 26, 28, 30, 33, 35, 36, 37, 39, 40, 41, 42, 44, 48, 49, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 65, 68, 69, 72, 73, 76, 77, 78, 80, 81, 82, 83, 85, 88, 91, 92, 93, 94, 98, 100, 101, 103, 104, 105, 108, 109, 111, 113, 116, 117, 119, 120, 121, 122, 123, 124, 125, 127, 128, 129, 137, 139, 141, 142, 143, 144, 145, 146, 147, 149, 150, 154, 155, 156, 157, 161, 163, 172, 174, 185; **RS:** S1, S2, S3, S4, S5, S6; **MH:** Esc1-2, Cas2-3, Cor1-3, Rap2-3; **SV:** i (e, s) (0 - >3); **DR:** -10 to 60; **SH:** 41-60%; **LI:** q, co, x, gr, ga, g; **AL:** 20-1070

***Fissidens pusillus* (Wilson) Milde**; **L:** 6, 16, 22, 53, 54, 57, 60, 79, 88, 90, 95, 102, 103, 122, 130, 137, 141, 142, 144, 146, 148, 154, 158, 163, 169, 174, 175, 186, 187; *Mi, *DL, *TM; **RS:** S2, S4, S5, S6; **MH:** Esc2, Cas2, Cor2, Rap2-3; **SV:** i (s, e) (0.4 - 2.09); **DR:** -10 to 20; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 5-966

***Fissidens rivularis* (Spruce) Schimp.**; **L:** 29; **RS:** S4; **MH:** Cor2, Rap2-3; **SV:** i (s) (0.35 - 1.2); **DR:** -5 to 5; **SH:** 61-80%; **LI:** ca; **AL:** 510

***Fissidens serrulatus* Brid.**; **L:** 10, 14, 16, 52, 53, 54, 55, 65, 77, 78, 79, 81, 82, 85, 88, 96, 100, 111, 116, 117, 130, 142, 144, 146, 151, 155, 157, 172, 174; **RS:** S2, S3, S4, S5; **MH:** Esc2, Cas3, Cor3, Rap3-4; **SV:** i (s, e) (0.01 - 1.68); **DR:** 0 to 100; **SH:** 0-100%; **LI:** co, x, gr, ga, g; **AL:** 65-950

***Fissidens taxifolius* Hedw.**; **L:** 29; *DL; **RS:** S4; **MH:** Esc2, Cas3, Cor3, Rap3-4; **SV:** s; **DR:** 0 to 20; **SH:** 61-80%; **LI:** ca; **AL:** 510

Fontinalis antipyretica* Hedw. subsp. *antipyretica; **L:** 20, 52, 59, 102, 146, 152, 160, 161, 162, 164, 165, 168, 170, 171, 187; **RS:** S4, S5; **MH:** Lag1-2, Cor1, Rap1; **SV:** i (e, s) (0 - 2.5); **DR:** -100 to 30; **SH:** 61-80%; **LI:** co, x, ga, g; **AL:** 20-890

***Fontinalis antipyretica* Hedw. subsp. *gracilis* (Lindb.) Kindb.**; **L:** 7, 59, 88, 133, 134, 139, 148; *BA, *DL, *TM; **RS:** S3, S4, S5; **MH:** Lag1-2, Cor1, Rap1; **SV:** i (s) (0 - 0.95); **DR:** -20 to 40; **SH:** 0-80%; **LI:** ga, g; **AL:** 284-1020

***Fontinalis hypnoides* C.Hartm. var. *duriaei* (Schimp.) Kindb.**; **L:** 178, 182; **RS:** S5; **MH:** Cor1-3, Rap1-3; **SV:** i (e) (0); **DR:** 0 to 100; **SH:** 0-20%; **LI:** cm; **AL:** 150-185

***Fontinalis squamosa* Hedw. var. *dixonii* (Cardot) A.J.E.Sm.**; **L:** 1, 2, 11, 12, 15, 16, 22, 49, 52, 53, 54, 56, 57, 58, 59, 61, 65, 67, 69, 70, 75, 80, 93, 94, 95, 96, 97, 100, 103, 106, 111, 115, 116, 118, 128, 132, 137, 138, 140, 141, 142, 148, 154, 155, 157, 158, 159, 160, 161, 163, 165, 167, 172, 173, 174, 175, 187 ; *Mi, *BA, *DL, *TM; **RS:** S4, S5, S6; **MH:** Lag1-2, Cor1-2, Rap1-2; **SV:** i (s, e) (0 - >3); **DR:** -50 to 40; **SH:** 0-100%; **LI:** co, x, gr, ga, g; **AL:** 20-1050

Fontinalis squamosa* Hedw. var. *squamosa; **L:** 161, 162, 187; **RS:** S5; **MH:** Cor1-2, Rap1-2; **SV:** i (s) (0.15 - 1.95); **DR:** -100 to 50; **SH:** 0-80%; **LI:** x, g; **AL:** 45-890

***Funaria hygrometrica* Hedw.**; **L:** 30, 67, 186, 187**RS:** S5; **MH:** Cor2-3, Rap3; **SV:** e; **DR:** 0 to 100; **SH:** 0-41%; **LI:** x, gr; **AL:** 70-530

***Grimmia lisae* De Not.**; **L:** 10, 21, 80, 163, 167, 173; **RS:** S4, S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e; **DR:** 0 to 60; **SH:** 0-60%; **LI:** gr, ga, g; **AL:** 20-650

***Grimmia montana* Bruch *et* Schimp.**; **L:** 12, 184**RS:** S2, S4; **MH:** Esc2, Cas3; **SV:** e (s); **DR:** 0; **SH:** 0-20%; **LI:** q, x, g; **AL:** 84-757

***Heterocladium wulfsbergii* I.Hagen**; **L:** 1, 9, 10, 11, 22, 44, 51, 52, 56, 59, 65, 69, 70, 71, 72, 78, 80, 82, 85, 90, 96, 103, 116, 121, 123, 127, 128, 129, 137, 139, 140, 142, 144, 145, 147, 149, 150, 151, 156; **RS:** S4, S5; **MH:** Esc2, Cas2-3, Cor2-3, Rap3-4; **SV:** e (i, s) (0.25 - 1.72); **DR:** -20 to 100; **SH:** 0-80%; **LI:** q, co, x, gr, ga, g; **AL:** 80-1050

***Hookeria lucens* (Hedw.) Sm.**; **L:** 65, 82, 88, 89; **RS:** S4; **MH:** Cas3, Cor3; **SV:** s; **DR:** 0 to 20; **SH:** 41-100%; **LI:** ga, g; **AL:** 630-830

***Hygrohypnum ochraceum* (Turner *ex* Wilson) Loeske**; **L:** 16, 52, 53, 54, 59, 80, 90, 95, 100, 101, 102, 103, 106, 137, 140, 142, 148, 154, 155, 158, 160, 161, 162, 163, 173; *DL; **RS:** S4, S5, S6; **MH:** Cas2, Cor1-2, Rap1-2; **SV:** i (s, e) (0.26 - >3); **DR:** -40 to 100; **SH:** 0-100%; **LI:** co, x, ga, g; **AL:** 20-1050

***Hyocomium armoricum* (Brid.) Wijk *et* Margad.**; **L:** 1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 16, 17, 18, 19, 22, 24, 26, 28, 30, 31, 33, 35, 36, 37, 41, 42, 44, 47, 49, 52, 53, 54, 56, 57, 58, 59, 61, 62, 64, 65, 69, 70, 72, 73, 77, 78, 79, 80, 81, 82, 85, 88, 92, 93, 96, 97, 98, 100, 103, 104, 105, 107, 108, 109, 111, 113, 114, 115, 116, 117, 118, 120, 121, 122, 123, 125, 127, 129, 131, 132, 134, 137, 139, 140, 141, 142, 144, 145, 147, 149, 150, 154, 155, 156, 157, 161, 162, 172, 174, 185; **RS:** S1, S2, S3, S4, S5, S6; **MH:** Esc1-2, Cas2-3, Cor2-3, Rap2-3; **SV:** i (e, s) (0 - >3); **DR:** -20 to 90; **SH:** 0-80%; **LI:** q, co, x, gr, ga, g; **AL:** 45-1070

∞ ***Isothecium holtii* Kindb.**; **L:** 8, 9, 10, 11, 12, 22, 26, 44, 51, 52, 53, 56, 59, 61, 65, 71, 78, 80, 81, 85, 88, 90, 95, 96, 100, 103, 104, 116, 117, 119, 121, 123, 127, 128, 129, 134, 135, 137, 140, 141, 142, 145, 147, 149, 150, 151, 152, 153, 157, 162, 173; *DL, *TM; **RS:** S3, S4, S5; **MH:** Esc2, Cor3-4, Rap3-4; **SV:** e (s, i) (0 - 1.9); **DR:** -10 to 100; **SH:** 0-100%; **LI:** co, x, gr, ga, g; **AL:** 65-1050

***Isothecium myosuroides* Brid.**; **L:** 152; **RS:** S5; **MH:** Rap4; **SV:** e; **DR:** 30 to 80; **SH:** 21-40%; **LI:** g; **AL:** 300

***Kindbergia praelonga* (Hedw.) Ochyra**; **L:** 3, 14, 18, 24, 25, 26, 28, 29, 53, 61, 65, 79, 85, 128, 130, 134, 135, 147, 151, 154, 155, 156, 157, 159, 161, 162, 163, 167, 168, 172, 177, 180, 185; **RS:** S2, S3, S4, S5, S6; **MH:** Esc2, Cas3, Cor3-4, Rap3-4; **SV:** e (s, i) (0.01 - 0.96); **DR:** -10 to 80; **SH:** 0-60%; **LI:** q, x, gr, ga, g, ca, cm; **AL:** 20-1020

***Leptodictyum riparium* (Hedw.) Warnst.**; **L:** 158, 160, 164, 165, 166, 167, 170, 186, 187; **RS:** S5, S6; **MH:** Cor1-2, Rap1-3; **SV:** i (s, e) (0 - 2.5); **DR:** -20 to 60; **SH:** 0-60%; **LI:** x, g; **AL:** 20-140

***Leskea polycarpa* Hedw.**; **L:** 159, 163; **RS:** S6; **MH:** Cor3-4, Rap3-4; **SV:** i (e, s) (0); **DR:** 0 to 100; **SH:** 0-20%; **LI:** g; **AL:** 20-30

***Mnium hornum* Hedw.**; **L:** 3, 10, 18, 24, 25, 26, 28, 60, 65, 109, 134, 139, 149, 151, 155, 157, 162, 185; **RS:** S1, S3, S4, S5; **MH:** Esc2, Cas3, Cor3, Rap3; **SV:** s (e, i) (0.01 - 0.1); **DR:** 0 to 60; **SH:** 0-100%; **LI:** q, x, gr, ga, g; **AL:** 65-1020

***Philonotis caespitosa* Jur.**; **L:** 67, 99, 183 ; *TM; **RS:** S3, S4, S5; **MH:** Esc2, Cas3, Cor2; **SV:** s (i) (0.01 - 0.1); **DR:** 0 to 100; **SH:** 0-60%; **LI:** x, gr, g; **AL:** 110-755

***Philonotis fontana* (Hedw.) Brid.**; **L:** 3, 7, 15, 23, 24, 25, 27, 30, 39, 67, 89, 99, 105, 112, 115, 130, 131, 151, 159, 162, 172; **RS:** S2, S3, S4, S5, S6; **MH:** Esc1-2, Cas2-3, Cor2-3, Rap3; **SV:** s (i, e) (0.01 - 0.04); **DR:** 0 to 100; **SH:** 0-60%; **LI:** x, gr, ga, g; **AL:** 30-1000

***Philonotis rigida* Brid.**; **L:** 120, 131; **RS:** S2; **MH:** Esc2; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** g; **AL:** 235-300

***Philonotis seriata* Mitt.**; **L:** 84; **RS:** S3; **MH:** Cas3; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** g; **AL:** 645

***Plagiomnium undulatum* (Hedw.) T.J.Kop.**; **L:** 25, 29, 52, 53, 54, 59, 61, 65, 75, 79, 81, 82, 85, 88, 99, 109, 111, 122, 129, 136, 141, 142, 146, 150, 153, 155, 157, 162, 163, 172; **RS:** S1, S3, S4, S5, S6; **MH:** Esc2, Cas3, Cor3-4, Rap3-4; **SV:** s (e); **DR:** 0 to 80; **SH:** 0-100%; **LI:** co, x, ga, ca; **AL:** 20-1000

***Plagiothecium nemorale* (Mitt.) A.Jaeger**; **L:** 14, 17, 18, 53, 65, 99, 120, 122, 130, 141, 144, 146, 147, 162, 172, 185; *DL; **RS:** S2, S3, S4, S5, S6; **MH:** Esc2, Cas3, Cor3, Rap3; **SV:** s (e); **DR:** 0 to 80; **SH:** 41-100%; **LI:** q, co, x, gr, ga, g; **AL:** 70-890

***Plagiothecium succulentum* (Wilson) Lindb.**; **L:** 52, 54, 65, 79, 82, 88, 111; *DL; **RS:** S4, S5; **MH:** Esc2, Cas3, Cor3, Rap3; **SV:** s; **DR:** 0 to 80; **SH:** 41-100%; **LI:** ga, g; **AL:** 240-830

∞ ***Platyhypnidium lusitanicum* (Schimp.) Ochyra *et* Bednarek-Ochyra**; **L:** 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 30, 31, 37, 39, 41, 44, 48, 49, 50, 51, 52, 56, 57, 58, 59, 60, 64, 65, 66, 67, 68, 69, 70, 71, 73, 75, 76, 77, 78, 79, 80, 81, 88, 89, 91, 93, 95, 96, 97, 98, 100, 102, 103, 105, 106, 107, 111, 113, 114, 115, 116, 118, 119, 120, 121, 123, 124, 127, 128, 129, 132, 137, 138, 139, 140, 141, 142, 143, 145, 146, 147, 149, 150, 151, 152, 155, 157, 158, 161, 162, 163, 165, 173, 174; **RS:** S3, S4, S5, S6; **MH:** Esc1, Cas1-2 Cor1-2, Rap1-2; **SV:** i (s, e) (0 - >3); **DR:** -30 to 100; **SH:** 0-60%; **LI:** q, co, x, gr, ga, g; **AL:** 20-1050

***Platyhypnidium riparioides* (Hedw.) Dixon; L:** 22, 29, 59, 67, 90, 126, 134, 135, 136, 137, 152, 153, 159, 162, 163, 164, 165, 168, 174, 180, 186, 187; **RS:** S2, S4, S5, S6; **MH:** Cas1-2 Cor1-2, Rap1-2; **SV:** i (s, e) (0 - 2.81); **DR:** -20 to 70; **SH:** 0-60%; **LI:** x, ga, g, ca, t; **AL:** 20-1020

† ***Pohlia annotina* (Hedw.) Lindb.**; **L:** 24, 30, 63, 155, 162; *Mi; *TM; **RS:** S1, S3, S5; **MH:** Esc2, Cor3, Rap3; **SV:** s (e) ; **DR:** 0 to 50; **SH:** 0-80%; **LI:** x, ga, g; **AL:** 100-980

***Pohlia cruda* (Hedw.) Lindb**.; **L:** 29; **RS:** S4; **MH:** Rap3; **SV:** e; **DR:** 0 to 10; **SH:** 61-80%; **LI:** ca; **AL:** 510

***Pohlia nutans* (Hedw.) Lindb.**; **L:** 76; *DL; **RS:** S5; **MH:** Rap4; **SV:** e; **DR:** 20 to 100; **SH:** 0-20%; **LI:** x, q; **AL:** 270

***Polytrichastrum formosum* (Hedw.) G.L.Sm.**; **L:** 18, 67, 158, 185; **RS:** S4, S5; **MH:** Cor3-4, Rap4; **SV:** e; **DR:** 0 to 50; **SH:** 0-100%; **LI:** q, x, gr, ga, g; **AL:** 20-814

***Polytrichum commune* Hedw.**; **L:** 3, 4, 5, 7, 9, 11, 12, 13, 19, 22, 23, 24, 25, 26, 27, 28, 30, 31, 33, 34, 35, 36, 37, 41, 42, 43, 44, 45, 46, 47, 54, 62, 63, 64, 65, 67, 71, 72, 73, 74, 76, 77, 80, 81, 85, 86, 91, 93, 100, 107, 109, 111, 113, 115, 116, 118, 121, 122, 123, 124, 127, 129, 131, 132, 134, 138, 145, 149, 150, 151, 154, 156, 157, 158; **RS:** S1, S2, S3, S4, S5; **MH:** Esc2, Cas3, Cor2-3, Rap2-3; **SV:** s (i, e) (0 - 2.03); **DR:** -10 to 100; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 20-1440

***Pseudotaxiphyllum elegans* (Brid.) Z.Iwats.**; **L:** 4, 38, 185; *DL; **RS:** S3, S4; **MH:** Cas3, Cor3-4, Rap3; **SV:** e (s); **DR:** 0 to 40; **SH:** 0-100%; **LI:** q, x, gr, ga; **AL:** 80-940

∞ ***Ptychomitrium polyphyllum* (Dicks. *ex* Sw.) Bruch *et* Schimp.**; **L:** 80, 146; **RS:** S4, S5; **MH:** Cor3-4; **SV:** e; **DR:** 30 to 80; **SH:** 0-80%; **LI:** co, x, g; **AL:** 170-560

***Racomitrium aciculare* (Hedw.) Brid.**; **L:** 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 30, 31, 32, 34, 35, 38, 39, 40, 41, 42, 44, 45, 46, 50, 51, 52, 53, 56, 58, 59, 61, 62, 63, 65, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 80, 81, 83, 85, 86, 88, 90, 91, 93, 95, 96, 97, 98, 100, 103, 104, 105, 106, 107, 109, 110, 111, 113, 114, 115, 116, 117, 118, 119, 121, 123, 127, 128, 132, 133, 134, 135, 136, 137, 138, 139, 140, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 156, 157, 161, 162, 165, 172, 173, 174, 183, 187; **RS:** S1, S3, S4, S5; **MH:** Esc2, Cas3, Cor2-3, Rap2-4; **SV:** e (i, s) (0 - >3); **DR:** -10 to 100; **SH:** 0-100%; **LI:** q, co, gr, ga, g; **AL:** 20-1440

***Racomitrium affine* (F.Weber *et* D.Mohr) Lindb.**; **L:** 3, 75; **RS:** S4, S5; **MH:** Cor3; **SV:** e (s); **DR:** 0 to 30; **SH:** 41-80%; **LI:** g; **AL:** 170-890

***Racomitrium aquaticum* (Brid. *ex* Schrad.) Brid.**; **L:** 6, 11, 38, 41, 42, 43, 45, 72, 76, 99, 114, 149, 156, 184, 185, 187; **RS:** S1, S3, S4, S5; **MH:** Esc2, Cas3, Cor2-3, Rap3; **SV:** e (i, s) (0.01 - 1.2); **DR:** -5 to 70; **SH:** 0-100%; **LI:** q, x, gr, ga, g; **AL:** 80-966

► ***Racomitrium hespericum* Sérgio, J.Muñoz *et* Ochyra**; **L:** 9, 14, 15, 71, 77, 103, 114, 118, 132, 143, 145, 149, 151; **RS:** S3, S4, S5; **MH:** Cas3, Cor2-3, Rap3; **SV:** e (s, i) (0.01 – 0.1); **DR:** 0 to 80; **SH:** 0-80%; **LI:** co, x, gr, ga, g; **AL:** 280-950

***Racomitrium lamprocarpum* (Müll.Hal.) A.Jaeger**; **L:** 1, 2, 4, 7, 9, 12, 13, 18, 19, 26, 28, 35, 36, 37, 39, 40, 41, 42, 43, 44, 62, 64, 65, 66, 71, 72, 73, 76, 77, 78, 81, 93, 96, 105, 107, 113, 115, 116, 118, 119, 121, 123, 127, 128, 129, 132, 138, 145, 148, 149, 151, 152, 157, 162; **RS:** S3, S4, S5; **MH:** Esc2, Cas3, Cor2-3, Rap2-3; **SV:** e (i, s) (0 - >3); **DR:** -10 to 100; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 65-1010

► ***Racomitrium lusitanicum* Ochyra *et* Sérgio**; **L:** 9, 26, 42, 78, 80, 90, 92, 96, 128, 137, 145, 153; *DL, *TM; **RS:** S3, S4, S5; **MH:** Cor2-3, Rap2-3; **SV:** s (e, i) (0.01 – 0.1); **DR:** 0 to 100; **SH:** 0-100%; **LI:** x, gr, ga, g; **AL:** 80-930

***Rhizomnium punctatum* (Hedw.) T.J.Kop.**; **L:** 3, 6, 10, 14, 24, 25, 26, 51, 53, 54, 56, 60, 65, 80, 85, 88, 89, 90, 99, 103, 108, 111, 113, 122, 126, 134, 135, 136, 137, 139, 140, 142, 144, 145, 149, 150, 155, 156, 157, 159, 162; **RS:** S3, S4, S5, S6; **MH:** Esc2, Cas3, Cor3, Rap3; **SV:** s (e, i) (0 - 0.38); **DR:** -15 to 80; **SH:** 0-100%; **LI:** q, x, gr, ga, g; **AL:** 30-1050

Rhynchostegiella curviseta* (Brid.) Limpr. var. *curviseta; **L:** 177; **RS:** S5; **MH:** Cor3; **SV:** e; **DR:** 0 to 100; **SH:** 61-80%; **LI:** cm; **AL:** 100

***Schistidium apocarpum* (Hedw.) Bruch *et* Schimp.**; **L:** 29, 80, 90, 95, 135, 136, 146, 152; *DL, *TM; **RS:** S4, S5; **MH:** Cor3-4, Rap4; **SV:** e (s); **DR:** 0 to 100; **SH:** 0-100%; **LI:** g, ca; **AL:** 160-800

• ***Schistidium rivulare* (Brid.) Podp.**; **L:** 21, 59, 95, 142, 152, 153, 159, 162; *DL, *TM; **RS:** S5, S6; **MH:** Esc2, Cor3-4, Rap3-4; **SV:** e; **DR:** 0 to 100; **SH:** 0-80%; **LI:** ga, g; **AL:** 30-890

***Sciuro-hypnum plumosum* (Hedw.) Ignatov *et* Huttunen**; **L:** 8, 10, 11, 22, 50, 51, 52, 53, 54, 56, 59, 61, 75, 80, 90, 95, 100, 103, 111, 116, 117, 127, 139, 140, 142, 144, 147, 148, 149, 151, 152, 153, 157, 161, 162, 163, 165, 167, 172; **RS:** S4, S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e (i, s) (0.01 - 0.6); **DR:** 0 to 100; **SH:** 0-60%; **LI:** x, gr, ga, g; **AL:** 20-1050

***Scleropodium touretii* (Brid.) L.F.Koch**; **L:** 67, 159, 173, 179; **RS:** S3, S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e (i, s) (0); **DR:** 0 to 100; **SH:** 0-20%; **LI:** x, gr, ga, g, cm; **AL:** 30-230

***Scorpiurium circinatum* (Bruch) M.Fleisch. *et* Loeske**; **L:** 176, 177, 178, 180; **RS:** S2, S5; **MH:** Cor3-4, Rap3-4; **SV:** e; **DR:** 0 a 100; **SH:** 0-60%; **LI:** cm, t; **AL:** 40-150

***Scorpiurium deflexifolium* (Solms) M.Fleisch. *et* Loeske**; **L:** 177, 178, 182; **RS:** S5; **MH:** Cor3-4; **SV:** e; **DR:** 20 to 100; **SH:** 0-80%; **LI:** cm; **AL:** 100-185

***Sphagnum auriculatum* Schimp.; L:** 1, 3, 4, 5, 7, 28, 30, 33, 39, 44, 68, 80, 84, 86, 87, 98, 103, 109, 111, 115, 134, 150, 157, 162, 185; **RS:** S1, S3, S4, S5; **MH:** Lag1-2, Esc2, Cas3, Cor3, Rap3; **SV:** s (i, e) (0 - 0.85); **DR:** -100 to 60; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 65-1440

***Sphagnum capillifolium* (Ehrh.) Hedw.**; **L:** 124; **RS:** S4; **MH:** Esc2; **SV:** s; **DR:** 0; **SH:** 81-100%; **LI:** g; **AL:** 400

***Thamnobryum alopecurum* (Hedw.) Gangulee**; **L:** 6, 29, 51, 52, 53, 55, 56, 59, 61, 65, 67, 82, 84, 85, 88, 90, 101, 136, 140, 142, 144, 146, 152, 161, 163, 165, 168, 172, 174, 185, 187; **RS:** S3, S4, S5, S6; **MH:** Esc2, Cas2-3, Cor2-3, Rap2-3; **SV:** i (s, e) (0 - >3); **DR:** -10 to 100; **SH:** 0-100%; **LI:** q, co, x, gr, ga, g; **AL:** 20-1050

† ∞ ***Thamnobryum maderense* (Kindb.) Hedenäs**; **L:** 15, 53, 54, 65, 75, 79, 80, 111, 122, 135, 136, 137, 142; *DL; **RS:** S4, S5; **MH:** Esc2, Cas2-3, Cor2-3, Rap2-3; **SV:** i (s, e) (0.4 - >3); **DR:** -5 to 100; **SH:** 41-100%; **LI:** q, x, gr, ga, g; **AL:** 170-830

***Thuidium tamariscinum* (Hedw.) Schimp.**; **L:** 65, 72, 82, 85, 150; **RS:** S4; **MH:** Cor3-4, Rap4, Cas3; **SV:** s (e, i) (0.01 - 0.4); **DR:** 0 to 100; **SH:** 41-100%; **LI:** ga, g; **AL:** 630-830

***Timmiella barbuloides* (Brid.) Mönk.**; **L:** 177; **RS:** S5; **MH:** Cor3; **SV:** e; **DR:** 0 to 100; **SH:** 61-80%; **LI:** cm; **AL: 100**

***Tortella flavovirens* (Bruch) Broth.**; **L:** 177, 178, 181; **RS:** S5; **MH:** Cor4, Rap4; **SV:** e; **DR:** 20 to 100; **SH:** 0-80%; **LI:** cm; **AL:** 60-150

***Tortella tortuosa* (Hedw.) Limpr.**; **L:** 180; **RS:** S2; **MH:** Rap2; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** t; **AL:** 90

***Trichostomum brachydontium* Bruch**; **L:** 59, 153, 163,168, 179; **RS:** S3, S5, S5, S6; **MH:** Cor3-4, Rap3-4; **SV:** e; **DR:** 0 to 70; **SH:** 0-60%; **LI:** g, ga, cm; **AL**: 40-150

***Trichostomum crispulum* Bruch**; **L:** 163, 176, 178, 179; **RS:** S2, S3, S5, S6; **MH:** Cor3-4, Rap4; **SV:** e; **DR:** 0 to 100; **SH:** 0-20%; **LI:** g, cm; **AL:** 40-150

***Warnstorfia exannulata* (Schimp.) Loeske**; **L:** 46; *Mi; **RS:** S1; **MH:** Cor1; **SV:** i (0.04 - 0.76); **DR:** 0 to 10; **SH:** 0-20%; **LI:** ga; **AL:** 760

ANTOCEROTOPHYTA (HORNWORTS)

***Phaeoceros laevis* (L.) Prosk.**; **L:** 130, 131; **RS:** S2; **MH:** Esc2; **SV:** s; **DR:** 0; **SH:** 0-20%; **LI:** g; **AL:** 70-300