



BRYOMOLECULES

List of new liverworts collected

D1.2

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BRYOMOLECULES Project



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Project information

Project acronym	BRYOMOLECULES
Project title:	Bioprospecting and production of bioactive molecules from European bryophytes
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Table 1 Project information

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0.1	24/09/2025	Nils Cronberg	Preliminary draft
0.2	26/09/2025	Mehrdad Jaber, Mingai Li, Claudio Varotto	Final draft
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Table 2 Document's update



Acknowledgement and disclaimer



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The BRYOMOLECULES project

Liverworts, an ancient group of land plants, are a rich yet underexploited source of a wide range of biologically active compounds with high potential for the bioeconomy sector as ingredients of cosmetics/cosmeceuticals and pharmaceuticals. However, their slow growth rate in nature and the consequent difficulty in obtaining large amounts of single compounds have, until now, severely hindered the in-depth exploration and exploitation of the full spectrum of activities of liverwort secondary metabolites. Recent breakthroughs in the identification of some of the genes involved in the early steps of liverwort-specific compounds suggest that, in addition to the establishment of improved methods for growth in axenic conditions, reconstruction of liverwort metabolic pathways in heterologous systems is a promising way forth towards the practical exploitation of liverwort biochemical diversity and its industrial scale up.

BRYOMOLECULES will provide actionable knowledge on European bryophyte species and their biosynthetic genes, which can be used to produce sustainable, bio-based cosmetics and pharmaceuticals ingredients for the European market.

To do so, the BRYOMOLECULES project will use a combination of the cultivation of axenic cultures and the production of the active compounds in heterologous systems to define the most suitable production platform(s) for their large-scale production. The project will achieve a very sustainable use of the chemical diversity of wild EU bryophyte species, a largely untapped source of high-added-value natural products, without significant impacts on their biodiversity.

Besides the identification of relevant lead compounds for cosmetics/cosmeceuticals and pharmaceuticals, another major impact of the project will be the production and release according to FAIR principles of a database of metabolites and biosynthetic genes of European bryophyte species that will fuel in the years to come the development of novel bio-based products based on bryophyte-derived lead compounds, according to the concept of EU valorising biodiversity for EU bioeconomy.



Project Consortium Members









 FONDAZIONE EDMUND MACH dal 1874	Fondazione Edmund Mach (FEM)
 HIT HUB INNOVAZIONE TRENTO	Fondazione HUB Innovazione Trentino (HIT) FEM LTP
 UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE	Université Jean Monnet Saint-Etienne (UJM)
 PAT Plant Advanced Technologies	Plant Advanced Technologies Pat Sa (PAT)
 Bionos Testing Efficacy	Bionos Biotech SI (BIONOS)
 LUNDS UNIVERSITET	Lunds Universitet (LU)
 UNIWERSYTET MEDYCYN W LUBLINIE	Uniwersytet Medyczny w Lublinie (UM)
 ESF Your Partner in Science	European Science Foundation (ESF)

Table 3 Consortium members



Summary

In this deliverable, we present liverworts which have been selected and collected for downstream analyses in the BRYOMOLECULES project. Plant material has been mostly collected from Sweden, as well as from Iceland and Italy. The list includes collection information, such as sampling place, coordinates, date of sampling, and collector names.

Sterile accessions have been achieved by surface sterilisation of either sporophytes or vegetative plant material with a 0.05% solution of Sodium Dichloroisocyanurate for 1-2 minutes, followed by washing with sterile deionised water. Accessions are maintained on Petri dishes with 1% agar in a medium as described by Rudolph et al. (1988). The medium was 2 times the original formulation with an addition of 12 mg of the fungicide Benomyl per litre to reduce the risk of fungal contamination. If needed, samples have been treated to eliminate infections by cyanobacteria using the antibiotic erythromycin. Collections are maintained in a culture room under artificial LED-tube light, 16/8 day/night cycles and a mean temperature of 20° C.

The collection contains a wide range of liverworts, including both thallose species and leafy liverworts. Taxon names are provided according to Hodgetts et al. (2020). Eventual synonyms used at the moment of collection are listed. The third column indicates what are the accessions for which stable sterile cultures have been obtained. The fourth column indicates whether multiple accession for the same taxon where collected. The fifth column indicates whether the corresponding taxon was used for transcriptomics analyses (See D3.1).

References:

Rudolph, H., Kirchhoff, M., Gliesmann, S. *Sphagnum* culture techniques. *Proc. Methods in Bryology, Nichinan, 1988:25–34*: Hattori Botanical Laboratory

Hodgetts, N. G., L. Söderström, T. L. Blockeel, et al. “An Annotated Checklist of Bryophytes of Europe, Macaronesia and Cyprus.” *Journal of Bryology* 42, no. 1 (2020): 1–116. <https://doi.org/10.1080/03736687.2019.1694329>.

Data

Species (Hodgetts et al. 2020)	Synonym	Sterile culture available	Multiple accessions	RNA-Seq
<i>Bazzania trilobata</i>		YES	YES	YES
<i>Blepharostoma trichophyllum</i>		YES	YES	YES
<i>Calypogeia integrastipula</i>		YES	NO	YES
<i>Calypogeia muelleriana</i>		NO	NO	YES
<i>Cephalozia indet</i>		YES	NO	YES
<i>Cephalozia ambigua</i>		YES	NO	YES
<i>Cephalozia bicuspidata</i>		YES	YES	YES
<i>Fuscocephaloziopsis connivens</i>	<i>Cephalozia connivens</i>	YES	NO	YES



<i>Fuscocephaloziopsis lunulifolia</i>	<i>Cephalozia lunulifolia</i>	YES	YES	YES
<i>Chiloscyphus polyanthos</i>		YES	YES	YES
<i>Crossocalyx hellerianus</i>		YES	NO	YES
<i>Diplophyllum albicans</i>		YES	YES	YES
<i>Fossombronia foveolata</i>		YES	NO	YES
<i>Frullania dilatata</i>		YES	YES	YES
<i>Frullania tamarisci</i>		YES	YES	YES
<i>Gymnocolea inflata</i>		YES	NO	YES
<i>Jungermannia leiantha</i>		YES	NO	YES
<i>Mesoptychia badensis</i>	<i>Leiocolea badensis</i>	YES	NO	YES
<i>Lepidozia reptans</i>		NO	YES	YES
<i>Lophocolea bidentata</i>		NO	YES	YES
<i>Lophocolea heterophylla</i>		YES	YES	YES
<i>Lophozia longidens</i>	<i>Lophozia longidens</i>	YES	NO	YES
<i>Lophozia longiflora</i>		YES	YES	YES
<i>Marsupella sprucei</i>		YES	NO	YES
<i>Metzgeria furcata</i>		NO	YES	YES
<i>Mylia anomala</i>		YES	YES	YES
<i>Nardia scalaris</i>		YES	NO	YES
<i>Nowellia curvifolia</i>		YES	YES	YES
<i>Odontoschisma sphagni</i>		YES	YES	YES
<i>Pellia cf borealis</i>		YES	NO	YES
<i>Plagiochila asplenoides</i>		YES	YES	YES
<i>Plagiochila porelloides</i>		YES	YES	YES
<i>Porella cordaeana</i>		NO	YES	YES
<i>Ptilidium ciliare</i>		YES	NO	YES
<i>Radula complanata</i>		YES	YES	YES
<i>Riccardia latifrons</i>		YES	YES	YES
<i>Riccia fluitans</i>		YES	NO	YES
<i>Scapania irrigua</i>		YES	NO	YES
<i>Scapania nemorea</i>		YES	YES	YES
<i>Trichocolea tomentella</i>		YES	YES	YES
<i>Trilophozia quinqueidentata</i>	<i>Tritomaria quinqueidentata</i>	YES	NO	YES
<i>Neoorthocaulis attenuatus</i>	<i>Barbilophozia attenuata</i>	NO	NO	NO
<i>Bazzania tricrenata</i>		NO	NO	NO
<i>Blasia pusilla</i>		NO	NO	NO
<i>Calypogeia azurea</i>		NO	NO	NO
<i>Fuscocephaloziopsis macrostachya</i>	<i>Cephalozia macrostachya</i>	NO	NO	NO
<i>Fuscocephaloziopsis pleniceps</i>	<i>Cephalozia pleniceps</i>	NO	NO	NO



<i>Cephaloziella grimsulana</i>		NO	NO	NO
<i>Chiloscyphus indet</i>		NO	NO	NO
<i>Odontoschisma francisci</i>	<i>Cladopodiella francisci</i>	NO	NO	NO
<i>Conocephalum conicum</i>		NO	NO	NO
<i>Diplophyllum taxifolium</i>		NO	NO	NO
<i>Fossombronia incurva</i>		NO	NO	NO
<i>Frullania austinii</i>		YES	YES	NO
<i>Frullania fragilifolia</i>		YES	YES	NO
<i>Frullania oakesiana</i>		NO	NO	NO
<i>Fuscocephaloziopsis catenulata</i>	<i>Fuscocephalozia catenulata</i>	NO	NO	NO
<i>Gymnomitrium condensatum</i>		YES	NO	NO
<i>Gymnomitrium corallioides</i>		NO	YES	NO
<i>Haplomitrium hookeri</i>		NO	NO	NO
<i>Jungermannia indet</i>		NO	NO	NO
<i>Kurzia trichoclados</i>		NO	NO	NO
<i>Mesoptychia collaris</i>	<i>Leiocolea cf collaris</i>	YES	NO	NO
<i>Lejeunea cavifolia</i>		NO	YES	NO
<i>Liochlaena lanceolata</i>		NO	NO	NO
<i>Lophocolea indet</i>		NO	NO	NO
<i>Isopaches bicrenatus</i>	<i>Lophozia bicrenata</i>	NO	NO	NO
<i>Schistochilopsis incisa</i>	<i>Lophozia incisa</i>	NO	NO	NO
<i>Lophozia silvicola</i>		NO	NO	NO
<i>Marsupella sprucei</i>		YES	NO	NO
<i>Metzgeria conjugata</i>		NO	NO	NO
<i>Moerckia blyttii</i>		YES	NO	NO
<i>Mylia taylorii</i>		NO	NO	NO
<i>Porella platyphylla</i>		NO	NO	NO
<i>Ptilidium pulcherrimum</i>		NO	NO	NO
<i>Radula lindenbergiana</i>		YES	NO	NO
<i>Riccardia incurvata</i>		NO	YES	NO
<i>Scapania curta</i>		YES	NO	NO
<i>Scapania undulata</i>		YES	YES	NO

Conclusion

The collection of sterile liverworts comprises 45 unique taxa, 41 of which have been used for RNA-Seq. The total number of taxa collected is 79, corresponding to a total of 129 unique accessions.