

THE BRYOPHYTE FLORA OF THE CADÍ-MOIXERÓ NATURAL PARK (EASTERN PYRENEES, CATALONIA, SPAIN)

Elena Ruiz ^{1*}, Pere Aymerich², Llorenç Sáez ¹ & Montserrat Brugués ¹

1. Botànica, Facultat de Biociències, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain.

2. C. Barcelona 29, 08600 Berga, Spain.

* Corresponding author: elena.ruiz@uab.cat

ABSTRACT: This work presents a comprehensive catalogue of the bryophyte flora of the Cadí-Moixeró Natural Park, based mainly on the collection campaigns conducted between 2016 and 2022. During this period, 1,118 bryophyte samples were collected in the 53 localities surveyed. The resulting bryophyte list is supplemented by previous literature reports and unpublished herbarium specimens from the Natural Park. The catalogue includes a total of 293 taxa, of which 48 are liverworts and 245 are mosses. Additionally, species of chorological and conservation interest in the macrohabitats studied are discussed.

Keywords: bryophytes, conservation, distribution, ecology, Iberian Peninsula, liverworts, mosses, threatened species.

LA FLORA BRIOFÍTICA DEL PARQUE NATURAL DEL CADÍ-MOIXERÓ (PIRINEOS ORIENTALES, CATALUÑA, ESPAÑA).

RESUMEN: En este trabajo se presenta un catálogo completo de la flora briofítica del Parque Natural del Cadí-Moixeró, basado en gran parte en las campañas de recolección realizadas entre 2016 y 2022. Durante estos años se recolectaron 1.118 muestras de briófitos en las 53 localidades prospectadas. La lista de briófitos resultado de dicho estudio se completa con citas bibliográficas previas y especímenes de herbario inéditos recolectados en el parque natural, en total incluye 293 táxones, de los cuales 48 son hepáticas y 245 musgos. Se comentan las especies de interés corológico y de conservación en los macrohábitats estudiados.

Palabras clave: briófitos, conservación, distribución, ecología, especies amenazadas, hepáticas, musgos, Península Ibérica.

INTRODUCTION

Since 1983, the Cadí-Moixeró Natural Park is a protected area in the Eastern Pyrenees, situated in Catalonia, in the northeastern of Spain. It covers more than 41,000 ha of mountainous terrain, with an altitudinal gradient that approaches 2,000 m, and a high degree of environmental diversity. Its main area is the Cadí-Moixeró-Tosa d'Alp-Puigllançada orographic axis, which covers more than 40 km of mountains

aligned from west to east. In addition to this axis, the park also includes the pre-Pyrenean mountains of Cloterons, Cadinell, Pedraforca, and Gisclareny to the south. Altitudes within the park range from 750 to over 2,500 m, with the highest point being 2,649 m at the summit of Vulturó in the Serra del Cadí, although most of the park's surface area is over 1,500 m. The watercourses in the area form part of two hydrographic basins: the Segre (a tributary of the Ebro) to the north and west, and the Llobregat to the southeast.

Limestone rocks constitute the primary geological substratum in the Cadí-Moixeró Natural Park, mainly originating from the Cretaceous and Jurassic periods in the Serra del Cadí and other pre-Pyrenean mountains. However, the eastern part, including Moixeró, Tosa d'Alp, and Puigllançada, there are also Devonian rocks. Siliceous rocks are confined to specific areas and exhibit considerable diversity, encompassing slates, various volcanic rocks, and siliceous conglomerates. They form extensive outcrops especially at medium altitudes on the northern slope of the Cadí-Moixeró-Tosa axis (Geological Map of Catalonia: https://betaportal.icgc.cat/visor/client_utfgrid_geo.html).

The Cadí-Moixeró Natural Park has a mountain climate with Mediterranean influences, yet it exhibits notable variations based on altitudes and geographical area. In general, the Segre watershed to the north and west has a near-continental climate, with greater temperature fluctuations and lower precipitation compared to the Llobregat basin to the southeast. The latter, with a weak maritime influence, tends to be milder and more humid. Average annual temperatures range from 10-12°C in the lower areas to less than 3°C in the summit areas, with temperatures as low as 2.6°C recorded at 2,480 m on the summit of Tosa d'Alp. Annual rainfall ranges from less than 700 mm per year in the western lowlands to well over 1,200 mm in the high mountains. In the easternmost peaks, it is likely closer to 1,500 mm, although precise records are not available. Snowfall is frequent above 1,800 m, and in certain areas, snow can remain for six months or even longer. In general, the combination of temperatures and rainfall categorizes the park as a subhumid area, without physiologically arid or subarid periods for plants. However, in the lower areas, situations of water stress characteristic of the Mediterranean climate can occur. The usual atmospheric humidity levels range between 55% and 80%, with annual averages typically spanning 65% to 75%. These levels tend to increase as one moves eastward and at higher altitudes. In topographically favourable areas, higher local humidities are often observed, leading to a greater abundance of bryophytes (Data from the Meteorological Service of Catalonia: <https://www.meteo.cat/wpweb/climatologia/dades-i-productes-climatics/anuari-de-dades/>).

The Park area is predominantly covered by woodlands, extending up to an altitude of about 2,000 m, above which (pseudo)alpine grasslands predominates. The natural tree-line varies, situated between 2,000 and 2,400 m, depending on factors such as exposure and location. However, above 1,800 m, extensive areas are characterised by pastures that have been deforested since the Middle Ages or even earlier. In the submontane belt, which extends from an elevation of 700 to 1,100-1,300 m, the dominant tree species are *Quercus pubescens* and *Pinus sylvestris*. However, in the lower parts of the valleys, there are also patches of deciduous trees such as *Fraxinus excelsior*, *Populus tremula*, *Corylus avellana*, and *Alnus glutinosa*. Within this submontane zone, there are also areas of Mediterranean vegetation, represented by forests and maquis of *Quercus ilex*, which are restricted to the sun-exposed rocky slopes. The

montane belt, which ranges from 1,100-1,300 m to 1,700-1,800 m in elevation, is predominantly covered by forests of *Pinus sylvestris*. However, woodlands of *Fagus sylvatica* in the southeast and *Abies alba*, especially in the north are also represented. Above 1,700-1,800 m, subalpine forests of *Pinus uncinata* forests are found, sometimes co-occurring with *Abies alba* in certain local areas.

Traditional land uses above 1,400 m were mainly grazing and forestry, while at lower altitudes, agricultural fields were historically prevalent but have now significantly declined. Present-day land use is primarily centred around tourism, cattle grazing, and forestry.

The prior knowledge of the bryophyte flora in this natural park was limited and fragmented, with few specific works contributing to our understanding. These contributions include Casas de Puig (1954b), who focused on bryophytes collected in the “Alt Berguedà” area, a doctoral thesis (Álvaro Martín 2001) with two previous publications (Álvaro 1982; Álvaro and Hladun 1983), and an unpublished dissertation on epiphytic bryophytes (Gorro Caelles 2005). Additionally, scattered published data provided some insights into the bryophyte flora.

Starting in 2016 and continuing to the present day, the Natural Park has actively promoted a series of field surveys with the primary objective of cataloguing the bryophytes that inhabit the protected area. Some of the data obtained during the initial two years of this inventory have already been published (Ruiz et al. 2018a, 2018b, 2019).

This paper details the findings from the 2016-2022 surveys, along with information gathered from literature reports and unpublished bryophyte data specific to the study area. The principal objective of this study is to present the first catalogue of the bryophyte flora of the Cadí-Moixeró Natural Park.

MATERIALS AND METHODS

The study area for this work is situated within the administrative limits of the Cadí-Moixeró Natural Park. In some exceptional cases, data from the periphery and areas near the park boundaries have been considered, mainly for taxa where specific data within the protected area were lacking, but it was reasonable to assume their presence.

The own data comes from surveys conducted between 2016 and 2022 at 53 specific sites within the Cadí-Moixeró Natural Park (Figure 1; Table 1). Each place covers relatively small to moderate areas, ranging from a few square meters to 2 ha, and is associated with a distinct macrohabitat. These macrohabitats include 12 localities in alpine habitats, 9 in coniferous forests, 10 in deciduous forests, 1 in Mediterranean sclerophyllous forest, 10 in non-alpine areas with limestone rocks, 5 in areas with siliceous rocks, 4 in semi-aquatic habitats like springs and fens, and 2 in anthropogenic habitats. Additionally, most sites also feature various secondary microhabitats or mesohabitats.

The collection sites, detailed in Table 1, are grouped by the main macrohabitats and west-east ordered. For each site, the following information are exposed: site code, municipality, place, UTM 1x1 km square (central approximate UTM 1x1 m square), altitude, dominant macrohabitat and collection date.

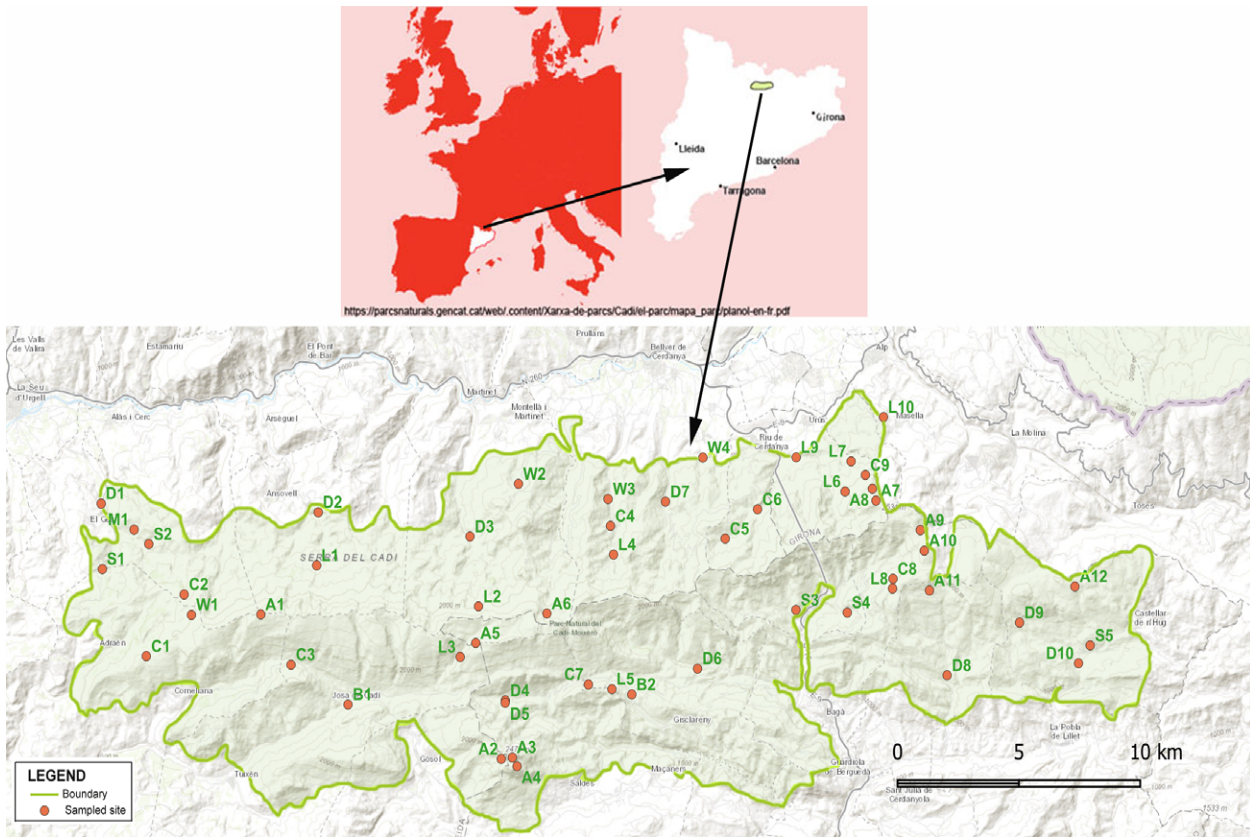


Figure 1. Map showing the location of the 53 sampled sites and the boundary of the Cadí-Moixeró Natural Park.

Table 1. Collection sites in the Cadí-Moixeró Natural Park.

Alpine habitats (A): Rocky habitats and soils above treeline. In some cases (range 1900-2200 m) it may be a secondary anthropogenic treeline.

- A1** Cava, Torreta de Cadí, 31TCG8382 (0383030-4682610), 2530 m, limestone cliffs north facing, 3/9/2017.
- A2** Gósol, Pedraforca, below Pollegó Inferior, 31TCG9277 (0392825-4677080), 2320 m, calcareous and sunny stony soil, 18/8/2022.
- A3** Saldes, Pedraforca, Punta Calderer, 31TCG9377 (0393281-4677126), 2480 m, limestone cliffs, 24/8/2017.
- A4** Saldes, Tartera del Pedraforca, 31TCG9376 (0393470-4676795), 2200 m, north facing limestone cliffs, 23/7/2018.

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- A5** Gisclareny, Serra Pedregosa, 31TCG9181 (0391840-4681410), 2290 m, north facing limestone cliffs, 5/9/2017.
- A6** Montellà i Martinet, upper Barranc de les Toselletes, 31TCG9482 (0394780-4682460), 2120 m, north facing limestone cliffs and screes, 19/8/2018.
- A7** Urús, above Coma Oriola 31TDG0886 (0408350-46864709), 2350 m, karstified limestone area, 17/8/2020.
- A8** Urús, west side of Coma Oriola, 31TDG0886 (0408210-4686910), 2160 m, limestone cliffs oriented E-NE, 8/6/2021.
- A9** Bagà, Comabella, 31TDG1085 (0410160-4685350), 2220 m, limestone rocks, 1/9/2017.
- A10** Bagà, Serrat Gran, 31TDG1084 (0410310-4684580), 2380 m, karstified limestone area, 7/9/2017.
- A11** Guardiola de Berguedà, Plans de Canells, 31TDG1083 (0410505-4683100), 1990 m, mosaic of limestone scree and pasture on a sunny slope, 14/8/2022.
- A12** Castellar de n'Hug, Pla Baguet, 31TDG1683 (0416480-4683170), 1910 m, soil and small outcrops of calcareous rock on a sunny slope, 7/5/2022.

Coniferous woodland (C): Pine or fir forests, which are dominant in the Natural Park. Most of these woods are poor in bryophytes, that only become common on moist north facing slopes. Bryophytes are mainly associated with soils and dead wood. Rocky habitats species are also found in these forests.

- C1** La Vansa i Fórnols, Obaga d'Adraén below the Collet de Bacanella, 31TCG7881 (0378300-4681140), 1800 m, *Pinus uncinata* forest, north-facing, on limestone, 9/6/2022.
- C2** Alàs i Cerc, upper Barranc de la Fou, 31TCG7983 (0379892-4683407), 1690 m, mixed forest of *Abies alba*, *Pinus uncinata* and *P. sylvestris*, north-facing, on limestone, 25/7/2016.
- C3** Josa i Tuixén, Serra de Cadinell above coll de Jovell, 31TCG8480 (0384240-4680720), 1810 m, *Pinus uncinata* forest north-facing, on mixed limestone and siliceous soils, 7/6/2021.
- C4** Bellver de Cerdanya, Pi valley, Barranc de l'Agre de Moixó, 31TCG9785 (0397440-4685680), 1500 m, *Abies alba* forest on limestone, 6/7/2019.
- C5** Riu de Cerdanya, Bagues de Riu, 31TDG0285 (0402144-4685140), 1620 m, *Abies alba* forest, north-facing, on siliceous substrate, 27/7/2016.

- C6** Riu de Cerdanya, Riu Major, 31TDG0386 (0403485-4686215), 1420 m, forest of *Pinus sylvestris* (and some *Abies alba*) with undergrowth of *Buxus sempervirens*, north-facing, on limestone, 11/8/2020.
- C7** Gisclareny, Coll de Balma, 31TCG9679 (0396445-4679795), 1580 m, *Pinus sylvestris* forest with undergrowth of *Buxus sempervirens*, north-facing, on limestone, 29/7/2022
- C8** Bagà, Els Orris, 31TDG0983 (0409013-4683555), 1930 m, *Pinus uncinata* forest, north-facing, on limestone, 22/8/2016.
- C9** Urús, west of Coma Oriola, 31TDG0787 (0407930-4687430), 1940 m, *Pinus uncinata* forest, north-facing, on limestone, 23/6/2020.

Deciduous woodland (D): Forests dominated by deciduous trees, a minority in the Natural Park. These are slope forests (of beech or oak) or tree formations associated to watercourses, the latter being more humid and richer in bryophytes. Rocky and water-related habitats species are also found in these forests.

- D1** Alàs i Cerc, Torrent de Cerc, 31TCG7686 (0376545-4686845), 920 m, riparian forest of *Alnus glutinosa*, on acidic substrate, 4/7/2019.
- D2** Cava, Costes de Cava, 31TCG8586 (0385450-4686370), 1270 m, *Quercus pubescens* forest on siliceous substrate, 10/8/2022.
- D3** Montellà i Martinet, Bastanist stream, 31TCG9185 (0391665-4685375), 1190 m, mixed deciduous forest dominated by *Fraxinus excelsior* and *Salix caprea*, on mixed siliceous-limestone substrate, 4/7/2019.
- D4** Saldes, Gresolet forest in Torrent de les Molleres area, 31TCG9379 (0393025-4679255), 1440 m, banks of an ephemeral stream in a *Fagus sylvatica* forest, 29/7/2022.
- D5** Saldes, Gresolet forest in Torrent de les Molleres area, 31TCG9379 (0393018-4679166), 1470 m, *Fagus sylvatica* forest on limestone (also some *Abies alba* and *Pinus sylvestris*), 2/8/2016.
- D6** Gisclareny, Torrent de la Muga-Dou del Bastareny, 31TDG0080 (0400940-4680320), 940 m, *Fraxinus excelsior* forest and stream banks on limestone, 8/7/2019.
- D7** Bellver de Cerdanya, Vall de l'Inglà, 31TCG9986 (0399710-4686550), 1250 m, *Fraxinus excelsior* forest with limestone rocks, 1/7/2021.
- D8** Guardiola de Berguedà, Riutort, L'Estret, 31TDG1179 (0411190-4679935), 1010 m, mixed forest dominated by *Fraxinus excelsior* on limestone, 1/7/2021.

- D9** Castellar de n'Hug, Torrent de les Tortes, DG1481 (0414190-4681859), 1480 m, *Fagus sylvatica* forest on limestone, 1/7/2016.
- D10** Castellar de n'Hug, SW of Sant Vicenç de Rus, 31TDG1680 (0416595-4680320), 1050 m, *Quercus pubescens* forest with siliceous rock outcrops, 3/7/2020.

Mediterranean woodland (M): A marginal habitat in the Natural Park, represented by evergreen oak forests limited to some rocky and very sunny slopes.

- M1** Alàs i Cerc, Toscarre, 31TCG7885 (0377880-4685855), 1220 m, *Quercus ilex* forest in a siliceous rocky area, 24/5/2021.

Limestone rocks (L): Very common macrohabitat in the Natural Park. This group includes only the rocky habitats located below the upper limit of the forests.

- L1** Cava, Barranc de la Canal de l'Aigua, 31TCG8384 (0385355-4684400), 1500 m, limestone blocks next to a temporary stream, 10/8/2022.
- L2** Montellà i Martinet, upper Torrent de l'Estenedor, 31TCG9182 (0391975-4682770). 1950 m, a cluster of large limestone blocks in an open forest of *Pinus uncinata* facing north, 17/8/2020.
- L3** Josa i Tuixén, Torrent dels Cortils, 31TCG9180 (0391195-4680900), 2080 m, limestone outcrops facing N, 18/7/2022.
- L4** Bellver de Cerdanya, Pi valley, Corral de la Por, 31TCG9784 (0397550-4684610), 1580 m, cluster of limestone blocks in a *Pinus sylvestris* forest, 23/6/2021.
- L5** Gisclareny, Baga dels Terrers, 31TCG9779 (0397410-4679610), 1650 m, north facing limestone scree, 6/8/2022.
- L6** Urús, serrat de les Pedrusques, 31TDG0786 (0407090-4686820), 1900 m, limestone outcrops in a *Pinus uncinata* forest, 5/8/2021.
- L7** Urús, Bac de la Balma del Fe, 31TDG0787 (0407350-4687940), 1630 m, limestone outcrops in a *Pinus uncinata* forest, 4/8/2021.
- L8** Bagà, La Bòfia, 31TDG0883 (0408990-4683190), 2000 m, limestone karstified area, 1/9/2017.
- L9** Urús, Solà d'Amunt, 31TDG0588 (0405100-4688120), 1360 m, limestone outcrops on a sunny and dry slope, 5/5/2022.
- L10** Alp, Serrat d'Escobairó, 31TDG0889 (0408700-4689570), 1705 m, limestone outcrops on a sunny and dry slope, 25/4/2022.

Siliceous rocks (S): Siliceous rocks are uncommon in the Natural Park, but occur in some areas. The most important outcrops belong to some weakly acidic volcanic rocks.

- S1** Alàs i Cerc, Les Colladetes, 31TCG7684 (0376550-4684410), 1310 m, volcanic rocks (andesites), 10/6/2018.
- S2** Alàs i Cerc, Barranc de la Fou, 31TCG7885 (0378475-4685310), 1300 m, volcanic rocks (andesites), 10/6/2018.
- S3** Guardiola de Berguedà, Gréixer, Rocs Negres, 31TDG0582 (0405010-4682450), 1240 m, volcanic rocks (rhyolites), 23/6/2018.
- S4** Guardiola de Berguedà, Gréixer, Torrent de les Rovires, 31TDG0782 (0407120-4682320), 1270 m, outcrops of siliceous conglomerates in a *Fagus sylvatica* forest, 5/7/2019.
- S5** Castellar de n'Hug, Solana de Sant Vicenç de Rus, 31TDG1780 (0417080-4680975), 1225 m, siliceous rock outcrops in a mixed forest of *Pinus sylvestris* and *Quercus pubescens* south facing, 25/6/2022.

Springs and fens (W): Water-related habitats generated by carbonated water springs. Bryophytes linked to these habitats have also been found in alpine rocky areas (A) and in deciduous forests associated with watercourses (D).

- W1** La Vansa i Fórnols, Pradell, 31TCG8082 (0380180-4682640), 1975 m, alkaline fen, 16/7/2022.
- W2** Montellà i Martinet, Els Munts, 31TCG9387 (0393685-4687300), 1525 m, spring of carbonated water, 5-V-2022.
- W3** Bellver de Cerdanya, Pi valley, Font de l'Escudella, 31TCG9786 (0397355-4686680), 1280 m, spring of carbonated water, 27/7/2022.
- W4** Bellver de Cerdanya, Fou de Bor, 31TDG0188 (0401270-4688165), 1120 m, spring of carbonated water and surroundings (wet rocks and trunks), 27/7/2022.

Man-made habitats (B): Stone walls in ancient fields and paths, often nitrified by livestock.

- B1** Josa i Tuixén, Josa de Cadí, 31TCG8679 (0386555-4679200), 1400 m, old limestone walls, 10/5/2022.
- B2** Gisclareny, Coll de la Bena, 31TCG9879 (0398225-4679400), 1435 m, old limestone walls, 9/5/2022.

A total of 1,118 bryophyte specimens were collected, identified, and subsequently added to the BCB herbarium, which is now part of the BCN herbarium at the “Centre de Documentació de Biodiversitat Vegetal” (University of Barcelona).

To create a comprehensive catalogue, all available bibliographical information on bryophytes collected within the Cadí-Moixeró Natural Park was compiled. Additionally, unpublished herbarium material, mostly deposited in the BCB, was incorporated after revision. The nomenclature for mosses and liverworts mainly follows Hodgetts et al. (2020).

RESULTS

The list of bryophytes presented below is mainly the result of our extensive collections made during field campaigns conducted between 2016 and 2022. For each taxon, we provide information about its habitat, elevation range, and the corresponding site code as detailed in Table 1. The subsequent paragraphs add bibliographical information for the taxa and unpublished herbarium specimens found within our study area. New records to the Cadí-Moixeró Natural Park are indicated by an asterisk (*) preceding the taxon name. The list also includes taxa that were not found during our study but are documented in the literature. Taxa of chorological or conservation importance from unpublished theses or dissertations, and for which specimens are not available for review, are indicated in a lighter colour.

MARCHANTIOPHYTA

***Aneura pinguis* (L.) Dumort.**

Spring of carbonated water, 1280 m (W3).

Previous records: Álvaro Martín (2001).

***Apopellia endiviifolia* (Dicks.) Nebel & D.Quandt**

Wet calcareous soils and springs of carbonated water, 920-1500 m (D1, D3, L1).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

Additional material studied: Castellar de n'Hug, Fonts del Llobregat, 31TDG18, Vives, 1971, BCB 40641; on riverbank rocks, E. Ruiz, 2023, BCB 61356.

***Barbilophozia barbata* (Schreb.) Loeske**

Shaded, calcareous soils and rocks, 1240-1900 m (L6, S3).

Previous records: Álvaro Martín (1982).

Additional material studied: Bellver de Cerdanya, Vall de Pi, 31TCG99, Mayol & Riba, 2000, BCB 52176.

***Barbilophozia hatcheri* (A.Evans) Loeske**

Wet soils and rocks, 1950 m (L2).
Previous records: Álvaro Martín and Hladun (1983).

***Barbilophozia lycopodioides* (Wallr.) Loeske**

Álvaro Martín (2001).

***Barbilophozia sudetica* (Nees ex Huebener) L.Söderstr., De Roo & Hedd.**

Álvaro Martín (2001).

***Blepharostoma trichophyllum* (L.) Dumort.**

Wet, acidic soils and rotten stumps, 1620-1690 m (C2, C5).
Previous records: Álvaro Martín and Hladun (1983).

***Chiloscyphus pallescens* (Ehrh.) Dumort.**

Álvaro Martín (2001).

***Clevea hyalina* (Sommerf.) Lindb.**

Limestone ledges, 2380-2480 (A3, A10).
Previous records: Miguel Velasco et al. (1995); Álvaro Martín (2001).

****Cololejeunea calcarea* (Lib.) Steph.**

Wet, shaded, calcareous rocks, 1580 m (L4).
Additional material studied: Bellver de Cerdanya, Vall d'Inglà, 31TCG89, Mayol & Riba, 2001, BCB 53624.

****Conocephalum salebrosum* Szweykowski, Buczkowska & Odrzykoski**

Wet, shaded, rocks and soils by streams, 900-2300 m (A4, A9, C4, C6, D1, D3, D7, L4, S4).
Additional material studied: Montellà i Martinet, Torrent d'Estana, 31TCG98, 1400 m, Álvaro, 1978, BCN-Bryo 521 (*sub. Conocephalum conicum*); Castellar de n'Hug, Fonts del Llobregat, 31TDG18, on riverbank rocks, E. Ruiz, 2023, BCB 61359.

***Frullania dilatata* (L.) Dumort.**

Rocks and bark of trees, 900-1400 m (D1, D2, D3, D5, D6, D7, D8, D9, D10, M1, S2, S3).
Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Gorro Caelles (2005).

***Frullania tamarisci* (L.) Dumort.**

Rocks and bark of trees, 1240-1300 m (D8, S1, S3).
Previous records: Casas de Puig (1954b).

***Fuscocephaloziopsis lunulifolia* (Dumort.) Vána & L.Söderstr.**

Álvaro Martín and Hladun (1983).

***Jungermannia atrovirens* Dumort.**

Rocks by streams and springs, 920-1500 m (D1, L1).
Previous records: Álvaro Martín (1982).

****Jungermannia polaris* Lindb.**

Wet, calcareous rocks, 2120-2220 m (A6, A9).

***Lejeunea cavifolia* (Ehrh.) Lindb.**

Bark of trees and sheltered soils and rocks, 920-1580 m (D1, D4, D6, L4).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

***Lepidozia reptans* (L.) Dumort.**

Rotten stumps and wet, shaded, acidic soils, 1500-1620 m (C2, C4, C5, C7).

Previous records: Álvaro Martín and Hladun (1983).

***Lophocolea heterophylla* (Schrad.) Dumort.**

Rotting stumps and humic slopes in forests, 1400-1600 m (C2, C5, C4, C6).

Previous records: Álvaro Martín (2001).

***Lophocolea minor* Nees**

Rotting stumps and humic slopes in forests, 1930-2120 m (A6, C8, C9).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Álvaro Martín and Hladun (1983).

***Lophozia guttulata* (Lindb. & Arnell) A.Evans**

Previous records: Álvaro Martín and Hladun (1983).

***Lophozia ventricosa* (Dicks.) Dumort.**

Shaded, acidic soils, 1620 m (C5).

Previous records: Álvaro Martín (2001).

***Lophozopsis excisa* (Dicks.) Konstant. & Vilnet**

Álvaro Martín (1982).

***Marchantia quadrata* Scop.**

Álvaro Martín (1982); Casas et al. (1992).

***Mesoptychia bantriensis* (Hook.) L.Söderstr. & Vána**

Wet, calcareous rocks and slopes, 2000-2220 m (A9, L8).

Previous records: Álvaro Martín (2001).

****Mesoptychia collaris* (Nees) L.Söderstr. & Vána**

Wet, shaded, calcareous soils, 2290-2480 m (A3, A5).

***Metzgeria furcata* (L.) Corda**

Bark of trees and wet and shaded rocks, 900-1500 m (C4, D1, D6, D9, D10, L1, S1, S3, S4).

Previous records: Casas de Puig (1954b); Gorro Caelles (2005).

***Metzgeria pubescens* (Schrank) Raddi**

Bark of trees and shaded, wet, calcareous rocks and ledges, 1190-1900 m (C4, C6, D3, D4, L4, L6).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

****Nardia insecta* Lindb.**

Shaded, calcareous rock crevices and soils, 1500-1940 m (C4, C9).

****Nowellia curvifolia* (Dicks.) Mitt.**

Rotting stumps, 1420 m (C6).

***Pedinophyllum interruptum* (Nees) Kaal.**

Wet, shaded, calcareous soils, 1240-2200 (A4, L4, L6, S3).

Previous records: Álvaro Martín (2001).

Additional material studied: Bellver de Cerdanya, Vall d'Inglà, 31TCG89, Mayol & Riba, 2001, BCB 53627.

***Plagiochila porelloides* (Torr. ex Nees) Lindenb.**

Rocks, base of trees, shaded, calcareous or slightly acidic soils, 920-2380 m (A4, A5, A7, A9, A10, A12, C2, C4, C5, C6, C7, C9, D1, D3, D4, D6, D7, L1, L2, L4, L6, L7, S4, W4).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001); Gorro Caelles (2005).

***Porella arboris-vitae* (With.) Grolle**

Wet, shaded, calcareous rocks, 1240 m (S3).

Previous records: Casas de Puig (1954b); Gorro Caelles (2005).

****Porella cordaeana* (Huebener) Moore**

Wet rocks and base of trees, 1270-1440 m (D4, S4).

****Porella obtusata* (Taylor) Trevis**

Shaded, calcareous rocks, 1225-1310 m (S1, S3, S5).

***Porella platyphylla* (L.) Pfeiff.**

Rocks and trunks of trees, 915-2080 m (C6, D1, D2, D3, D5, D7, D8, D10, L3, L4, L10, W4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Gorro Caelles (2005).

***Radula complanata* (L.) Dumort.**

Bark of trees and shaded rocks, 920-2000 m (C2, C3, C6, D1, D2, D3, D4, D7, D8, D9, D10, L7, L8, S3, S4, W4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Gorro Caelles (2005).

***Radula lindenbergiana* Gottsche ex C.Hartm.**

Álvaro Martín (2001).

****Reboulia hemisphaerica* (L.) Raddi**

Calcareous ledges and rocks crevices, 1400-2380 m (A4, A5, A10, B1, L1).

***Scapania aequiloba* (Schwägr.) Dumort.**

Rock crevices and shaded, calcareous rocks, 1580-2480 m (A3, C4, L2, L4, L6, L7).

Previous records: Álvaro Martín (2001).

***Scapania aspera* M.Bernet & Bernet**

Shaded, usually calcareous rocks and slopes, 1420-1650 m (C6, L1, L5).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

Additional material studied: Bellver de Cerdanya, Vall de Pi, 31TCG99, Mayol & Riba, 2000, BCB 52189; Bellver de Cerdanya, Vall d'Inglà, 31TCG89, Mayol & Riba, 2001, BCB 53633.

***Scapania calcicola* (Arnell & J.Perss.) Ingham**

Shaded, calcareous rocks, 940-2350 m (A5, A6, A7, D6, L4).

Previous records: Álvaro Martín (2001).

***Scapania curta* (Mart.) Dumort.**

Álvaro Martín (2001).

***Scapania cuspiduligera* (Nees) Müll.Frib.**

Shaded, limestone crevices, 2120-2290 m (A5, A6).

Previous records: Álvaro Martín (2001).

***Scapania irrigua* (Nees) Nees**

Álvaro Martín (2001).

****Scapania praetervisa* Meyl.**

Additional material studied: Bellver de Cerdanya, Vall d'Inglà, 31TCG89, on limestone rock ledges, Mayol & Riba, 2001, BCB 53634.

****Solenostoma hyalinum* (Lyell) Mitt.**

Wet rocks, 2120 -2290 m (A5).

***Trilophozia quinquedentata* (Huds.) Bakalin**

Previous records: Álvaro Martín (2001).

Additional material studied: Bellver de Cerdanya, Vall de Pi, 31TCG99, on limestone rock ledges, Mayol & Riba, 2000, BCB 52192.

BRYOPHYTA

***Abietinella abietina* (Hedw.) M.Fleisch.**

Exposed, calcareous soils, rocks and slopes, 1010-2220 m (A8, A9, A12, C7, D8, L4, L8, L10, S1).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Casas et al. (1992).

Additional material studied: Bellver de Cerdanya, vall de Pi, 31TCG99, Mayol & Riba, 2000, BCB 52159.

***Alleniella besserii* (Lobarz.) S.Olsson, Enroth & D.Quandt**

Epiphyte, usually on *Buxus*, 915-2000 m (C6, D1, D2, D4, D6, D7, D8, D9, D10, L8).

Previous records: Casas de Puig (1954b); Casas (1999); Álvaro Martín (2001); Gorro Caelles (2005).

***Alleniella complanata* (Hedw.) S.Olsson, Enroth & D.Quandt**

Trunks of trees and shaded rocks, 915-1690 m (C2, C4, C4, C6, D1, D3, D6, D7, D8, D10, L5, L6, L7, S4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Álvaro Martín and Hladun (1983); Gorro Caelles (2005).

***Amblystegium serpens* (Hedw.) Schimp.**

Wet, shaded, calcareous rocks, 1400-2320 m (A2, B1).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

****Amphidium mougeotii* (Schimp.) Schimp.**

Acidic, rock crevices, 1240 m (S3).

***Anomodon viticulosus* (Hedw.) Hook. & Taylor**

Epiphyte and shaded, calcareous rocks and walls, 914-1580 m (B1, C6, D1, D3, D7, D8, D9, D10, L4, W4).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

****Atrichum undulatum* (Hedw.) P.Beauv.**

Shady, acidic slope, 1620 m (C5).

Additional material studied: Montellà i Martinet, Torrent de Bastanist, 31TCG98, 1400 m, N-NE slope, in deep crevices with wet soil, Álvaro, 1978, BCN-Bryo 1920 (*sub. Mnium hornum*).

****Aulacomnium androgynum* (Hedw.) Schwägr.**

Tree stumps, 1580-1940 m (C7, C9).

***Bartramia halleriana* Hedw.**

Álvaro Martín (1982).

***Bartramia ithyphylla* Brid.**

Álvaro Martín (1982); Casas *et al.* (1992).

***Bartramia pomiformis* Hedw.**

Calcareous rock crevices, 2080 m (L3).

Previous records: Álvaro Martín (1982); Casas *et al.* (1992).

***Blindiadelphus recurvatus* (Hedw.) Fedosov & Ignatov**

Álvaro Martín (2001).

****Brachytheciastrum salicinum* (Schimp.) J.D.Orgaz, M.J.Cano & J.Guerra**

Shaded rocks and base of trees, 1250-1810 m (C3, C4, D7, S4).

***Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen**

Shaded rocks, rock crevices, rotten woods and base of trees, 1050-2380 m (A7, A9, A10, C5, C7, C8, C9, D2, D4, D9, D10, S3).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

***Brachythecium cirrosum* (Schwägr.) Schimp.**

Álvaro Martín (2001).

***Brachythecium glareosum* (Bruch ex Spruce) Schimp.**

Rocks and slopes 1050-2290 m (A4, A5, D7, D10).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

***Brachythecium rivulare* Schimp.**

Soils and rocks in streams, 1120-2000 m (C5, C6, L8, W2, W4).

Previous records: Álvaro Martín (2001).

Additional material studied: La Fou de Bor, 31TDG08, J. Vives, 1973, BCB 34148.

***Brachythecium rutabulum* (Hedw.) Schimp.**

Shaded, wet rocks and slopes, rotten stumps and tree bases, 915-1690 m (C2, C4, D1, D6, D9, S4, W4).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

Additional material studied: Castellar de n'Hug, Fonts del Llobregat, 31TDG18, on wet rocks, E. Ruiz, 2023, BCB 61360.

***Brachythecium salebrosum* (Hoffm. ex F.Weber & D.Mohr) Schimp.**

Shaded slopes 1250 m (D7).

Previous records: Álvaro Martín (2001).

****Brachythecium tommasinii* (Sendtn. ex Boulay) Ignatov & Huttunen**

Shaded, calcareous rocks 1420-2160 m (A6, A8, C6, L8).

****Brachythecium turgidum* (Hartm.) Kindb.**

Wet, calcareous soils and rocks 1990-2480 m (A3, A6, A11).

***Bryoerythrophyllum recurvirostrum* (Hedw.) P.C.Chen**

Calcareous rocks and soils, 1050-2000 m (C4, D10, L1, L8).

Previous records: Álvaro Martín (2001).

****Bryum argenteum* Hedw.**

Soils, exposed rock ledges and slopes, 1240-2320 m (A2, A11, A12, L10, L5, M1, S1, S3, S5).

Additional material studied: Gósol, 31TCG87, Vives, 1991, BCB 34601.

***Buckia vaucheri* (Lesq.) D.Rios, M.T.Gallego & J.Guerra**

Calcareous rocks and soils, 1360-2220 m (A9, C7, L10, L9).

Previous records: Álvaro Martín (2001); Ruiz and Brugués (2011).

***Buxbaumia aphylla* Hedw.**

Álvaro Martín and Hladun (1983).

***Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl.**

Rotting stumps of *Abies alba* and *Pinus uncinata*, 1500-1930 m (C3, C4, C5, C8).

Previous records: Carnicero and Unzeta (2016); Jover et al. (2021).

***Calliergonella cuspidata* (Hedw.) Loeske**

Wet grasslands near carbonated water spring, 1525 m (W2).

Previous records: Álvaro Martín (2001); Ruiz and Brugués (2011).

***Campyliadelphus chrysophyllus* (Brid.) R.S.Chopra**

Soils and exposed, calcareous rocks, 1440-2220 m (A9, A12, C4, C9, D4, D5, D6, L1, L6).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

***Campylium stellatum* (Hedw.) Lange & C.E.O.Jensen**

Wet, calcareous soils, 1950-1975 m (L2, W1).

Previous records: Ruiz and Brugués (2011).

****Campylium protensum* (Brid.) Kindb.**

Additional material studied: Montellà i Martinet, Prat de Cadí, 31TCG88, 1900 m, on wet, calcareous soils, Álvaro, 1978, BCC-Bryo 1910, 1950 (*sub. Campylium stellatum*).

***Campylophyllopsis calcarea* (Crundw. & Nyholm) Ochyra**

Wet, calcareous soils and rocks, 1010-2160 m (A8, D3, D4, D8, L5, W2).

Previous records: Álvaro Martín (2001); Ruiz and Brugués (2011).

***Campylophyllum halleri* (Hedw.) M.Fleisch.**

Wet, calcareous soils, 1500-2380 m (A7, A9, A10, C4).

Previous records: Álvaro Martín (2001); Casas *et al.* (2006).

Additional material studied: Saldes, enforcadura del Pedraforca, 31TCG97, on wet, calcareous soil, Sotiaux, 1983, BCB 25276.

****Campylopus atrovirens* De Not.**

Wet, acidic rocks, 1240 m (S3).

****Campylopus fragilis* (Brid.) Bruch & Schimp.**

Wet, acidic rocks, 1240 m (S3).

****Campylopus pilifer* Brid.**

Wet, exposed, acidic rocks, 1240 m (S3).

***Ceratodon purpureus* (Hedw.) Brid.**

Exposed soils, 1240-1470 m (D5, S3).

Previous records: Álvaro Martín (1982).

****Chionoloma tenuirostre* (Hook. & Taylor) M.Alonso, M.J.Cano & J.A.Jiménez**

Wet rocks and soils, 1580-2000 m (L4, L8).

***Cinclidotus aquaticus* (Hedw.) Bruch & Schimp.**

Submerged calcareous rocks, 940 m (D6).

Previous records: Casas *et al.* (2006).

****Cinclidotus riparius* (Host ex Brid.) Arn.**

Submerged calcareous rocks, 1120 m (W4).

****Cirriphyllum crassinervium* (Taylor) Loeske & M.Fleisch.**

Dry, exposed rocks, 940-1400 m (B1, D6).

****Cirriphyllum piliferum* (Hedw.) Grout**

Wet tree bases and limestone ledges, 1420-2480 (A3, A5, C6).

****Claopodium rostratum* (Hedw.) Ignatov**

Vertical limestone rocks, 1900-2160 m (A8, L6).

***Climacium dendroides* (Hedw.) F.Weber & D.Mohr**

Álvaro Martín (2001).

****Cratoneuron curvicaule* (Jur.) G.Roth**

Calcareous soil in a doline, 2380 m (A10).

***Cratoneuron filicinum* (Hedw.) Spruce**

Moist or wet, calcareous soils and rocks, by streams, 920-2290 m (A4, A5, A9, D1, D6, S4, W1, W4).

Previous records: Álvaro Martín (1982).

Additional material studied: La Fou de Bor, 31TDGO8, J. Vives, 1973, BCB 33760; BCB38896;. Castellar de n'Hug, Fonts del Llobregat, 31TDG18, on wet, calcareous rocks, E. Ruiz, 2023, BCB 61357.

***Ctenidium molluscum* (Hedw.) Mitt.**

Soils and calcareous rocks, 940-2480 m (A3, A4, A5, A6, A8, A9, A10, C4, C6, D1, D3, D4, D6, D7, L2, L3, L4, L5, L6, L7, L8).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

****Cyrtomnium hymenophylloides* (Huebener) T.J.Kop.**

Limestone crevices and small holes, 2290 m. (A5).

***Dicranella varia* (Hedw.) Schimp.**

Calcareous soils, 2380 m. (A10).

Previous records: Álvaro Martín (2001).

***Dicranoweisia cirrata* (Hedw.) Lindb.**

Álvaro Martín (2001).

***Dicranum scoparium* Hedw.**

Shaded, stony soils, base of rotting trees and trunks, 1240-1940 m (C1, C2, C3, C4, C5, C7, C8, C9, D5, L4, L5, S1, S2, S3).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Álvaro Martín and Hladun (1983); Gorro Caelles (2005).

Additional material studied: Gósol, Coll de Trapa, 31TCG97, Vives, 1971, BCB 35463.

****Dicranum tauricum* Sapjegin**

Rotting stumps, 1580 m. (C7).

***Didymodon rigidulus* Hedw.**

Calcareous exposed soils, 1910 m (A12).

Previous records: Casas de Puig (1954b).

***Distichium capillaceum* (Hedw.) Bruch & Schimp.**

Calcareous rock crevices, 1580-2530 m (A1, A3, A4, A5, A6, A7, A8, A9, A10, C9, L3, L4, L6, L7, L8).

Previous records: Casas (1993a); Álvaro Martín (2001).

****Drepanium fastigiatum* (Hampe) C.E.O.Jensen**

Shaded, calcareous rocks and soils 1940-1950 m (C9, L2).

****Encalypta affinis* R.Hedw.**

Calcareous rock crevices, 1900-2220 m (A9, L6).

***Encalypta alpina* Sm.**

Calcareous rock crevices, 2220-2480 m (A3, A9).

Previous records: Canalís and Casas (1992); Álvaro (2006).

Additional material studied: Pedraforca, Pollegó Superior, 31TCG97, Vives, 1986, BCB 35632.

***Encalypta ciliata* Hedw.**

Álvaro Martín (1982); Álvaro (2006).

***Encalypta raptocarpa* Schwägr.**

Álvaro (2006).

***Encalypta spathulata* Müll.Hal.**

Calcareous rock, 2530 m (A1).

Previous records: Álvaro (2006).

***Encalypta streptocarpa* Hedw.**

Limestone crevices and slopes, 1440-2120 m (A6, C4, D4, L1, L2, L3, L5).

Previous records: Álvaro Martín (1982); Álvaro (2006); Casas de Puig (1954b).

***Encalypta vulgaris* Hedw.**

Limestone crevices and soils, 1440-2220 m (A1, A12, A3, A9, C9, D4, L3, L8).

Previous records: Álvaro Martín (1982); Álvaro (2006).

***Eucladium verticillatum* (Brid.) Bruch & Schimp.**

Casas de Puig (1954b); Álvaro Martín (2001).

****Eurhynchiastrum diversifolium* (Schimp.) J.Guerra**

Shaded, calcareous soils, 1949 m (C9).

****Eurhynchium angustirete* (Broth.) T.J.Kop.**

Shaded, humus-rich soils, 1010 m (D8).

****Eurhynchium striatum* (Hedw.) Schimp.**

Shaded soils, 1050-1580 m (C6, C7, D7, D10).

***Exsertotheca crispa* (Hedw.) S.Olsson, Enroth & D.Quandt**

Calcareous rocks and ledges, 940-2000 m (C6, D6, L4, L8).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001); Gorro Caelles (2005).

***Fabronia ciliaris* (Brid.) Brid.**

Segarra-Moragues (2018).

***Fissidens adianthoides* Hedw.**

Seeping, calcareous rocks, 1910 m (A12).

Previous records: Álvaro Martín (1982).

***Fissidens dubius* P.Beauv.**

Calcareous slopes and rock crevices, 1420-2290 m (A4, A5, A6, C3, C6, D4, D6, L1, L3, L4, L5, L7).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

****Fissidens rivularis* (Spruce) Schimp.**

Additional material studied: Castellar de n'Hug, 31TDG18, moist rocks by stream Vives, 1971, BCB 2155; BCB 37041.

***Fissidens taxifolius* Hedw.**

Moist, shaded slopes, 1010-2290 m (A5, A9, D3, D8, D10).

Previous records: Casas Sicart (1959); Álvaro Martín (1982).

***Flexitrichum flexicaule* (Schwägr.) Ignatov & Fedosov**

Calcareous rocks, 1240-2530 m (A1, A4, A5, A6, A7, A9, A12, C9, L1, L2, L4, L5, L6, S3).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

Additional material studied: Gósol, Coll de Trapa, 31TCG97, Vives, 1971, BCB 35638.

***Flexitrichum gracile* (Mitt.) Ignatov & Fedosov**

Calcareous rocks and soils, 1250-2480 m (A3, A6, A8, C4, C6, D7, L1, L6, L7).

Previous records: Casas et al. (1992); Álvaro Martín (2001).

***Funaria hygrometrica* Hedw.**

Exposed soils, 1310 m (S1).

Previous records: Álvaro Martín (2001).

****Geheebia fallax* (Hedw.) R.H.Zander**

Calcareous soils, 1650 m (L5).

***Geheebia ferruginea* (Schimp. ex Besch.) R.H.Zander**

Calcareous soils, 2120-2530 m (A1, A6).
Previous records: Álvaro Martín (2001).

***Geheebia spadicea* (Mitt.) R.H.Zander**

Previous records: Álvaro Martín (2001).
Additional material studied: Castellar de n'Hug, Fonts del Llobregat, 31TDG18, on riverbank
rocks, E. Ruiz, 2023, BCB 61358.

***Geheebia tophacea* (Brid.) R.H.Zander**

Álvaro Martín (1982).

***Grimmia anodon* Bruch & Schimp.**

Calcareous rocks, 2220 m (A9).
Previous records: Álvaro Martín (1982).
Additional material studied: Gósol, 31TCG87, Vives, 1971, BCB 2408.

***Grimmia decipiens* (Schultz) Lindb.**

Álvaro Martín (1982).

***Grimmia laevigata* (Brid.) Brid.**

Exposed, volcanic rocks, 1240-1310 m (S1, S2, S3).
Previous records: Álvaro Martín (1982).

***Grimmia orbicularis* Bruch ex Wilson**

Calcareous rocks and rock crevices, 1270-1650 m (D2, L5, L9).
Previous records: Álvaro Martín (2001).

***Grimmia ovalis* (Hedw.) Lindb.**

Exposed, acidic rocks, 1050 m (D10).
Previous records: Álvaro Martín (2001).

***Grimmia pulvinata* (Hedw.) Sm.**

Exposed, acidic rocks, 1220 m (M1).
Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

****Grimmia trichophylla* Grev.**

Shaded, acidic rocks, 1225-1310 m (S1, S2, S3, S5).

Gymnostomum aeruginosum* Sm. var. *aeruginosum

Wet, calcareous rocks 1440-2350 m (A7, A9, D4, L1).
Previous records: Álvaro Martín (2001).

Gymnostomum calcareum* Nees & Hornsch. var. *calcareum

Damp, calcareous rocks, 1050 m (D10).
Previous records: Álvaro Martín (2001).

***Habrodon perpusillus* (De Not.) Lindb.**

Previous records: Álvaro Martín & Hladun Simón (1983).

Additional material studied: Castellar de n'Hug, 31TDG18, on tree trunk, Vives, 1971, BCB 37703.

***Hedwigia ciliata* (Hedw.) P.Beauv.**

Siliceous or poorly basic rocks, 1050-1310 m (D10, S1, S2, S3, S5).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

***Herzogiella seligeri* (Brid.) Z.Iwats.**

Rotting stumps, 1470-1930 m (C2, C3, C4, C5, C6, C7, C8, D5).

Previous records: Álvaro Martín and Hladun (1983); Carnicero and Unzeta (2016).

***Heterocладиella dimorpha* (Brid.) Ignatov & Fedosov**

Shaded soils and base of tress, 1940 m (C9).

Previous records: Álvaro Martín (2001).

****Heterocladium heteropterum* (Brid.) Schimp.**

Wet, shaded soils, 1810 m (C3).

***Homalothecium aureum* (Spruce) H.Rob.**

Exposed slopes and rocks, 1010-1705 m (B1, D8, L10, L9).

Previous records: Álvaro Martín (2001).

***Homalothecium lutescens* (Hedw.) H.Rob.**

Calcareous soils and rocks, 940-1910 m (A12, C4, D2, D3, D4, D5, D6, L1, L5).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Gorro Caelles (2005).

***Homalothecium philippeanum* (Spruce) Schimp.**

Calcareous rocks, 1050-2200 m (A4, D10, L8).

Previous records: Álvaro Martín (2001).

***Homalothecium sericeum* (Hedw.) Schimp.**

Dry, calcareous, soils, rocks and trunks of trees, 1120-2480 m (A3, A9, A10, C3, C6, D7, D9, L3, L4, L5, L6, L7, S1, S2, S4, W4).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

****Homomallium incurvatum* (Schrad. ex Brid.) Loeske**

Wet, calcareous rocks 1010-1190 m (D3, D8).

****Hygroamblystegium varium* (Hedw.) Mönk.**

Siliceous rocks, 1270 m (S4).

***Hygrohypnum luridum* (Hedw.) Jenn.**

Wet soils and rocks, 1440-1500 m (C4, D3, D4, D6, L1).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

***Hylocomiadelphus triquetrus* (Hedw.) Ochyra & Stebel**

Shaded, humus-rich soils, 940-1900 m (C1, C2, C3, C4, C5, C6, C7, D6, L2, L4, L6, L7).

Previous records: Álvaro Martín (1982); Álvaro Martín and Hladun (1983).

***Hylocomium splendens* (Hedw.) Schimp.**

Shaded, humus-rich soils, 1190-1900 m (C1, C2, C3, C4, C5, C6, C7, C9, D3, D5, L4, L6, L7, S2, S4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

****Hypnum andoi* A.J.E.Sm.**

Epiphyte, 920 m (D1).

Hypnum cupressiforme* Hedw. var. *cupressiforme

Soils, rocks, tree bases and stumps, 940-1990 m (A11, C1, C3, C4, C5, C6, C7, D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, L5, M1, S1, S2, S3, S4, S5, W4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Gorro Caelles (2005).

***Hypnum cupressiforme* var. *filiforme* Brid.**

Epiphyte, 1420 m (C6).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001); Gorro Caelles (2005).

***Hypnum cupressiforme* var. *lacunosum* Brid.**

Shaded or exposed soils and rocks 1190-1300 m (D3, S3).

Previous records: Álvaro Martín (2001).

***Hypnum cupressiforme* var. *subjulaceum* Molendo**

Calcareous rocks, 1500-1650 m (L1, L4, L5).

Previous records: Casas et al. (2006).

****Imbricium alpinum* (Huds. ex With.) N.Pedersen**

Wet, acidic slopes, 1240 m (S3).

***Isopterygiopsis muelleriana* (Schimp.) Z.Iwats.**

Acidic rocks, 1270 m (S4).

Previous records: Álvaro Martín (2001).

***Isopterygiopsis pulchella* (Hedw.) Z.Iwats.**

Calcareous rocks and crevices, 2220-2530 m (A1, A9).

Previous records: Álvaro Martín (2001).

****Isothecium alopecuroides* (Lam. ex Dubois) Isov.**

Shaded rocks, 1630 m (L7).

****Isothecium myosuroides* Brid.**

Shaded, calcareous rocks, 1010 m (D8).

***Kindbergia praelonga* (Hedw.) Ochyra**

Shaded soils and slopes and tree bases, 940-1950 m (D6, L2, L4).

Previous records: Álvaro Martín (2001); Gorro Caelles (2005).

***Leptodon smithii* (Hedw.) F.Weber & D.Mohr**

Trunks of trees and rocks, 1050-1480 m (D9, D10, S1, S2, S5).

Previous records: Casas de Puig (1954b); Casas et al. (1992); Gorro Caelles (2005).

***Lescuraea incurvata* (Hedw.) E.Lawton**

Crevice and calcareous rocks, 2000-2480 m (A3, A4, A5, A6, A7, A8, A10, L3, L8).

Previous records: Casas et al. (2006).

Additional material studied: Cadí, Prat d'Aguiló, 31TCG98, Vives, 1949, BCB 38813.

****Lescuraea plicata* (Schleich. ex F.Weber & D.Mohr) Broth.**

Shaded, calcareous rocks, 1950-2350 m (A7, A8, A9, L2).

***Leucodon sciuroides* (Hedw.) Schwägr.**

Trees and rocks, 940-2200 m (A4, C6, D2, D3, D6, D8, D9, D10, L10, M1, S1, S2, S5).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Gorro Caelles (2005).

***Lewinskya acuminata* (H.Philib.) F.Lara, Garilleti & Goffinet**

Gorro Caelles (2005); Vigalondo et al. (2016).

***Lewinskya affinis* (Schrad. ex Brid.) F.Lara, Garilleti & Goffinet**

Epiphytic, 1220-1690 m (C2, D3, D6, D7, D9, M1).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Casas et al. (2006); Gorro Caelles (2005).

Additional material studied: Bellver de Cerdanya, Font de l'Inglà, 31TCG99, epiphytic on *Pinus uncinata*, Cros, 1978, BCB 56850.

***Lewinskya fastigiata* (Bruch ex. Brid) Vigalondo, F.Lara & Garilleti**

Vigalondo et al. (2019).

***Lewinskya rupestris* (Schleich. ex Schwägr.) F.Lara, Garilleti & Goffinet**

Calcareous rocks, 1240-1310 m (D2, S1, S2, S3).

Previous records: Casas de Puig (1954a); Casas et al. (2006); Álvaro Martín (2001); Gorro Caelles (2005).

***Lewinskya speciosa* (Nees) F.Lara, Garilleti & Goffinet**

Epiphytic, 1250-1690 m (C2, D7, D9, L7).

Previous records: Casas et al. (2006).

***Lewinskya striata* (Hedw.) F.Lara, Garilleti & Goffinet**

Epiphytic, 1220-1420 m, (C6, D10, M1).

Previous records: Casas de Puig (1954b); Casas et al. (2006); Gorro Caelles (2005).

***Mnium hornum* Hedw.**

Fuertes and Acón (1999).

***Mnium lycopodioides* Schwägr.**

Wet, acidic slopes and rocks, 1190-1810 m, (C3, D3).

Previous records: Fuertes and Acón (1999).

***Mnium marginatum* (Dicks.) P.Beauv.**

Calcareous rocks, 2350 m, (A7).

Previous records: Álvaro Martín (1982).

***Mnium spinosum* (Voit) Schwägr.**

Shaded soils, 1620 m, (C5).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

***Mnium stellare* Hedw.**

Shaded soils and rocks, 920-1470 m (C6, D1, D3, D4, D5, S4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Casas et al. (1989).

***Mnium thomsonii* Schimp.**

Calcareous soils and rocks 1420-2480 m, (A3, A4, A5, A6, A7, A8, A9, A10, C4, C6, C9, D4, L2, L8).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

***Myurella julacea* (Schwägr.) Schimp.**

Calcareous ledges and rock crevices, 1630-2290 m, (A5, A9, A12, L6, L7, A5).

Previous records: Casas et al. (1985); Álvaro Martín (2001).

****Nogopterium gracile* (Hedw.) Crosby & W.R.Buck**

Trunks of trees, 920 m (D1).

***Nyholmia obtusifolia* (Brid.) Holmen & Warncke**

Previous records: Álvaro Martín (2001); Lara and Estébanez (2014).

Additional material studied: Gósol, 31TCG87, on tree trunk, Vives, 1971, BCB 38750.

***Orthothecium intricatum* (Hartm.) Schimp.**

Wet, limestone rocks and cliffs, 2220-2350 m (A5, A8, A9).

Previous records: Cano (2018a).

Additional material studied: Bellver de Cerdanya, vall de Pi, 31TCG99, Mayol and Riba, 2000, BCB 52143.

****Orthothecium rufescens* (Dicks. ex Brid.) Schimp.**

Wet, shaded, calcareous or volcanic rocks, 1240-2290 m (A5, A6, S3).

****Orthotrichum alpestre* Bruch & Schimp.**

Calcareous rocks, 2220 m (A9).

***Orthotrichum anomalum* Hedw.**

Calcareous rocks, 1050-1580 m (B1, B2, D10, L4, S2).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Lara and Garilleti (2014); Gorro Caelles (2005).

Orthotrichum cupulatum* Hoffm. ex Brid. var. *cupulatum

Calcareous rocks, 2200 m (A4).

Previous records: Álvaro Martín (2001); Casas et al. (2006).

***Orthotrichum diaphanum* Schrad. ex Brid.**

Previous records: Álvaro Martín (2001); Gorro Caelles (2005).

Additional material studied: Bellver de Cerdanya, Font de l'Inгла, 31TCG99, epiphytic on *Pinus uncinata*, Cros, 1978, BCB 56852.

****Orthotrichum pallens* Bruch ex Brid.**

Epiphytic, 1050-1690 m (C2, D10).

****Orthotrichum pumilum* Sw. ex anon.**

Additional material studied: Bellver de Cerdanya, Font de l'Inгла, 31TCG99, epiphytic on *Pinus uncinata*, Cros, 1978, BCB 56849.

***Orthotrichum rogeri* Brid.**

Gorro Caelles (2005).

****Orthotrichum schimperi* Hammar**

Additional material studied: Bellver de Cerdanya, Font de l'Inгла, 31TCG99, epiphytic on *Pinus uncinata*, Cros, 1978, BCB 61354.

***Oxyrrhynchium hians* (Hedw.) Loeske**

Shaded soils, slopes and by streams, 1120-2380 m (A6, A8, A10, D3, D4, L1, L3, W4).

Previous records: Álvaro Martín (2001).

***Oxyrrhynchium schleicheri* (R.Hedw.) Röhl**

Álvaro Martín and Hladun (1983).

***Palustriella commutata* (Hedw.) Ochyra**

Wet, calcareous substrata by springs and streams, 940-1525 m (D4, D6, L1, W2, W3).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

***Palustriella falcata* (Brid.) Hedenäs**

Spring of carbonated water, 1975 m (W1).

Previous records: Álvaro Martín (2001).

***Philonotis calcarea* (Bruch & Schimp.) Schimp.**

Spring of carbonated water, 1500-1525 m (L1, W2).

Previous records: Álvaro Martín (1982).

***Philonotis fontana* (Hedw.) Brid.**

Casas (1993b); Álvaro Martín (2001).

***Plagiomnium affine* (Blandow ex Funck) T.J.Kop.**

Wet, shaded soils and rocks 1420-1900 m (C4, C5, C6, D5, L6).
Previous records: Álvaro Martín (1982).

***Plagiomnium cuspidatum* (Hedw.) T.J.Kop.**

Wet, shaded soils and rock crevices, 920-1270 m (D1, D3, D6, D7, D10, S4, W4).
Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

****Plagiomnium elatum* (Bruch & Schimp.) T.J.Kop.**

Spring of carbonated water, 1525 m (W2).

****Plagiomnium ellipticum* (Brid.) T.J.Kop.**

Shaded, wet soils, slopes and rock ledges, 1250-1940 m (C6, C9, D7, L4).

****Plagiomnium medium* (Bruch & Schimp.) T.J.Kop.**

Wet soils and water-splashed rocks, 1690-1975 m (C2, L6, W1).

***Plagiomnium rostratum* (Schrad.) T.J.Kop.**

Wet o damp, shaded soils and rocks, 920-1500 m (C4, D1, D3, D9, W4).
Previous records: Álvaro Martín (1982).

***Plagiomnium undulatum* (Hedw.) T.J.Kop.**

Wet, shaded soils, 1120-1630 m (C4, C7, D3, D7, L7, W4).
Previous records: Álvaro Martín (1982).

***Plagiopus oederianus* (Sw.) H.A.Crum & L.E.Anderson**

Calcareous rocks, crevices and base of trees, 1420-2120 m (A6, C6, L4, L6).
Previous records: Casas et al. (1985); Álvaro Martín (2001).

****Plagiothecium laetum* Schimp.**

Rotten stumps, 1580 m. (C7).

****Plasteurhynchium meridionale* (Schimp.) M.Fleisch.**

Shaded, calcareous rock ledges, 940 m. (D6).

***Platydictya jungermannioides* (Brid.) H.A.Crum**

Calcareous soils, rocks, in rock crevices and tree bases, 940-2290 m (A5, A6, A8, C9, D10, D6, L4, L8, W4).
Previous records: Cano (2018b).

***Pleurozium schreberi* (Willd. ex Brid.) Mitt.**

Wet, shaded soils, 1580-1690 m (C2, C5, C7).
Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

***Pogonatum urnigerum* (Hedw.) P.Beauv.**

Shady, acidic slopes, 1620 m. (C5).

Previous records: Álvaro Martín (1982); Casas et al. (1992).

***Pohlia cruda* (Hedw.) Lindb.**

Soils and rock crevices 1050-2480 m (A1, A3, A5, A7, A8, A10, C9, D10, L6).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

***Pohlia nutans* (Hedw.) Lindb.**

Wet, shaded slopes, ledges and rotten stumps, 1930-1940 m (C1, C3, C8, C9).

Previous records: Álvaro Martín and Hladun (1983).

***Pohlia wahlenbergii* (F.Weber & D.Mohr) A.L.Andrews**

Álvaro Martín (1982).

***Polytrichastrum alpinum* (Hedw.) G.L.Sm.**

Previous records: Álvaro Martín (2001).

Additional material studied: Bellver de Cerdanya, Moixeró, Font Freda, 31TDG08, 1880 m, on shaded, acidic soil, Álvaro, 1985, BCN-Bryo 1088.

***Polytrichum formosum* Hedw.**

Shaded, acidic soil, 1620 m. (C5).

Previous records: Álvaro Martín (2001).

***Polytrichum juniperinum* Hedw.**

Exposed, soils and rocks 1580-1810 m (C3, C7).

Previous records: Álvaro Martín and Hladun (1983).

***Polytrichum piliferum* Hedw.**

Acidic rocky soils, 1310 m. (S1).

Previous records: Álvaro Martín (2001).

****Pseudanomodon attenuatus* (Hedw.) Ignatov & Fedosov**

Shaded rocks, 1270 m. (S4).

****Pseudoamblystegium subtile* (Hedw.) Vanderp. & Hedenäs**

Tree bases and decaying wood, 1250-1630 m (D7, L7).

***Pseudoleskeella catenulata* (Brid. ex Schrad.) Kindb.**

Shaded, calcareous rocks, 1470-2480 m (A3, A8, A10, A11, C4, C9, D5, L4, L6).

Previous records: Álvaro Martín (1982).

***Pseudoleskeella nervosa* (Brid.) Nyholm**

Base of trees, barks and calcareous rocks, 1010-1480 m (C6, D3, D7, D8, D9, D10, W4).

Previous records: Casas de Puig (1954b); Gorro Caelles (2005).

****Pseudoleskeella rupestris* (Berggr.) Hedenäs & L.Söderstr.**

Calcareous rock ledges, 1420 m. (C6).

****Pseudoleskeella tectorum* (Funck ex Brid.) Kindb. ex Broth.**

Shaded, calcareous rocks, 1270-2220 m (A9, A11, D2, L8).

****Pseudoscleropodium purum* (Hedw.) M.Fleisch.**

Shaded, calcareous soils, 940 m. (D6).

***Pseudostereodon procerrimus* (Molendo) M.Fleisch.**

Álvaro Martín (2001).

***Pseudotaxiphyllum elegans* (Brid.) Z.Iwats.**

Álvaro Martín (1982).

***Pterigynandrum filiforme* Hedw.**

Decaying wood, 1930 m. (C8).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

****Ptychostomum capillare* (Hedw.) Holyoak & N.Pedersen**

Wet shaded, soils and rocks, 1220-2290 m (A4, A5, C1, C3, D7, L5, L7, L8, M1, S3).

Additional material studied: Montellà i Martinet, entrada al Torrent d'Estana, 31TCG98, 1400 m,

Álvaro, 1978, BCC 1895 (*sub. Bryum pallens*).

***Ptychostomum compactum* Hornsch.**

Wet, calcareous slopes, 2120 m (A6).

Previous records: Álvaro Martín (2001).

***Ptychostomum elegans* (Nees in Brid.) Holyoak**

Calcareous rocks, 1270-2530 m (A1, A4, A5, A6, A8, A9, A10, D2, L3, L5, L7).

Previous records: Álvaro Martín (2001).

***Ptychostomum imbricatum* (Müll.Hal.) Holyoak & N.Pedersen**

Calcareous or siliceous soils and rocks, 1690-1810 m. (C2, C3).

Previous records: Álvaro Martín (1982).

****Ptychostomum intermedium* (Brid.) J.R.Spence**

Calcareous rocks crevices, 2290 m (A5).

***Ptychostomum moravicum* (Podp.) Ros & Mazimpaka**

Rocks, soils and trunks, 940-1990 (A11, D4, D5, D10).

Previous records: Álvaro Martín (2001).

****Ptychostomum pallescens* (Schleich. ex Schwägr.) J.R.Spence**

Wet, calcareous soils and rocks, 1630-2530 m (A1, A6, A8, A10, L4, L7, L8).

Ptychostomum pseudotriquetrum* (Hedw.) J.R.Spence & H.P.Ramsay var. *pseudotriquetrum

Spring of carbonated water 1280-1975 m (W1, W2, W3).

Previous records: Álvaro Martín (1982).

****Pulviger a lyellii* (Hook. & Taylor) Plášek, Sawicki & Ochyra**

Epiphyte, 1190-1220 m (D3, M1).

***Pylaisia polyantha* (Hedw.) Schimp.**

Epiphyte, 1050 m (D10).

Previous records: Álvaro Martín (2001).

***Racomitrium canescens* (Hedw.) Brid.**

Acidic rock ledges, 1310 m (S1).

Previous records: Álvaro Martín (1982).

****Rhabdoweisia fugax* (Hedw.) Bruch & Schimp.**

Acidic rock crevices, 1240 m (S3).

***Rhizomnium punctatum* (Hedw.) T.J.Kop.**

Wet, shaded soils and rocks, and rotting stumps, 1050-1690 m (C2, C5, C6, D10).

Previous records: Álvaro Martín and Hladun (1983).

***Rhodobryum ontariense* (Kindb.) Kindb.**

Calcareous soils and rock ledges, 1050-1705 m (D10, L10).

Previous records: Casas (1985); Casas et al. (1985); Álvaro Martín (2001).

***Rhodobryum roseum* (Hedw.) Limpr.**

Shady, siliceous soils, 1620 m (C5).

Previous records: Álvaro Martín (1982).

****Rhynchostegiella tenella* (Dicks.) Limpr.**

Volcanic rock ledges, 1310 m (S1).

****Rhynchostegiella teneriffae* (Mont.) Dirkse & Bouman**

Additional material studied: Castellar de n'Hug, 31TDG18, Vives, 1971, by stream, BCB 38217.

****Rhynchostegium murale* (Hedw.) Schimp. var. *murale***

Calcareous rock ledges, 1420 m (C6).

****Rhynchostegium murale* var. *julaceum* Schimp.**

Wet, calcareous rocks, 2120 m (A6).

***Rhynchostegium riparioides* (Hedw.) Cardot**

Submerged rocks or by streams, 920-1190 m (D1, D3, D6, D7, W4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

***Rhytidium rugosum* (Hedw.) Kindb.**

Exposed soils and slopes, 940-1705 m (D6, L10, S1, S3).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Casas et al. (1985); Gorro Caelles (2005).

****Roaldia revoluta* (Mitt.) P.E.A.S.Câmara & M.Carvalho-Silva**

Calcareous rocks, 1910-2220 m (A9, A12, L8).

***Sanionia uncinata* (Hedw.) Loeske**

Wet soils and tree trunks, 1500-1950 m (C2, C4, C5, C6, C9, L2).

Previous records: Álvaro Martín (1982).

***Schistidium apocarpum* (Hedw.) Bruch & Schimp.**

Calcareous or silicious rocks (D1, L10).

Previous records: Álvaro Martín (1982).

***Schistidium atrofusum* (Schimp.) Limpr.**

Dry, exposed, calcareous rocks, 2220 m (A9).

Previous records: Álvaro Martín (1982).

****Schistidium brunnescens* Limpr.**

Dry, exposed, calcareous rocks, 2380 m (D10).

***Schistidium crassipilum* H.H.Blom**

Calcareous or siliceous rocks, 1010-1910 m (A12, C4, D3, D7, D8, L1).

Previous records: Álvaro Martín (2001).

Additional material studied: Bellver de Cerdanya, vall de Pi, 31TCG99, Mayol & Riba, 2000, BCB 52154.

****Schistidium elegantulum* H.H.Blom subsp. *elegantulum***

Calcareous or siliceous rocks, 1050-1435 m (B2, D10).

****Schistidium flaccidum* (De Not.) Ochyra**

Calcareous rocks, 2380 m. (A10).

****Schistidium helveticum* (Schkuhr) Deguchi**

Calcareous rocks, 940 m (D6).

***Schistidium robustum* (Nees & Hornsch.) H.H.Blom**

Dry or periodically wet, calcareous rocks 1120-1800 m (C1, C4, L7, W4).

Previous records: Casas (2001); Álvaro Martín (2001).

Additional material studied: Castellar de n'Hug, 31TDG18, Vives, 1971, BCB 39395.

***Sciuro-hypnum populeum* (Hedw.) Ignatov & Huttunen**

Wet siliceous rock and base of trees by streams, 920-1270 m (D1, S4).

Previous records: Álvaro Martín (2001).

***Sciuro-hypnum reflexum* (Starke) Ignatov & Huttunen**

Casas et al. (2006).

****Scorpidium cossonii* (Schimp.) Hedenäs**

Calcareous waterlogged soil, 1975 m (W1).

***Serpoleskea confervoides* (Brid.) Schimp.**

Calcareous rock ledges, 2350 m (A7).

Previous records: Álvaro Martín (2001).

***Sphagnum auriculatum* Schimp.**

Casanovas Poch (1996).

***Stegonia latifolia* (Schwägr.) Venturi ex Broth.**

Álvaro Martín (2001).

***Syntrichia calcicola* J.J.Amann**

Casas et al. (2006); Gallego (2005).

****Syntrichia fragilis* (Taylor) Ochyra**

Siliceous rock, 1050 m (D10).

****Syntrichia laevipila* Brid.**

Bark of trees, 1190-1480 m (D3, D9).

***Syntrichia norvegica* F.Weber**

Calcareous rock ledges, 2200-2350 m (A4, A7).

Previous records: Álvaro Martín (2001).

****Syntrichia papillosa* (Wilson) Jur.**

Bark of older trees, 1270 m (D2).

Syntrichia ruralis* (Besch.) Mans var. *ruralis

Rock ledges, walls and tree bases, 1220-1990 m (A2, A4, A9, A11, A12, B1, C2, D2, L10, L6, L7, L8, M1, S1).

Previous records: Álvaro Martín (1982); Gorro Caelles (2005).

***Syntrichia sinensis* (Müll.Hal.) Ochyra**

Shaded, siliceous rocks, 1050 m (D10).

Previous records: Gallego (2005).

****Syntrichia subpapillosissima* (Bizot & R.B.Pierrot ex W.A.Kramer) M.T.Gallego & J.Guerra**

Additional material studied: Bellver de Cerdanya, Bor, vers la Mata Negra, 31TDG08, on calcareous soil, Vives, 1973, BCB 46457.

***Tetraxis pellucida* Hedw.**

Rotting stumps, 1580 m (C7).

Previous records: Álvaro Martín and Hladun (1983); Carnicero and Unzeta (2016).

***Thamnobryum alopecurum* (Hedw.) Gangulee**

Water-splashed rocks by streams, 1270-2000 m (L8, S4).

Previous records: Álvaro Martín (2001).

***Thuidium assimile* (Mitt.) A.Jaeger**

Shaded, calcareous soils and rocks, 940-1500 m (C4, D3, D4, D6, S4).

Previous records: Casas de Puig (1954b); Álvaro Martín (1982); Casas et al. (1992).

***Thuidium delicatulum* (Hedw.) Schimp.**

Shaded rocks and base of trees, 940-1500 m (B1, C4, D6).

Previous records: Casas et al. (1992); Álvaro Martín (2001).

***Thuidium recognitum* (Hedw.) Lindb.**

Calcareous rocks and tree bases, 1050-1500 m (C4, D10).

Previous records: Casas de Puig (1954b); Álvaro Martín (2001).

***Thuidium tamariscinum* (Hedw.) Schimp.**

Álvaro Martín (1982); Casas et al. (1992).

***Timmia austriaca* Hedw.**

Stony soils and calcareous rock crevices, 1940-2450 m (A3, A4, A5, A8, A9, C9, L2).

Previous records: Álvaro Martín (1982); Manobens Rigol (1984); Casas (1993b).

***Timmia bavarica* Hessel.**

Soils and calcareous rock crevices, 1580-2380 m (A7, A8, A9, A10, L4, L8).

Previous records: Álvaro (2010).

****Timmia norvegica* J.E.Zetterst.**

Calcareous rock crevices, 2120 m (A6).

***Tortella densa* (Lorentz & Molendo) Crundw. & Nyholm**

Calcareous rocks, 1705-1990 m (A11, L10).

Previous records: Álvaro Martín (2001).

***Tortella fragilis* (Drumm.) Limpr.**

Puche (2006).

***Tortella humilis* (Hedw.) Jenn.**

Casas de Puig (1954b).

***Tortella inclinata* (R.Hedw.) Limpr.**

Calcareous soils and rock ledges, 2120 m (A6).

Previous records: Álvaro Martín (2001).

****Tortella nitida* (Lindb.) Broth.**

Dry, exposed, calcareous rocks, 1650 m (L5).

***Tortella tortuosa* (Hedw.) Limpr.**

Calcareous rocks, crevices, ledges and soils, 940-2530 m (A1, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, C2, C3, C4, C6, C9, D2, D4, D5, D6, D8, L1, L2, L3, L4, L5, L7, L9, M1, S1, S5).
Previous records: Casas de Puig (1954b); Álvaro Martín (1982).

****Tortula atrovirens* (Sm.) Lindb.**

Stony siliceous soil, 1220 m (M1).

****Tortula inermis* (Brid.) Mont.**

Siliceous, rocky soils, 1270 m (D2).

***Tortula mucronifolia* Schwägr.**

Calcareous rock, 2120 m (A6).
Previous records: Casas de Puig (1954b); Álvaro Martín (2001).
Additional material studied: Cadí, Mare de Déu de Bastanist, 31TCG98, Llensa, 1971, BCB 5994.

***Tortula muralis* Hedw.**

Calcareous rocks, 1910 m (A12).
Previous records: Álvaro Martín (2001).

***Tortula subulata* Hedw.**

Slopes and rock ledges, 1270-2220 m (A9 A12, C9 S4).
Previous records: Álvaro Martín (1982).

****Trichostomum crispulum* Bruch**

Exposed, calcareous soils and rocks, 1270-2290 m (A5, A6, A9, D2, L1).

***Ulota crispa* (Hedw.) Brid.**

Gorro Caelles (2005).

****Weissia brachycarpa* (Nees & Hornsch.) Jur.**

Calcareous soils and rocks, 1240-1910 m (A12, S3).

DISCUSSION

Based on our findings, the bryophyte flora of the Cadí-Moixeró Natural Park comprises 293 taxa, including 48 liverworts and 245 mosses. This represents 24% of the known liverwort taxa and 37% of the known moss taxa in Catalonia, which is remarkable for an area of only 41,000 ha.

The surveys conducted between 2016 and 2022, together with the study of herbarium material, have increased the number of known bryophyte taxa in this park by 30%. As a natural consequence, the exploration of new sites has extended the distribution range of many species previously recorded in the Park. On the other hand, of the 293 taxa listed, 13% were not rediscovered during our study.

ANALYSIS OF THE MACROHABITATS STUDIED

SPECIES RICHNESS

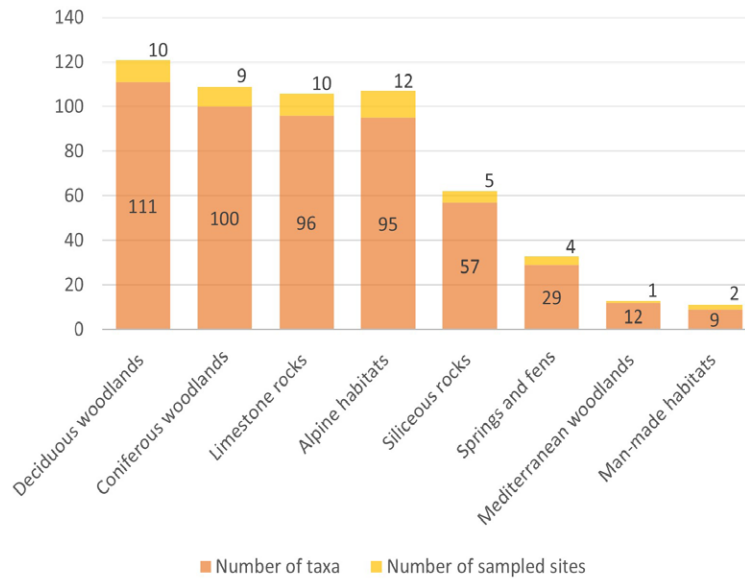


Figure 2. Number of taxa and sampled sites in main macrohabitats.

As shown in Figure 2, deciduous woodlands, coniferous woodlands, limestone rocks, and alpine habitats have the highest species richness, with a similar number of sampled sites in each. In contrast, siliceous rocks, springs, and fens have lower species richness. Mediterranean woodlands and man-made habitats have the lowest species richness, although it should be noted that the number of localities sampled for these areas was also relatively low.

SPECIES OF CONSERVATION CONCERN

The various macrohabitats studied are home to bryophyte species with different levels of threat, as evaluated by the Red List of Bryophytes of Catalonia (Sáez et al., 2019). Some of these species are granted legal protection, being included in the Catalogue of Threatened Flora of Catalonia (Resolution ACC/3929/2023, 20 November; DOGC 9047 23/11/2023), such as *Buxbaumia viridis* and *Cyrtomnium hymenophylloides*. Furthermore, *Buxbaumia viridis* is also listed in Annex II of the Habitats Directive 92/43/ECC of the European Union. Figure 3 shows the number of threatened species found in each

macrohabitat, as well as those likely to face threats in the near future. Table 2 lists these species along with their assigned IUCN (2012) categories (CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened), with species under legal protection highlighted in bold. It is possible that some of these categories may need to be reassessed in the future based on the outcomes of this study. Additionally, some taxa discovered during our work may not have been assigned a threat category at the time, but they may deserve such categorisation. This is the case with *Cratoneuron curvicaule*, *Eurhynchiastrum diversifolium*, *Hypnum cupressiforme* var. *subjulaceum*, *Mesoptychia collaris*, *Ptychostomum compactum*, *Ptychostomum intermedium* and *Tortella densa*.

Table 2. Threatened and near threatened taxa, along with their IUCN category (2012), assigned according to the Red List of Bryophytes of Catalonia (Sáez et al. 2019). Species in bold are legally protected.

<i>Nardia insecta</i>	CR	<i>Claopodium rostratum</i>	NT
<i>Drepanium fastigiatum</i>	EN	<i>Clevea hyalina</i>	NT
<i>Jungermannia polaris</i>	EN	<i>Encalypta affinis</i>	NT
<i>Brachythecium tommasinii</i>	VU	<i>Encalypta spathulata</i>	NT
<i>Cinclidotus riparius</i>	VU	<i>Eurhynchium angustirete</i>	NT
<i>Cyrtomnium hymenophylloides</i>	VU	<i>Fissidens rivularis</i>	NT
<i>Nowellia curvifolia</i>	VU	<i>Homomallium incurvatum</i>	NT
<i>Orthotrichum alpestre</i>	VU	<i>Isothecium myosuroides</i>	NT
<i>Pseudeskeella rupestris</i>	VU	<i>Lescurea plicata</i>	NT
<i>Scapania cuspiduligera</i>	VU	<i>Mnium lycopodioides</i>	NT
<i>Syntrichia fragilis</i>	VU	<i>Plagiothecium laetum</i>	NT
<i>Timmia norvegica</i>	VU	<i>Pseudeskeella tectorum</i>	NT
<i>Aulacomnium androgynum</i>	NT	<i>Scapania calcicola</i>	NT
<i>Brachythecium turgidum</i>	NT	<i>Schistidium atrofusum</i>	NT
<i>Buxbaumia viridis</i>	NT	<i>Schistidium flaccidum</i>	NT
<i>Campylophyllum halleri</i>	NT	<i>Schistidium robustum</i>	NT
<i>Chiloscyphus pallescens</i>	NT	<i>Syntrichia sinensis</i>	NT
<i>Cinclidotus aquaticus</i>	NT	<i>Syntrichia subpapillosissima</i>	NT
<i>Cirriphyllum piliferum</i>	NT		

MACROHABITATS INSIDE

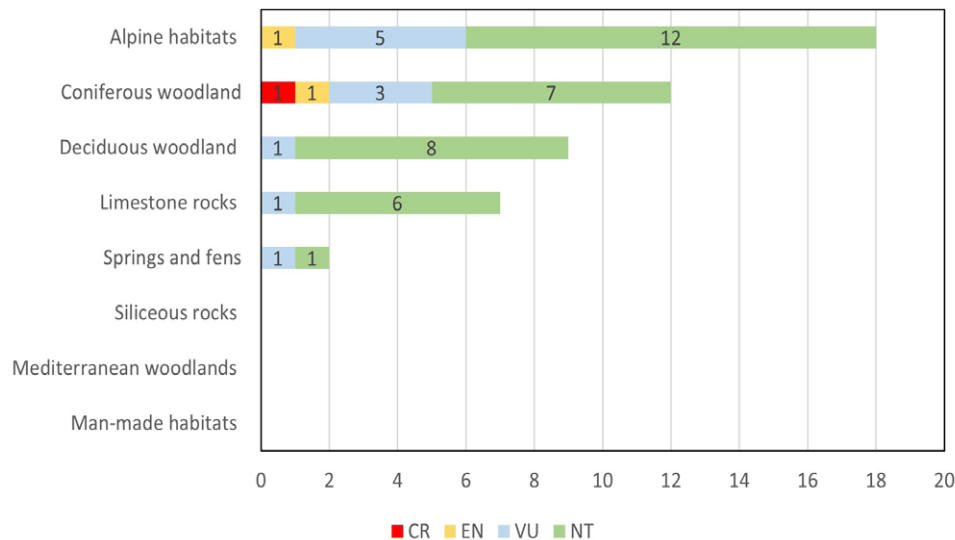


Figure 3. Number of threatened and near threatened taxa in main macrohabitats. CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened.

The IUCN categories assigned to some of the species discussed below are based on the Red List of Bryophytes of Catalonia (Sáez et al. 2019).

Alpine habitats (1,910-2,530 m). These rocky, limestone, high mountain environments are home to the highest number of species with some degree of threat (Figure 3), as well as those of greatest chorological interest:

Cyrtomnium hymenophylloides, assessed as Vulnerable (VU D2), and *Cratoneuron curvicaule* are notable for being chorological novelties. The inclusion of *C. hymenophylloides* (genus and species) in the Spanish bryophyte catalogue resulted from our report at the Serra Pedregosa site (Figure 4), and further herbarium research led to the addition of another locality in the Aragonese Pyrenees (Ruiz et al. 2018b). As for *C. curvicaule*, it had been excluded from the Spanish bryophyte catalogue following a revision of the herbarium material (Brugués and Ruiz 2003), but our report from the Serrat Gran site (Figure 5), together with another record from the Aragonese Pyrenees, led to its reinstatement (Ruiz et al. 2019).

Jungermannia polaris is restricted to the northernmost regions of Spain, including the Cantabrian Mountains, the Basque Mountains, and the Central Pyrenees. The records from Barranc de les Toselletes (Figure 6) and Comabella, extend the distribution of this species to the Eastern Pyrenees. In Catalonia, it is assessed as Endangered (EN B1ab(iii)+2ab(iii)).



Figure 4. Habitat of *Cyrtomnium hymenophylloides* at Serra Pedregosa. Photo by P. Aymerich.



Figure 5. Habitat of *Cratoneuron curvicaule* at Serrat Gran. Photo by P. Aymerich.

Other notable species found in this macrohabitat include *Brachythecium tommasinii*, *Orthotrichum alpestre*, *Scapania cuspiduligera*, and *Timmia norvegica*, all assessed as Vulnerable (VU D2). Additionally, there is a significant number of taxa categorized as Near Threatened (NT), such as *Brachythecium turgidum*, *Campylophyllum halleri*, *Cirriphyllum piliferum*, *Claopodium rostratum*, *Clevea hyalina*, *Encalypta affinis*, *Encalypta spathulata*, *Lescuraea plicata*, *Pseudoleskeella tectorum*, *Scapania calcicola*, *Schistidium atrofuscum* and *S. flaccidum*. Most of these species initially had a very restricted distribution in the central and eastern Pyrenees, which our records have extended.

Coniferous woodlands (1,400-1,930 m), this macrohabitat exhibit high species richness (Figure 2) and diverse microhabitats (rocks, rock ledges, soils, logs, and decaying wood) and include some taxa with assigned threat categories:

Nardia insecta, classified as Critically Endangered (CR B1ab(iii)+2ab(iii); D), was previously known from a single site in the Central Pyrenees. However, our records from Coma Oriola (Figure 7) and Barranc de l'Agre de Moixó extend its distribution to the Eastern Pyrenees.

Drepanium fastigiatum, classified as Endangered (EN B1ab(iii)+2ab(iii)), is a very rare species known from only two localities in the Pyrenees.

Pseudoleskeella rupestris, *Brachythecium tommasinii* and *Nowellia curvifolia* are classified as Vulnerable (VU D2). The first two were previously restricted to a few localities in the Pyrenees, and our study has extended their distribution southwards.



Figure 6. Habitat of *Jungermannia polaris* in the Barranc de les Toselletes. Photo by P. Aymerich.



Figure 7. Habitat of *Nardia insecta* at Coma Oriola. Photo by P. Aymerich.

Aulacomnium androgynum, *Buxbaumia viridis*, *Campylophyllum halleri*, *Cirriphyllum piliferum*, *Eurhynchiastrum diversifolium*, *Plagiothecium laetum* and *Schistidium robustum* are categorized as Near Threatened (NT). Our records often extend the distribution of these species in Catalonia, establishing their southern limit. The same applies to *Dicranum tauricum* and *Timmia austriaca*, which, although considered of least concern, were previously only recorded from areas further north in the Pyrenees.

Deciduous woodlands (915-1,480 m), is the macrohabitat with the highest species richness (Figure 2) and is characterised by a wide range of microhabitats, including rocks, soils, stream banks, logs, and stumps. Notably, this habitat is home to *Syntrichia fragilis*, a threatened species classified as Vulnerable (VU D2). These deciduous forests also contribute a significant number of Near Threatened (NT) taxa, such as *Cinclidotus aquaticus*, *Eurhynchium angustirete*, *Homomallium incurvatum*, *Isothecium myosuroides*, *Pseudoleskeella tectorum*, *Scapania calcicola*, and *Syntrichia sinensis*. Other species, although considered to be of least concern, are of importance due to their restricted distribution in Catalonia, such as *Homalothecium philippeanum* and *Pylaisia polyantha*, both from Sant Vicenç de Rus (Figure 8), which are restricted to the Pyrenees, and *Schistidium elegantulum* subsp. *elegantulum*, which occurs in only four localities.

Limestone rocks (1,360-2,100 m) are prevalent in the Natural Park (Figure 9). It is worth noting the presence of *Brachythecium tommasinii*, which grows on calcareous rocks, is considered Vulnerable



Figure 8. Habitat of *Homalothecium philippeanum* and *Pylaisia polyantha* at Sant Vicenç de Rus. Photo by P. Aymerich.



Figure 9. Limestone rocks in a *Pinus sylvestris* forest at Corral de la Por. Photo by P. Aymerich.

(VU D2) and is also found in alpine habitats and coniferous forests. Other notable species in this habitat, such as *Claopodium rostratum*, *Encalypta affinis*, *Lescurea plicata*, *Pseudeskeella tectorum*, *Scapania calcicola* and *Schistidium robustum*, are classified as Near Threatened (NT) in Catalonia.

Springs and fens (1,110-1,975 m) in the study area are associated with carbonate waters. The most notable species here is *Cinclidotus riparius*, assessed as Vulnerable (VU D2) due to its restricted distribution and sensitivity to habitat alterations and anthropogenic threats, it was found in a karst spring of tourist interest called Fou de Bor, with only one locality in the Natural Park. *Schistidium robustum*, a Near Threatened (NT) species, was found not only in the coniferous woodlands and calcareous rocks macrohabitats, but also on the rocks of a carbonate spring.

Siliceous rocks (1,210-1,320 m) are rare in the Natural Park. The species found in this macrohabitat are not particularly noteworthy in terms of chorology or conservation. An exception is *Campylopus atrovirens* collected on volcanic rocks at Rocs Negres (Figure 10), which adds a new site to the few found in the Pyrenees. The species richness in this macrohabitat, although lower than in the previous ones, may be significant, considering that only five localities were studied.

In the **Mediterranean woodlands** (1,220 m), with a small area and a single site studied, the species found were not particularly significant from a chorological or conservation perspective. The same observation applies to **Man-made habitats** (1,400-1,435 m), where two localities were studied.



Figure 10. Habitat of *Campylopus atrovirens* at Rocas Negres. Photo by P. Aymerich.

COMMENTS ON CONTROVERSIAL SPECIES INCLUDED IN THE BRYOPHYTE LIST

Some of the species of chorological or conservation interest included in the catalogue were not rediscovered during our study. Among them, the species listed below are not available for verification, and their presence in the Park should be approached with caution:

- *Brachythecium cirrosum* is classified as Critically Endangered in Catalonia (CR B1ab (iii,iv)+2ab(iii,iv)) according to Sáez et al. (2019).
- *Buxbaumia aphylla* is assessed as Endangered (EN B1ab(iii)+2ab(iii)) according to Sáez et al. (2019) and is included in the Catalogue of threatened flora of Catalonia (Resolution ACC/3929/2023, 20 November; DOGC 9047 23/11/2023).
- *Blindiadelphus recurvatus*, *Chiloscyphus pallescens*, *Fuscocephaloziopsis lunulifolia*, *Lophozia guttulata*, *Encalypta rhaptocarpa*, *Pseudostereodon procerrimus*, *Scapania curta* and *Stegonia latifolia*, are all classified as Near Threatened (NT) in Catalonia (Sáez et al. 2019).
- *Orthotrichum rogeri*, assessed as Vulnerable (VU D2) in Catalonia (Sáez et al. 2019), is additionally listed in Annex II of the Habitats Directive.
- *Dicranoweisia cirrata* was excluded from Catalonia in the work "Flora Briofítica Ibérica" (Bru-gués and Ruiz, 2015) because all available revised specimens were found to be incorrect.
- *Sphagnum auriculatum*: The authors consider this citation to be highly improbable. The specimens corresponding to Casanovas Poch (1996) are deposited in the BCN herbarium and do not include *S. auriculatum* from the Cadí-Moixeró Natural Park. Furthermore, the area where it is cited has been explored several times without this species being found.

In conclusion, this comprehensive catalogue highlights the remarkable diversity of bryophytes within the Cadí-Moixeró Natural Park, featuring species of conservation interest and chorological significance due to their southern distribution limits or rarity. There exists an ongoing opportunity for improving our knowledge and further campaigns focused on locating some of the remarkable species not found during our study would be highly recommended. Therefore, we hope that this catalogue will serve as a basis for future research, enriching the catalogue with new records and monitoring the species listed as threatened.

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