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BOTANICAL CHECKLISTS

Checklist of lichenized and lichenicolous fungi from the Penyagolosa Massif and nearby areas (Castelló, eastern Iberian Peninsula)

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Abstract. The Penyagolosa Massif (Castelló, Valencian Community), which includes the Penyagolosa Natural Park, is one of the most emblematic natural landscapes of the eastern Iberian Peninsula. It hosts a wide variety of Mediterranean habitats, including groves of several *Quercus* species and extensive *Pinus* spp. forests. The present checklist represents the first compilation of lichenized and lichenicolous fungi for the protected as well as nearby areas and is mostly based on species records available at the Biodiversity Data Bank of the Valencian Community (BDBCV). We report 221 and 12 infrageneric taxa of lichenized and lichenicolous fungi, respectively. *Punctelia caseana* is reported for the first time for the European continent. Six lichenicolous fungi are newly reported for the Valencian Community. The study area includes the red-listed lichen *Xanthoparmelia camtschadalis*. The families *Parmeliaceae* and *Teloschistaceae* were the most represented. By evaluating the functional traits, we found that the most abundant lichens are those having (1) crustose thalli, (2) with sexual reproduction, mainly through the formation of apothecia, and (3) that are associated with trebouxioid green microalgae. Furthermore, the most frequent lichen community in the study area is formed by xerophytic lichens that can tolerate very high direct solar irradiation and grow under weak eutrophication conditions. Finally, we emphasize the need to accelerate the compilation of the diversity of lichenized and lichenicolous fungi in the park through DNA sequencing and molecular phylogenetic studies.
Keywords. biodiversity, conservation, lichens, literature review, plant micro-reserve, natural park, Valencian Community.

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Introduction

Lichenization has been a prominent force in fungal evolution that explains why lichen-forming fungi account for at least one fifth of all known fungi (Kirk *et al*., 2008; Lücking *et al*., 2017). In the Iberian Peninsula and Balearic Islands, the first formal checklist of lichenized fungi compiled by Llimona & Hladun (2001) encompassed ca. 12% of the total lichen diversity known globally, i.e., 2426 out of 19000 species (Lücking *et al*., 2017). Llimona & Hladun (2001) also included 368 lichenicolous fungi, which, according to Lücking *et al*. (2021), may be divided into mycoparasites, when they attack the lichen mycobiont causing a considerable damage to the thallus, gall-formers, and other fungi that share the algal partner without causing any visible symptoms on thalli. Lichen and lichenicolous fungal checklists have been assembled at a more regional scales in the Iberian Peninsula coinciding with administrative boundaries (e.g., autonomous communities, provinces, and districts) or with emblematic natural landscapes, either protected by law or not (e.g., Boqueras *et al*., 1989; Fos, 2000; Martínez *et al*., 2000; Sarrión, 2001; Aragón, 2002; Pérez-Ortega & Álvarez-Lafuente, 2006a,b; Etayo, 2010; Burgaz, 2014; Burgaz *et al*., 2017; Blázquez, 2022). The lichen and lichenicolous fungal checklist of the Valencian Community, an administrative area encompassing ca. 23×10^3 km^2 in the eastern Iberian Peninsula, was first compiled in 1999 based on a bibliographic review including more than 3700 specimen records and hosted 569 infrageneric taxa (Atienza & Segarra, 1999). A recent revision raised the number of infrageneric taxa to 836 lichenized and 94 lichenicolous fungi (Fos, 2023; BDBCV, 2023). Local lichenologists have also focused their attention on the diversity of lichens occurring in areas of this region often hosting protected natural landscapes: Els Ports and El Baix Maestrat, including La Tinença de Benifassà Natural Park (Atienza, 1990), the Font Roja Natural Park (Barreno *et al*., 1990; Calvo & Sanz, 2000; Fos & Atienza, 2009), the Illes Columbretes Natural Park (Calatayud, 1998), the plant micro-reserve Las Hoyuelas (Fos, 2001), and more recently, the Albufera of Valencia Natural Park (Atienza & Fos, 2011; García Alonso *et al*., 2018). The diversity of lichens has also been compiled from areas with high anthropogenic use (l'Horta Sud; Fos, 2022), and specific habitats, such as siliceous rocks in the Serra Calderona and Serra d'Espadà natural parks (Calatayud & Barreno, 1994; Calatayud *et al*., 1995; Calatayud, 1998) and epiphytic lichens on cork and holm oaks (Fos, 1998; Fos *et al*., 2001; Garrido-Benavent *et al*., 2013). However, other emblematic areas in the Valencian Community completely lack checklists about lichens and lichenicolous fungi.

A major geographical landmark in the north-western Valencian Community lacking one such checklist is the Penyagolosa Massif, which is located between the municipalities of Vistabella del Maestrat, Xodos and Villahermosa del Río in the province of Castelló. It is a cultural reference point deeply rooted in local tradition that host the second highest peak in the Valencian Community (1814 m asl) and encompasses the Penyagolosa Natural Park, with 1094.45 protected hectares (ha). The vegetation of the Penyagolosa Massif and nearby areas is composed of holm oak groves (*Quercus rotundifolia* Lam.) enriched with maples (*Acer opalus* subsp. *granatense* (Boiss.) Font Quer & Rothm.) and some gall oaks (*Q. faginea* Lam.) that are replaced at higher altitudes by extensive pine forests of black pine (*Pinus nigra* Arnold subsp. *salzmannii* (Dunal) Franco) and Scots pine (*P. sylvestris* L.) with a diverse understorey that includes populations of holly (*Ilex aquifolium* L.) and yew (*Taxus baccata* L.), the rare wild apple tree (*Malus sylvestris* Mill.), linden (*Tilia platyphyllos* Scop.), and mountain elms (*Ulmus glabra* Huds.). In the areas with acidic (siliceous) soils, groves of *Quercus pyrenaica* Willd. and mature forests of maritime pine (*Pinus pinaster* Aiton) occur, and these are accompanied by several species of rockroses (*Cistus populifolius* L., *C. laurifolius* L.) and heather (*Erica* L. spp. and *Calluna vulgaris* (L.) Hull). The bioclimatic characterization indicates that this area includes from the meso- to oromediterranean thermoclimatic belts, and a subhumid ombroclimate (Rivas-Martínez *et al.*, 2017). In the Valencian Community, the typical vegetation from the oromediterranean belt is only present in this area, around the Penyagolosa peak, and in the highest areas of the Rincón de Ademuz (Valencia), in the surroundings of Alto del las Barracas or Cerro Calderón (1836 m asl), where the maximum regional altitude is reached.

From an historical perspective, Cavanilles (1795) highlighted the remarkable diversity of plants that grew in the municipality of Vistabella del Maestrat, but without any mention of the presence of cryptogams (i.e., fungi and fungi-like organisms, algae, ferns, and mosses). Later, numerous botanists visited the region and contributed data on its flora and vegetation: E. Reverchon, P. Font i Quer, A. de Bolòs, O. de Bolòs, C. Pau, S. Rivas Goday, J. Borja and, especially, J. Vigo (1968). None of them, however, provided any reference to the Penyagolosa's cryptogams. The first documented observations of lichens in this natural park corresponded to collections of *Cladonia pyxidata* (L.) Hoffm. and *Umbilicaria pustulata* (L.) Hoffm. made in the 1970's and 80's (Burgaz, 2015; BDBCV, 2023), and the last were made in the 90s, in a study on lichen phytochemistry by Miguel & Villa (1990). Other references to lichens from that decade were referred to areas surrounding Villafranca del Cid, a municipality located further north of the study area.

The present work assembles the first checklist of lichenized and lichenicolous fungi of the Penyagolosa Massif, including the natural park as well as nearby areas, mostly based on species records available at the Biodiversity Data Bank of the Valencian Community (BDBCV, 2023). Various functional traits like thallus growth form, reproduction type, and associated photobiont were considered to characterize the suite of compiled lichens. The preferences of the listed taxa for different environmental factors, such as aridity, substrate pH, solar irradiation, and eutrophication, were also considered based on Nimis (2023). By compiling this checklist, we aim at providing a basis for developing conservation studies in the Penyagolosa Natural Park that take lichens into consideration, and to adopt management measures that deal with anthropogenic threats as well as climate disruption, given that lichens are excellent biomonitors of environmental change (Nash III, 2008; Abas, 2021).

Methods

The checklist has been compiled using two data sources. First, 2418 lichen and lichenicolous fungal records available at the Biodiversity Data Bank of the Valencian Community (BDBCV, 2023) that were incorporated into this database after intense surveys conducted by one of the authors (SF) from 1996 to 2022. Most identifications were done *de visu*, whereas material was collected to identify doubtful species or tiny lichens in the laboratory. We downloaded species records for nine 10×10 km UTM grids (900 km^2 or 9×10^4 ha), including the grid 30TYK25 that contains the Penyagolosa Natural Park (1094.45 ha, Figure 1; Table 1). Within these grids, lichens were recorded in eighty-six 1×1 km grids (86 km^2 or 8600 ha; Supplementary Material S1), which can be accessed virtually at https://bdb.gva.es/es/.

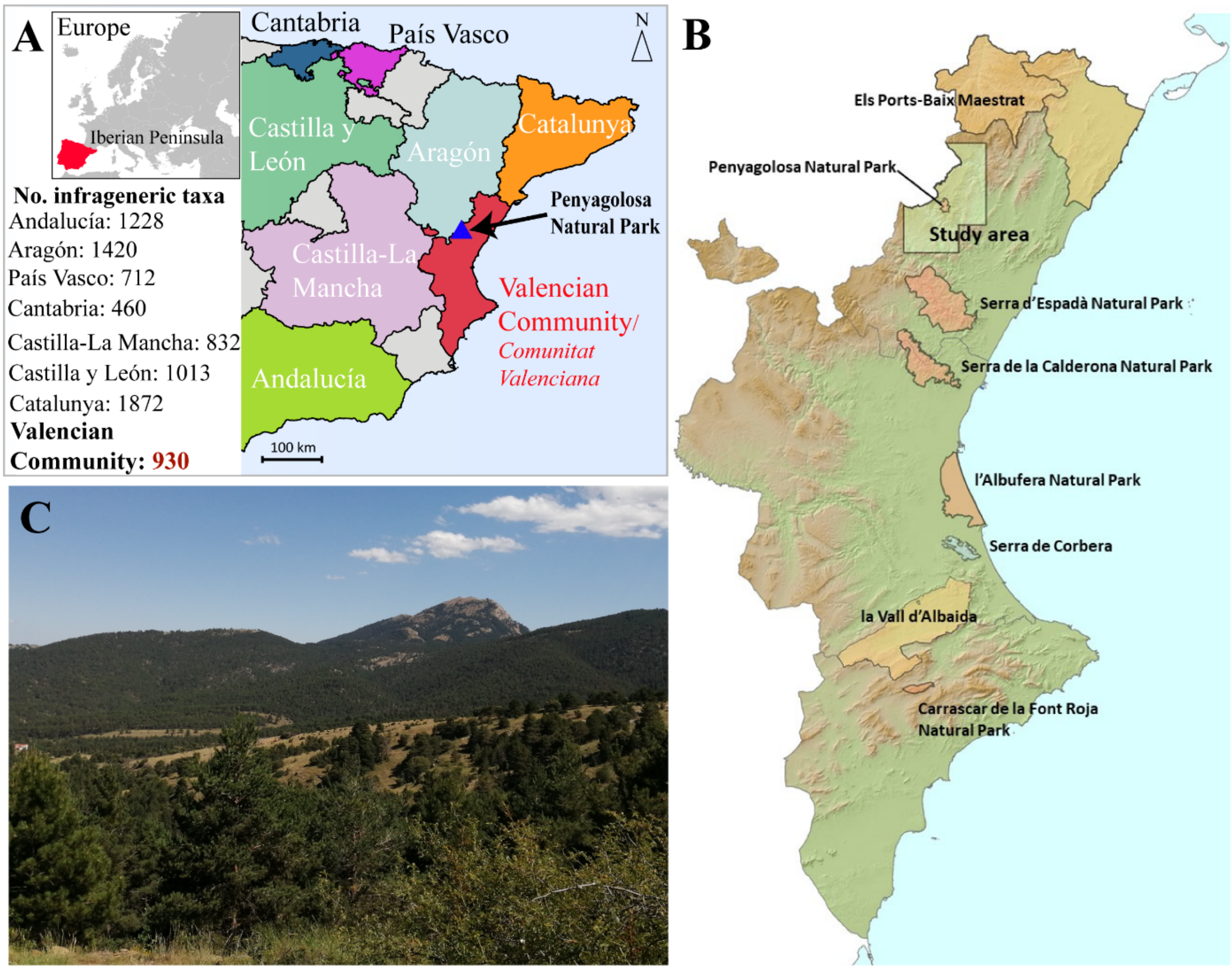

Figure 1. A, Location of the Penyagolosa Massif in the Iberian Peninsula, with data on total number of lichen and lichenicolous infrageneric taxa for several administrative Spanish regions [Aragón: Etayo (2010); Andalucía: Burgaz (2014); País Vasco: Ihobe (2010); Cantabria and Castilla y León: Pérez-Ortega & Álvarez-Lafuente (2006a,b); Castilla-La Mancha: Blázquez (2022); Catalunya: Hladun (2023); Valencian Community/Valencian Community/Comunitat Valenciana: Fos (2023), BDBCV (2023)]; B, Map of the Valencian Community depicting the location of the Penyagolosa Natural Park and the whole study area, with the placement of other studied areas with available checklists on lichenized and/or lichenicolous fungi (Table 1); C, view of Penyagolosa summit; Maps and photograph: IGB & SF.

Table 1. Studied localities (10×10 km grids, datum ETRS89) comprising lichen and lichenicolous fungal occurrence data.

Locality code	UTM 10×10 km grid	Included municipalities
1	30TYK14	Zucaina
2	30TYK15	Villahermosa del Río
3	30TYK24	Villahermosa del Río and Castillo de Villamalefa
4	30TYK25	Vistabella del Maestrat, Villahermosa del Río and Xodos
5	30TYK26	Vistabella del Maestrat and Xodos
6	30TYK27	Vistabella del Maestrat and Villafranca del Cid
7	30TYK35	Xodos
8	30TYK36	Vistabella del Maestrat and Benafigos
9	30TYK37	Villafranca del Cid and Benassal

Second, lichen and lichenicolous fungi were collected during a field trip organized by the XXIII International Symposium of Cryptogamic Botany that was held in Valencia in July 2022. Material was collected in three localities: Mas Roig and El Rebollar, both located in the UTM 1×1 km grid 30TYK2359, and a protected plant micro-reserve named Barranc de la Pegunta (30TYK2557). Collections were deposited in the herbarium of the Faculty of Biological Sciences of the University of Valencia (acronym VAL_Lich).

Specimens were identified in the laboratory based on general lichen guides and identification keys: Clauzade & Roux (1985), Giralt (1996), Boqueras (2000) and Smith *et al*. (2009). The identification of the material included the analysis of microscopic characters and chemical reactions (K, C, P). Thin layer chromatography (TLC) was conducted to identify the lichen substances of *Cladonia*, *Ochrolechia*, *Usnea*, *Punctelia* and *Xanthoparmelia* specimens according to standardised protocols (Orange *et al*., 2001). The nomenclature and species authorities were retrieved from MycoBank (2023). All information is available for consultation in the BDBCV (2023) and in the GBIF biodiversity data platform (GBIF, 2023).

Percentages of the following functional traits were also calculated based on categories proposed by Nimis (2023): 1) growth form (crustose, foliose, fruticose, and squamulose; we considered species in the genus *Cladonia* to have mixed or composite thalli, following Burgaz & Ahti (2009)); 2) photobiont type (three categories: trebouxioid or chlorococcoid algae other than *Trentepohlia*, cyanobacteria, and others); 3) reproductive strategy (sexual vs. asexual); 4) type of reproductive structures (apothecia, perithecia, isidia, soredia, thallus fragments); and 5) habitat (epiphytic, saxicolous and terricolous). Regarding the response to different environmental factors, we considered eutrophication, solar irradiation, aridity (water requirement) and pH of substratum. Additionally, we classified the species in terms of poleotolerance, which is a parameter indicating the tendency of a lichen to occur in areas with different degrees of human disturbance (Nimis, 2023).

Results and Discussion

The assembled checklist includes 221 lichenized and 12 lichenicolous fungi at the infrageneric level (Appendix 1). These numbers are relevant for the studied ecosystem given that lichens, together with bryophytes, contribute significantly to carbon and nitrogen fixation (Elbert *et al*., 2012). Lichens also show a remarkable ability to uptake and retain atmospheric water and provide shelter and food for a multitude of microbial and microarthropod communities (Cornelissen *et al*., 2007; Asplund & Wardle 2017). Furthermore, the diversity of lichenized fungi in the Penyagolosa Massif and nearby areas represents ca. 26% of all known lichens from the Valencian Community (Fos, 2023; BDBCV, 2023). Compared to similar surveys in and out of the Valencian Community, the diversity of lichens in the studied area is moderately high (Table 2). For example, another emblematic protected area at the south of the Valencian Community, the Font Roja Natural Park (Alacant province), encompasses 128 lichenized and two lichenicolous fungi so far (Fos & Atienza, 2009). The lichen biota of the Albufera Natural Park includes 140 lichenized and 6 lichenicolous fungi (Atienza & Fos, 2011; García Alonso *et al*., 2018). However, comparisons based on Table 2 data must be done with caution as either the lichen groups or the total area surveyed differs between studies. In general, many checklists lack data from saxicolous species (Figure 2A-C), especially those occurring on calcareous rocks. In the study area, saxicolous species are clearly underrepresented. The use of molecular phylogenetic studies would speed up the rate at which additional lichen taxa are added to the checklist.

The number of lichenized and lichenicolous taxa above the species level in the Penyagolosa Massif and nearby areas were 115 genera, 41 families, 27 orders, and 8 classes (Supplementary Material S2). The most diverse genera were *Xanthoparmelia*, with nine species, and *Cladonia*, *Lecanora* and *Physcia*, with eight species each, followed by *Ramalina* with six species. *Cladonia* and *Lecanora* have often been found to be two of the most diverse genera in other mountain ecosystems in the Iberian Peninsula (Boqueras *et al*., 1989; Fos, 2000; Fos & Atienza, 2009; Burgaz *et al*., 2017). Regarded in a wide sense, the genus *Caloplaca* would have been the most species-rich genera in the study area, with almost 30 species; however, the taxonomy of the family *Teloschistaceae*, to which this genus belongs, has undergone dramatic changes at the genus level in the last decade, and *Caloplaca* has been split into several new genera (e.g., Arup *et al*., 2013; Frolov *et al*., 2021). Nowadays, *Caloplaca sensu lato* in the Penyagolosa Massif and nearby areas is divided into sixteen different genera. At the family level, *Parmeliaceae* (44), *Teloschistaceae* (35), *Physciaceae* (22) and *Lecanoraceae* (20) were the ones that included the highest number of species. Finally, the *Lecanorales*, with 98 species and *Teloschistales*, with 35, were the orders that showed the highest diversity of lichenized fungi.

Lichens with crustose and foliose thalli were the most abundant, with 47% and 34% of the total species diversity, respectively (Figure 3A; Supplementary Material S2). On the opposite, fruticose and composite lichens were the rarest (12 and 10 species, respectively). Percentages of abundance ranging from nearly 50 to 60% of crustose lichens and 30 to 40% of foliose lichens have also been calculated for epiphytic lichens from Sierra del Tremedal (Aragón *et al*., 1999), Sierra de Javalambre (Atienza *et al*., 1992; Fos, 2000), Sierra de Gúdar (Martínez *et al*., 2000), the Vall d'Albaida region, and the Font Roja Natural Park (Fos & Atienza, 2009; Garrido-Benavent *et al*., 2013). These coincidences should not be interpreted as a pattern for all Mediterranean ecosystems, as Burgaz *et al*. (2017) found opposite values (i.e., higher percentages of foliose than crustose lichens) in their assessment of the lichen diversity of the Serranía de Ronda (southern Iberian Peninsula). In the Penyagolosa Massif and nearby areas, crustose lichens of the genera *Lecanora*, *Lecidella* and *Caloplaca* s.l. generally dominate epiphytic communities on the nutrient-rich bark of young deciduous and evergreen trees (e.g., holm and gall oaks, maples, and lime and apple trees), often in exposed

Table 2. Number of lichens and lichenicolous fungi recorded for various areas in the Iberian Peninsula with special emphasis on studies conducted in the Valencian Community (see also Figure 1).

Studied area	Administrative region	Lichens	Licheni-colous	Studied lichen groups	Work
Penyagolosa Natural Park and nearby areas	Valencian Community	221	12	Epiphytic, terricolous, and saxicolous	Present study
Els Ports & Baix Maestrat (incl. La Tinença de Benifassà Natural Park)	Valencian Community	210	5	Epiphytic	Atienza (1990)
Sierra de Corbera	Valencian Community	66	n/a	Epiphytic	Atienza & Crespo (1984)
Sierra de Espadán Natural Park	Valencian Community	126	n/a	Saxicolous (silicicolous)	Calatayud (1991); Calatayud & Barreno (1994)
Font Roja Natural Park	Valencian Community	128	2	Epiphytic, terricolous, and saxicolous	Barreno *et al*. (1990); Fos & Atienza (2009)
Vall d'Albaida	Valencian Community	55	2	Epiphytic (*Quercus rotundifolia*)	Garrido-Benavent *et al*. (2013)
Albufera of Valencia Natural Park	Valencian Community	140	6	Epiphytic, terricolous, and saxicolous	García Alonso *et al.* (2018)
Montseny Natural Park	Catalunya	202	n/a	Saxicolous (silicicolous)	Hladun (1982)
Sierra del Moncayo	Aragón	122	n/a	Epiphytic	Boqueras *et al*. (1989)
Sierra del Tremedal	Aragón	127	n/a	Epiphytic	Aragón *et al*. (1999)
Sierra de Javalambre	Aragón	124	n/a	Epiphytic	Fos (2000)
Sierra de Gúdar	Aragón	101	n/a	Epiphytic	Martínez *et al*. (2000)
Sierra Madrona-Valle de Alcudia	Castilla-La Mancha	235	13	Epiphytic	Sarrión (2001)
Cazorla, Segura and Las Villas Natural Park	Andalucía	465	3	Epiphytic, terricolous, and saxicolous	Aragón (2002)
Serranía de Ronda	Andalucía	336	24	Epiphytic, terricolous, and saxicolous	Burgaz *et al*. (2017)

areas, roadsides, and tracks, as well as areas disturbed by livestock and agricultural use, as observed in Sierra del Tremedal and Javalambre (Aragón *et al*., 1999; Fos, 2000). The crustose growth form is often the most frequent on either acidic or calcareous rocks as well. Foliose lichens, however, develop profusely on the bark of older oaks as well as pines; in the studied area, species in the genera *Hypogymnia*, *Flavoparmelia*, *Melanelixia*, *Parmelia*, and *Parmelina*, all belonging to *Parmeliaceae*, and *Anaptychia* and *Physconia* (*Physciaceae*) showed the highest cover on tree trunks. The foliose species *Pseudevernia furfuracea* (Figure 2D) is nowadays the most abundant species on *Pinus* bark in the study area. Regarding the fruticose lichens, species of the genus *Ramalina* are frequently found in oak trunks and branches, whereas *Bryoria fuscescens* and *Usnea hirta* are often found on *Pinus* bark. The phorophytes supporting the highest number of different lichen taxa were *Quercus rotundifolia*, with more than 50 species, followed by *Pinus sylvestris* (40) and the broadleaved *Acer opalus* subsp. *granatense* (>30; Figure 3H). Regarding other functional lichen traits, the 64% of all listed taxa in the Penyagolosa Massif and nearby areas displayed sexual reproduction (Figure 3B; Supplementary Material S2), mostly through the production of apothecia (137 species), whereas the remaining taxa reproduced asexually, with 58 sorediate and 17 isidiate species (Figure 3B). Regarding the photobiont choice, most lichens (ca. 94%) associated with a trebouxioid green microalga, whereas only a few (12 species, ca. 5%) partnered with cyanobacteria. Previous studies have shown that the abundance of fertile lichens with *Trebouxia* s.l. as primary photobiont increases linearly with intensification of land use, whereas asexually reproducing lichens are more common in well-preserved forests (Stofer *et al*., 2006; Lundström *et al*., 2013). The almost lack of old forests in the study area might explain at least partially the absence of some asexually reproducing taxa (Stofer *et al*., 2006; Zarabska-Bożejewicz & Kujawa, 2018).

The most frequent lichen community in the Penyagolosa Massif and nearby areas was formed by xerophytic lichens (44% of total lichen taxa; Figure 3C; Supplementary Material S2) that can stand a very high direct solar irradiation (65%; Figure 3D), usually grow on subacid to subneutral substrata (38%; Figure 3E) and develop under weak eutrophication conditions (43%; Figure 3F). Hygrophytic species that occur on very shaded habitats and that develop under no eutrophication conditions were the least frequent (Figure 3C). Similar percentages for eutrophication and aridity tolerance categories were calculated in the evaluation of the lichen diversity of the Vall d'Albaida region and the Font Roja Natural Park (Garrido-Benavent *et al*., 2013), thus suggesting that both the Mediterranean macroclimate, with a marked aridity period during summer, and land use (especially agriculture and livestock) might be driving the lichen community assembly in the study area (Aragón *et al*., 2010; Matos *et al*., 2015). However, other forest variables like patch size or stand variability, as well as the altitude and slope might be playing a role in lichen community composition (e.g., de Gea *et al*., 2023). Finally, the 39% of the compiled lichens are typical from moderately perturbed areas (Figure 3G), according to the

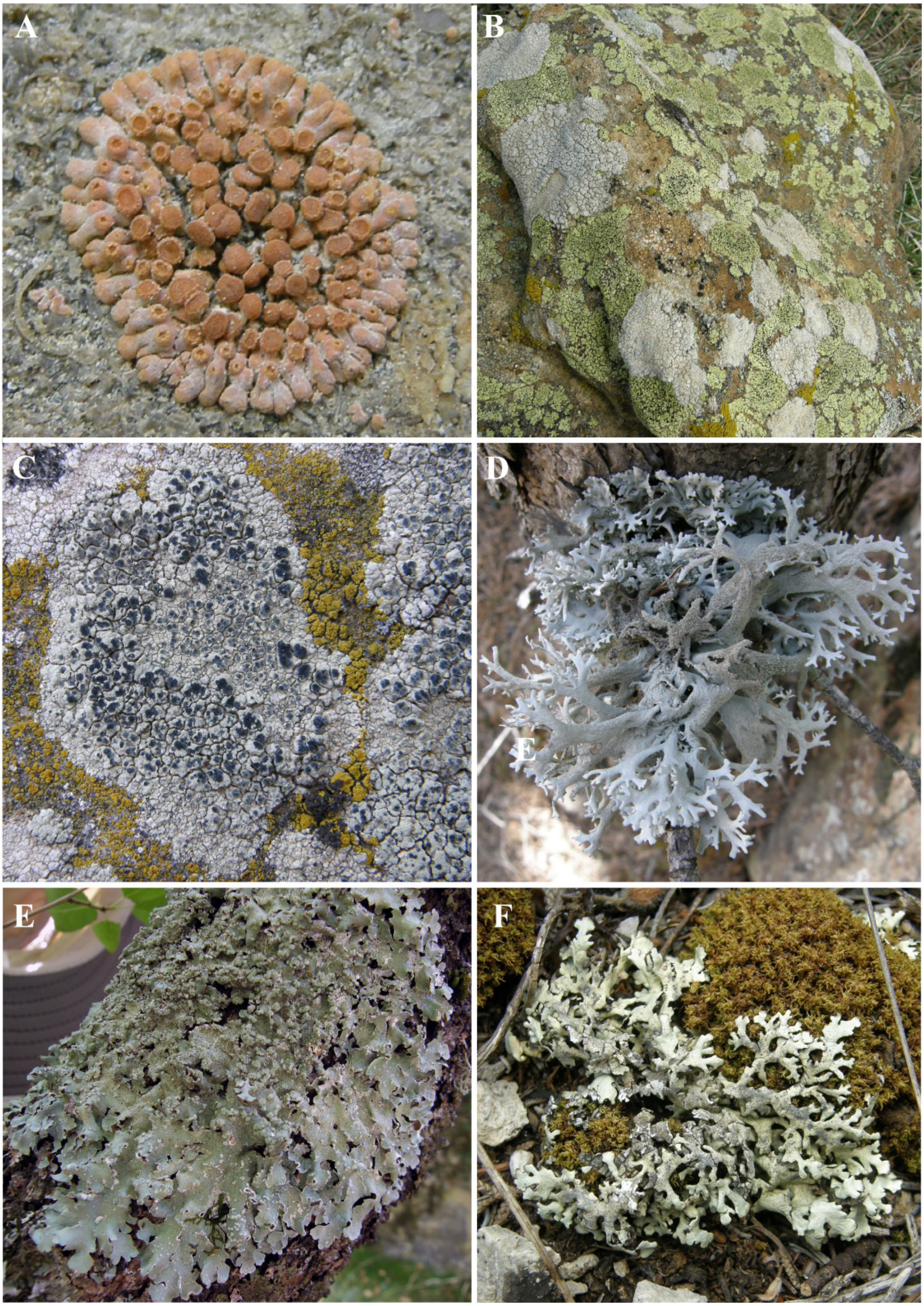

Figure 2. Diversity of lichenized fungi in the Penyagolosa Massif. A, *Calogaya pusilla*; B, Community of lichenized fungi on an acidic rock; C, *Lecanora sulphurea*; D, *Pseudevernia furfuracea*; E, *Punctelia caseana*; F, *Xanthoparmelia camtschadalis*. Photographs: IGB.

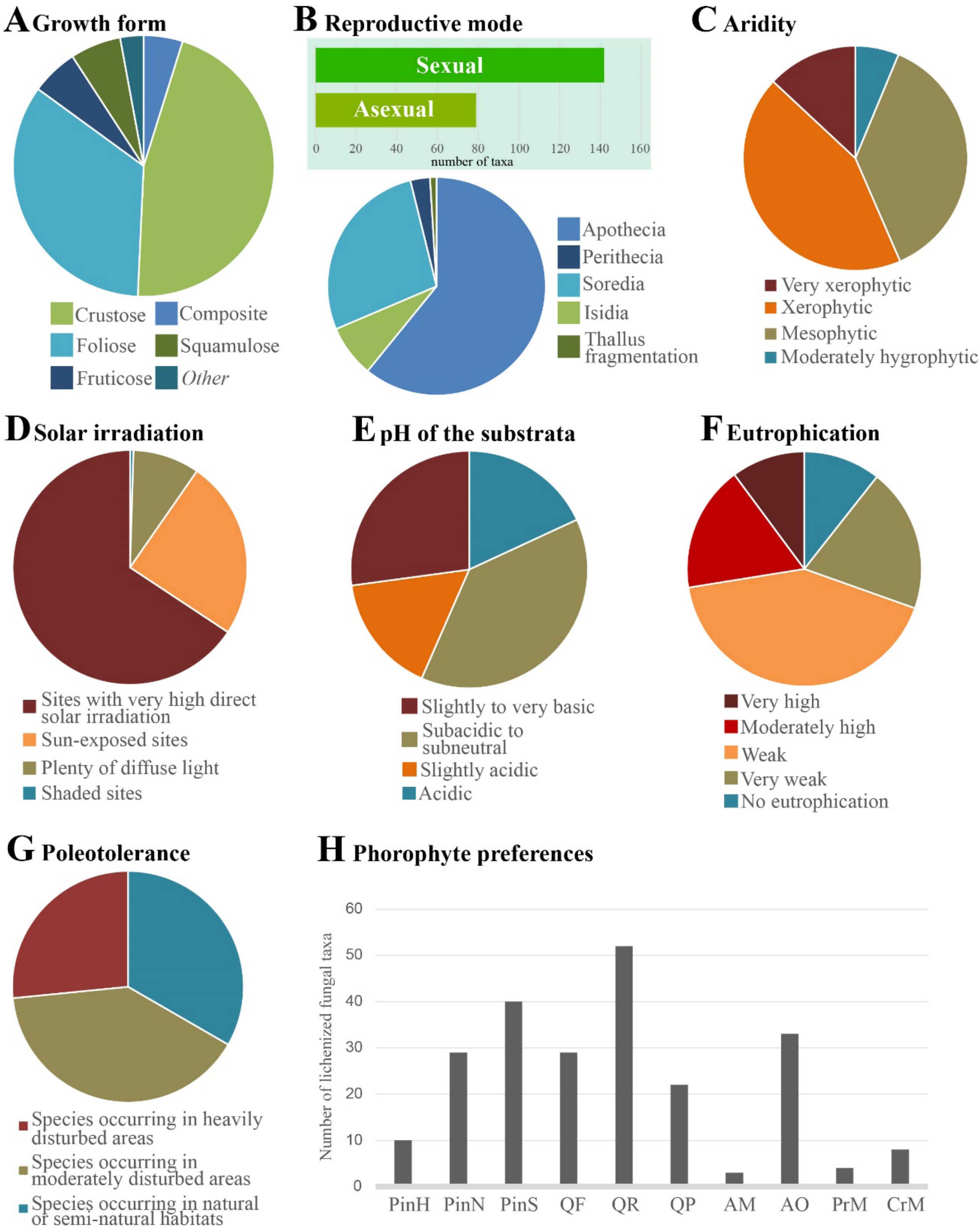

Figure 3. Characterization of functional and ecological traits in the checklist taxa. A, Prevalence of thallus growth forms; B, Abundance of reproductive modes and relative frequencies of dispersal strategies; C, Prevalence of different tolerances to aridity; D, Prevalence of different tolerances to several levels of solar irradiation; E, Prevalence of different tolerances to substratum pH; F, Prevalence of different tolerances to eutrophication; G, Prevalence of different poleotolerances; H, Preference for particular phorophytes (PinH: *Pinus halepensis*; PinN: *P. nigra* subsp. *salzmannii*; PinS: *P. sylvestris*; QF: *Quercus faginea*; QR: *Q. rotundifolia*; QP: *Q. pyrenaica*; AM: *Acer monspessulanum*; AO: *A. opalus* subsp. *granatense*; PrM: *Prunus mahaleb*; CrM: *Crataegus monogyna*).

different poleotolerance categories proposed by Nimis (2023); the percentages of species occurring in the study area that typically inhabit natural or seminatural areas and very perturbed areas were also noticeable (35 and 26%, respectively; Figure 3G). These results should be re-evaluated once species groups still poorly studied in the area are included, such as the calcareous saxicolous species.

During the field trip of 2022, a specimen of *Punctelia caseana* (Figure 2E) was collected on the trunk of *Prunus mahaleb* in the plant micro-reserve Barranc de la Pegunta (1×1 km UTM grid 30TYK2557). This corticolous lichen is characterized by producing foliose thalli with a grey-blue upper surface with epruinose lobe tips, and with frequent soralia, which are primarily marginal along the secondary lobes, or laminal when they develop from pseudocyphellae in the older portions of the thallus; conidia are filiform and on average 9–10 µm long (Lendemer & Hodkinson, 2010). *Punctelia caseana* was described from North America and, so far, it has been only recorded from USA, Canada, and Mexico (Lendemer & Hodkinson, 2010); to the best of our knowledge, our collection represents the first record outside the American continent. Corroboration of the identity of this species has been done estimating a phylogeny with data from the fungal barcode marker nuclear ribosomal Internal Transcribed Spacer (results not shown; GenBank accession number for the obtained nrITS sequence of *P. caseana*: PP760193). Regarding its chemistry, we have also detected atranorin and lecanoric acid (Lendemer & Hodkinson, 2010). The 2022 field trip made it also possible to add the following six lichenicolous fungi to the Valencian Community checklist for the first time: *Bryostigma parietinarium*, *Clypeococcum hypocenomyces*, *Heterocephalacria physciacearum*, *Muellerella erratica*, *Protousnea huuskonenii*, and *Tremella hypogymniae*. Furthermore, the lichen *Xanthoparmelia camtschadalis* (Figure 2F) is the only red-listed species included in the checklist as endangered (Atienza & Segarra, 1999, 2000). We determined that it produces usnic, salazinic and consalazinc acids, in agreement with Hale (1990). In the study area, this lichen grows in cold grassy plains soils, and it is distributed in the grids 30TYK2155, 30TYK2359, 30TYK2879, 30TYK3069, 30TYK3174, 30TYK3177, and 30TYK3275.

Taxonomically, *Cladonia subrangiformis* was assumed to conform a subspecies of *C. furcata* in the compiled checklist given that the phenotypic traits that have often been used to distinguish these two species were found to be highly homoplastic (Pino-Bodas *et al.*, 2015). The unclear boundaries revealed by phylogenetic analyses between the morphologically similar species *Cladonia convoluta* and *C. foliacea* (Pino-Bodas *et al*., 2010), and *C. pocillum* and *C. pyxidata* (Kotelko & Piercey-Normore, 2010; Stenroos *et al*., 2019), led us to consider them as conspecific. However, *C. pocillum* and *C. pyxidata* were kept as different forms of *Cladonia pyxidata*. Additionally, it must be noted that the identity of some listed species, in particular those belonging to the genera *Blastenia*, *Flavoplaca*, *Parmelia* s.l. or *Pyrenodesmia*, is in need for further corroboration using molecular phylogenetic analyses, as species circumscriptions in these genera based solely on morphological characters are often imprecise (Molina *et al*., 2004; Divakar *et al*., 2005; Vondrák *et al*., 2020; Frolov *et al*., 2021; Garrido-Benavent *et al*., 2023).

Conclusions

The Penyagolosa Massif and nearby areas support a moderately rich community of lichenized and lichenicolous fungi. Climatic and geographic factors, as well as different intensities of land use (agriculture, livestock, and forest management) are probably shaping species composition of lichen communities in the study area. In fact, a more comprehensive study considering the different areas of the Penyagolosa Massif is needed to evaluate the impact of different intensities of land use on lichen diversity. Furthermore, there is a pressing need to adopt more straightforward techniques to accelerate the compilation of species diversity. DNA sequencing and molecular phylogenetic studies are expected to contribute to this end. This combined approach would also allow for unravelling the taxonomic identity of the associated photobionts (either eukaryotic microalgae or cyanobacteria), thus generating knowledge for a neglected fraction of the biodiversity hosted in the protected area. It would also allow for elucidating mycobiont-photobiont interaction patterns, which often remain unknown for most Mediterranean ecosystems.

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Authorship contribution

IGB: conceptualization, data curation, formal analysis, fundraising, research, methodology, management of the project, resources, writing (first draft, review, and editing); LE: data curation, formal analysis, methodology, supervision writing (review); VA, LV, JCZ: formal analysis, research, resources, supervision writing (review); MJC, LF: research; SF: data curation, research, methodology, supervision writing (review).

Conflict of interest

None.

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Supplementary Material

S1. List of 1×1 km UTM grids (datum ETRS89) from which lichen and lichenicolous fungal records were retrieved based on the Biodiversity Data Bank of the Comunitat Valenciana (BDBCV, 2023).

S2. Functional and ecological traits in the checklist taxa.

Appendix 1. Checklist of lichenized and lichenicolous fungi from the Penyagolosa Massif and nearby areas. The taxa are listed alphabetically, indicating for each species the locality of collection (see list in Table 1), the habitat and ecology, and the availability of specimens at VAL_Lich. For taxa that have recently been combined into other genera, the most widely used synonyms are also given. The symbol * denotes that the species is novel for the checklist of lichens and lichenicolous fungi of the Valencian Community. Abbreviations for phorophyte species are AM (*Acer monspessulanum* L.), AO (*A. opalus* subsp. *granatense*), CoA (*Corylus avellana* L.), CrM (*Crataegus monogyna* Jacq.), Er (*Erica* sp.), JugR (*Juglans regia* L.), JunO (*Juniperus oxycedrus* L.), OE (*Olea europaea* L.), PinH (*Pinus halepensis* Mill.), PinS (*P. sylvestris*), PinN (*P. nigra* subsp. *salzmannii*), PisL (*Pistacia lentiscus* L.), PoN (*Populus nigra* L.), PrA (*Prunus avium* (L.) L.), PrD (*P. dulcis* (Mill.) D. A. Webb), PrM (*P. mahaleb* L.), PrS (*P. spinosa* L.), QF (*Quercus faginea*), QR (*Q. rotundifolia*), QP (*Q. pyrenaica*), RP (*Robinia pseudoacacia* L.) and SA (*Salix atrocinerea* Brot.). Lack of data is denoted by "n/a".

Scientific name	**Localities**	**Habitat**	**Voucher**
Abrothallus parmeliarum (Sommerf.) I. Kotte	4	Lichenicolous; parasitic on *Parmelia saxatilis*	VAL_Lich 33255
Acarospora cervina (Ach.) A. Massal.	4, 5, 6 & 9	Saxicolous on calcareous rocks	n/a
Amandinea punctata (Hoffm.) Coppins & Scheid.	4	Epiphytic on AO	VAL_Lich 26525 & 29748
Anaptychia ciliaris (L.) Flot	4, 5 & 6	Epiphytic on AO, QF and QR	VAL_Lich 33232
Athallia alnetorum (Giralt, Nimis & Poelt) Arup, Frödén & Søchting (≡ *Caloplaca alnetorum* Giralt, Nimis & Poelt)	4	Epiphytic on AO and PinS	VAL_Lich 26530, 26537 & 29749
Athallia cerinella (Nyl.) Arup, Frödén & Søchting (≡ *Caloplaca cerinella* (Nyl.) Flagey)	4	Epiphytic on AO	VAL_Lich 29750
Athallia cerinelloides (Erichsen) Arup, Frödén & Søchting (≡ *Caloplaca cerinelloides* (Erichsen) Poelt)	4	n/a	n/a
Athallia holocarpa (Hoffm.) Arup, Frödén & Søchting (≡ *Caloplaca holocarpa* (Hoffm.) A.E. Wade)	4 & 6	Epiphytic on QR	n/a
Bagliettoa marmorea (Scop.) Gueidan & Cl. Roux (≡ *Verrucaria marmorea* (Scop.) Arnold)	2, 3, 4, 5 & 9	Saxicolous on calcareous rocks	n/a
Bagliettoa parmigerella (Zahlbr.) Vězda & Poelt (≡ *Verrucaria parmigerella* Zahlbr.)	4	Saxicolous on calcareous rock	VAL_Lich 29734
Bilimbia sabuletorum (Schreb.) Arnold	6	On mosses	n/a
Blastenia crenularia (With.) Arup, Søchting & Frödén (≡ *Caloplaca crenularia* (With.) J.R. Laundon)	4	n/a	VAL_Lich 33859
Blastenia ferruginea (Huds.) A. Massal. (≡ *Caloplaca ferruginea* (Huds.) Th. Fr.)	4, 5, 6 & 9	Epiphytic on AO, QF, QR, and QP	n/a
Blastenia hungarica (H. Magn.) Arup, Søchting & Frödén (≡ *Caloplaca hungarica* H. Magn.)	4, 5 & 6	Epiphytic on PinS and PinN	VAL_Lich 26533, 26538 & 29727
Bryoria fuscescens (Gyeln.) Brodo & D. Hawksw.	4 & 6	Epiphytic on QR and PinS	VAL_Lich 29240, 33213 & 33243
**Bryostigma parietinarium* (Hafellner & A. Fleischhacker) S.Y. Kondr. & Hur (≡ *Arthonia parietinaria* Hafellner & A. Fleischhacker)	4	Lichenicolous; parasitic on *Xanthoria parietina*	VAL_Lich 33244
Buellia disciformis (Fr.) Mudd	6	Epiphytic on PinN	n/a
Calogaya decipiens (Arnold) Arup, Frödén & Søchting (≡ *Caloplaca decipiens* (Arnold) J. Steiner)	4, 5, 7 & 9	Mainly saxicolous on calcareous rocks and mortar, rarely terricolous	n/a
Calogaya pusilla (A. Massal.) Arup, Frödén & Søchting (≡ *Caloplaca pusilla* (A. Massal.) Zahlbr.)	2, 7 & 9	Saxicolous on calcareous rocks and mortar	n/a
Calogaya schistidii (Anzi) Arup, Frödén & Søchting (≡ *Fulgensia schistidii* (Anzi) Poelt)	4	On mosses over calcareous substrata	n/a
Caloplaca aegatica Giralt, Nimis & Poelt	4	Epiphytic on AO	VAL_Lich. 29745
Caloplaca agardhiana (Flot.) Clauzade & Cl. Roux	4	Saxicolous on calcareous sandstone	VAL_Lich 29731_3
Caloplaca cerina (Hedw.) Th. Fr.	4, 5, 6 & 9	Epiphytic on several phorophytes: AO, QR, and QP	VAL_Lich 26534 & 29751

Scientific name	Localities	Habitat	Voucher
Candelaria concolor (Dicks.) Stein	8	Epiphytic on *Pinus* sp.	n/a
Candelariella aurella (Hoffm.) Zahlbr.	4, 5, 7, 8 & 9	Saxicolous on calcareous rocks and mortar	n/a
Candelariella coralliza (Nyl.) H. Magn.	5	Saxicolous on acidic sandstone	VAL_Lich 33717
Candelariella vitellina (Hoffm.) Müll. Arg.	4 & 5	Epiphytic on PinS and saxicolous on orthoquartzitic sandstone	n/a
Candelariella xanthostigma (Pers. ex Ach.) Lettau	4, 5 & 6	Epiphytic on several phorophytes: JunO, PinS and QR	n/a
Carbonea latypizodes (Nyl.) Knoph & Rambold	4	Saxicolous on sandstone	VAL_Lich 28203
Catillaria chalybeia (Borrer) A. Massal.	8	Saxicolous on acidic sandstone	VAL_Lich 33464
Catillaria nigroclavata (Nyl.) J. Steiner	4	n/a	n/a
Cetraria aculeata (Schreb.) Fr.	4, 6, 8 & 9	Terricolous	VAL_Lich 24765, 29677, 33240 & 33865
Cetraria islandica (L.) Ach.	4	Terricolous	n/a
Circinaria calcarea (L.) A. Nordin, Savić & Tibell (≡ *Aspicilia calcarea* (L.) Bagl.)	2, 3, 4, 5, 6, 7, 8 & 9	Saxicolous on calcareous rocks	n/a
Circinaria contorta (Hoffm.) A. Nordin, Savić & Tibell (≡ *Aspicilia contorta* subsp. *contorta* (Hoffm.) Körb.)	3, 4, 6 & 9	Saxicolous on calcareous rocks	VAL_Lich 29731_2
Circinaria hoffmanniana (S. Ekman & Fröberg ex R. Sant.) A. Nordin (≡ *Aspicilia contorta* subsp. *hoffmanniana* S. Ekman & Fröberg)	2, 3, 4, 5 & 9	Saxicolous on calcareous rocks	VAL_Lich 26527
Cladonia cervicornis (Ach.) Flot.	4	n/a	n/a
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.	4	On mosses	VAL_Lich 29721
Cladonia coniocraea (Flörke) Spreng.	4, 5 & 6	Terricolous or at the base of *Pinus sylvestris* trunks	VAL_Lich 24747, 27282a, 32857 & 33230
Cladonia fimbriata (L.) Fr.	4, 5 & 6	Terricolous or muscicolous	VAL_Lich 24748, 27282, 28032, 28033, 28202, 29722 & 33246
Cladonia foliacea (Huds.) Willd.	4, 5, 6, 8 & 9	Terricolous, especially in areas with plant debris, or muscicolous	VAL_Lich 28030, 29246, 29604, 29676, 29742, 32747, 32751 & 33631 (TLC: fumarprotocetraric and usnic acids).
Cladonia furcata (Huds.) Schrad. subsp. *furcata*	4	On mosses	n/a
Cladonia furcata (Huds.) Schrad. subsp. *subrangiformis* (L. Scriba ex Sandst.) Pišút	4, 5, 6, 8 & 9	n/a	VAL_Lich 29611, 29678, 32752 & 33864
Cladonia pyxidata (L.) Hoffm. f. *pocillum* (Ach.) Nyl.	2, 4, 5, 6 & 8	Terricolous, muscicolous, or in calcareous rocks cracks	n/a
Cladonia pyxidata (L.) Hoffm. f. *pyxidata*	3, 4, 5 & 6	Terricolous, muscicolous, or at the base of *Pinus* spp.	VAL_Lich 24692, 29247, 29741 & 33250
Cladonia rangiformis Hoffm.	4, 5, 6, 8 & 9	Terricolous and muscicolous	VAL_Lich 28031, 29611_2, 29723, 29741_2, 32697 & 32748
**Clypeococcum hypocenomyces* D. Hawksw.	4	Lichenicolous; parasitic on *Hypocenomyce scalaris*	VAL_Lich 33257
Collema furfuraceum (Arnold) Du Rietz	4	Saxicolous on calcareous rocks	VAL_Lich 33866

Scientific name	Localities	Habitat	Voucher
Dermatocarpon miniatum (L.) W. Mann	4	Saxicolous on calcareous rocks	VAL_Lich 27193, 33219 & 33245
Diploschistes muscorum (Scop.) R. Sant.	4	Parasitic on terricolous *Cladonia pyxidata*	VAL_Lich 27192
Diploschistes scruposus (Schreb.) Norman	4	n/a	n/a
Diplotomma alboatrum (Hoffm.) Flot.	4 & 5	Saxicolous on calcareous rocks	n/a
Diplotomma venustum (Körb.) Körb.	3, 4, 5, 8 & 9	Saxicolous on calcareous rocks	n/a
Enchylium tenax (Sw.) Gray (= *Collema tenax* Sommerf.)	8	Terricolous, on clayish soil	n/a
Evernia prunastri (L.) Ach.	4, 5, 6 & 9	Epiphytic on several phorophytes: AM, Er, PinH, PinN, PinS, QF, QR and QP	VAL_Lich 33458
Flavoparmelia caperata (L.) Hale	4, 5, 6, 8 & 9	Epiphytic on several phorophytes: OE, PinH, PinN, PinS, PrD, QF, QR and QP	VAL_Lich 25178, 27194 & 33459
Flavoparmelia soredians (Nyl.) Hale	3, 4, 5 & 6	Epiphytic on several phorophytes: PinN, PinS, PisL, and QR	VAL_Lich 26532
Flavoplaca citrina (Hoffm.) Arup, Frödén & Søchting (≡ *Caloplaca citrina* (Hoffm.) Th. Fr.)	2, 4, 5, 6, 7 & 9	Saxicolous on either calcareous or acidic rocks (e.g., sandstone) and mortar	n/a
Glaucomaria carpinea (L.) S.Y. Kondr., Lőkös & Farkas (≡ *Lecanora carpinea* (L.) Vain.)	3, 4, 5, 6 & 9	Epiphytic on several phorophytes: PrA, PrD, QF, QR and QP	n/a
Glaucomaria leptyrodes (G.B.F. Nilsson) S.Y. Kondr., Lőkös & Farkas (≡ *Lecanora leptyrodes* G.B.F. Nilsson)	4, 6 & 8	Epiphytic on QR	n/a
Gyalolechia flavorubescens (Huds.) Søchting, Frödén & Arup var. *flavorubescens* (≡ *Caloplaca flavorubescens* (Huds.) J.R. Laundon)	4	n/a	n/a
**Heterocephalacria physciacearum* (Diederich) Millanes & Wedin	4	Lichenicolous on *Physcia sp.*	n/a
Huneckia pollinii (A. Massal.) S.Y. Kondr., Elix, Kärnefelt, A. Thell, J. Kim, A.S. Kondratyuk & J.-S. Hur (≡ *Caloplaca pollinii* (A. Massal.) Jatta)	3, 4 & 6	Epiphytic on PisL and QR	n/a
Huriopsis plana (H. Magn.) S.Y. Kondr. & Lőkös (≡ *Rinodina plana* H. Magn.)	4	Epiphytic on AO	VAL_Lich 29753
Hyperphyscia adglutinata (Flörke) H. Mayrhofer & Poelt	1, 2, 3, 4, 5, 6 & 9	Epiphytic on several phorophytes: AO, CoA, JugR, PinH, PisL, PoN, PrA, PrD, PrM, QR, QP and SA	n/a
Hypocenomyce scalaris (Ach. ex Lilj.) M. Choisy	4 & 6	Lignicolous on PinN and PinS	VAL_Lich 29238, 29609, 33216 & 33218
Hypogymnia farinacea Zopf	3, 4, 5, 6 & 9	Epiphytic on several phorophytes: AO, Er, PinH, PinN, PinS, PrA, PrD, QF, QR and QP	VAL_Lich 29237 & 33262
Hypogymnia physodes (L.) Nyl.	4, 5 & 6	Epiphytic on several phorophytes: On PinN, PinS and, more rarely, on QF and QR	VAL_Lich 29239, 29603, 29740, 33217 & 33226
Hypogymnia tubulosa (Schaer.) Hav.	4, 6 & 7	Epiphytic on PinN and PinS, and, more rarely, QR	VAL_Lich 29242, 33223, 33225 & 33268
Imshaugia aleurites (Ach.) S.L.F. Mey.	4, 5 & 6	Epiphytic on PinN and PinS	VAL_Lich 25180, 26540, 26674, 29607 & 33263

Scientific name	Localities	Habitat	Voucher
Kuettlingeria erythrocarpa (Pers.) I.V. Frolov, Vondrák & Arup (≡ *Caloplaca erythrocarpa* (Pers.) Zwackh)	4, 5, 6, 8 & 9	Saxicolous on calcareous rocks	VAL_Lich 33860
Kuettlingeria teicholyta (Ach.) Trevis. (≡ *Caloplaca teicholyta* (Ach.) J. Steiner)	7 & 9	Saxicolous on calcareous rocks and mortar	n/a
Lathagrium cristatum (L.) Otálora, P.M. Jørg. & Wedin (≡ *Collema cristatum* (L.) Weber ex F.H. Wigg.)	2, 3, 4, 5, 6, 7, 8 & 9	Saxicolous on calcareous rocks and mortar	VAL_Lich 26529, 26560, 33248 & 33861
Lathagrium undulatum (Flot.) Poetsch (≡ *Collema undulatum* Laurer ex Flot.)	4	Terricolous or on calcareous rocks	VAL_Lich 26528 & 26562
Lecania naegelii (Hepp) Diederich & van den Boom	4	Epiphytic on AO	VAL_Lich 29745_2
Lecanora argentata (Ach.) Malme	6	Epiphytic on QR	n/a
Lecanora campestris (Schaer.) Hue	4, 5, 6 & 9	Saxicolous either on calcareous rocks or acidic sandstones	n/a
Lecanora chlarotera Nyl. subsp. *chlarotera*	3, 4, 5 & 6	Epiphytic on AO, PisL and QR	VAL_Lich 29753_2
Lecanora expallens Ach.	4	Epiphytic on PinS	n/a
Lecanora horiza (Ach.) Röhl.	4, 5, 6, 8 & 9	Epiphytic on PoN, PrD, PrM, QR and QP	VAL_Lich 29752
Lecanora hybocarpa (Tuck.) Brodo	3 & 4	Epiphytic on PrD and QR	n/a
Lecanora strobilina (Spreng.) Kieff.	3, 4, 5, 6 & 8	Epiphytic on several phorophytes: PinN, PinS, PrA and QR	n/a
Lecanora sulphurea (Hoffm.) Ach.	4	Saxicolous on acidic sandstones	VAL_Lich 33127
Lecidella carpathica Körb.	4	Saxicolous on acidic sandstone	VAL_Lich 33719
Lecidella elaeochroma (Ach.) M. Choisy	3, 4, 5, 6, 8 & 9	Epiphytic on several phorophytes: AO, PinN, PoN, PrA, PrD, PrS, QR and QP	VAL_Lich 26531, 29744 & 29747
Lecidella stigmatea (Ach.) Hertel & Leuckert	4	Saxicolous on calcareous sandstone	VAL_Lich 29731_4
Lendemeriella lucifuga (G. Thor) S.Y. Kondr. (≡ *Caloplaca lucifuga* G. Thor)	4 & 9	Epiphytic on JunO	n/a
Lepra albescens (Huds.) Hafellner (≡ *Pertusaria albescens* (Huds.) M. Choisy & Werner)	4 & 5	Epiphytic on CrM and *Quercus* sp.	n/a
Lepra amara (Ach.) Hafellner (≡ *Pertusaria amara* (Ach.) Nyl.)	4 & 6	Epiphytic on AO and PinN	VAL_Lich 29235 & 29608
Lepra aspergilla (Ach.) Hafellner (≡ *Pertusaria aspergilla* (Ach.) J.R. Laundon)	4	n/a	n/a
Lepra leucosora (Nyl.) Hafellner (≡ *Pertusaria leucosora* Nyl.)	4	Saxicolous on acidic sandstone	VAL_Lich 33857
Lepraria crassissima (Hue) Lettau	3, 4, 5 & 6	Either terricolous (e.g., on clayish slopes) or within cracks of calcareous rocks	VAL_Lich 28034
Lepraria lobificans Nyl.	2, 3 & 4	Terricolous or saxicolous on calcareous rocks (also in rock cracks)	n/a
Leprocaulon quisquiliare (Leers) M. Choisy (= *L. microscopicum* (Vill.) Gams)	4	Saxicolous on acidic soil	VAL_Lich 27189
Leproplaca chrysodeta (Vain.) J.R. Laundon ex Ahti	4	n/a	n/a
Leproplaca xantholyta (Nyl.) Nyl.	2, 3, 4, 6 & 9	Saxicolous on calcareous rocks	n/a
Lichenoconium erodens M.S. Christ. & D. Hawksw.	4	Lichenicolous	n/a
Lichenodiplis lecanorae (Vouaux) Dyko & D. Hawksw.	4	Lichenicolous	n/a

Scientific name	Localities	Habitat	Voucher
Lobothallia radiosa (Hoffm.) Hafellner	2, 3, 4, 5, 6 & 9	Saxicolous on either calcareous rocks or orthoquartzitic sandstone	n/a
Marchandiomyces corallinus (Roberge) Diederich & D. Hawksw.	4	Lichenicolous on *Physcia aipolia*	VAL_Lich 26015
Megaspora verrucosa (Ach.) Arcadia & A. Nordin	4	n/a	n/a
Melanelixia glabra (Schaer.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	4, 5 & 6	Epiphytic on AO, *Pinus* sp., QF and QR	n/a
Melanelixia glabratula (Lamy) Sandler & Arup	4 & 6	Epiphytic on QR	n/a
Melanelixia subargentifera (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	6	Epiphytic on AO	n/a
Melanelixia subaurifera (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	4, 5, 6 & 8	Epiphytic on several phorophytes: AO, CrM, *Pinus* sp., QF, QR and QP	VAL_Lich 33463
Melanohalea elegantula (Zahlbr.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	4, 5 & 6	Epiphytic on PinN, PinS and PrM	VAL_Lich 33294
Melanohalea exasperata (De Not.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	4, 5 & 6	Epiphytic on AO, PinN, QF, QR and QP	VAL_Lich 33241
Melanohalea exasperatula (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	4, 5 & 6	Epiphytic on PinN, PinS and QR	n/a
Melaspilea bagliettoana Zahlbr.	6	Muscicolous	n/a
Micarea peliocarpa (Anzi) Coppins & R. Sant.	4	n/a	n/a
**Muellerella erratica* (A. Massal.) Hafellner & Volk. John (≡ *Muellerella pygmaea* var. *athallina* (Müll. Arg.) Triebel)	4	Lichenicolous; parasitic on *Kuettlingeria erythrocarpa*	VAL_Lich 33636
Mycocalicium subtile (Pers.) Szatala	4	On lignum of a fallen trunk of *Pinus* sp.	VAL_Lich 33634
Myriolecis albescens (Hoffm.) Śliwa, Zhao Xin & Lumbsch (≡ *Lecanora albescens* (Hoffm.) Branth & Rostr.)	9	Saxicolous on mortar	n/a
Myriolecis dispersa (Pers.) Śliwa, Zhao Xin & Lumbsch (≡ *Lecanora dispersa* (Pers.) Röhl.)	6	Saxicolous on calcareous rocks	VAL_Lich 33243
Myriolecis hagenii (Ach.) Śliwa, Zhao Xin & Lumbsch (= *Lecanora umbrina* (Ach.) A. Massal.)	4	Epiphytic on AO	VAL_Lich 29751_2
Nephromopsis chlorophylla (Willd.) Divakar, A. Crespo & Lumbsch (≡ *Cetraria chlorophylla* (Willd.) Vain.)	4	n/a	n/a
Niorma chrysophthalma (L.) S.Y. Kondr., Kärnefelt, Elix, A. Thell, N.H. Jeong & Hur (≡ *Teloschistes chrysophthalmus* (L.) Th. Fr.)	1, 3, 4, 5, 6, 8 & 9	Epiphytic on several phorophytes: AO, CoA, CrM, PisL, PrD, PrS, QF and QR	VAL_Lich 29243
Ochrolechia arborea (Kreyer) Almb.	4 & 9	Epiphytic on PinN	VAL_Lich 29726
Ochrolechia pallescens (L.) A. Massal.	4	n/a	VAL_Lich 33247
Ochrolechia subviridis (Høeg) Erichsen	6	Epiphytic on PinS	n/a
Ochrolechia szatalaensis Verseghy	4 & 9	Epiphytic on PinN and PinS	VAL_Lich 26673, 29725 & 33126 (TLC: variolaric acid)
Ochrolechia turneri (Sm.) Hasselrot	4	Epiphytic on PinS	VAL_Lich 26536
Parmelia barrenoae Divakar, M.C. Molina & A. Crespo	4 & 6	Epiphytic on PinS and PrM	VAL_Lich 33295
Parmelia saxatilis (L.) Ach.	4, 5 & 6	Epiphytic on several phorophytes: PinN, PinS, QF and QR	VAL_Lich 25179, 29730, 33224, 33265 & 33267
Parmelia serrana A. Crespo, M.C. Molina & D. Hawksw.	4	Epiphytic on PinS	VAL_Lich 33457
Parmelia sulcata Taylor	4, 5 & 6	Epiphytic on several phorophytes: PinN, PinS, QR and QP	VAL_Lich 33461
Parmelina carporrhizans (Taylor) Poelt & Vězda	4	Epiphytic on bark of an unknown phorophyte	VAL_Lich 33237

Scientific name	Localities	Habitat	Voucher
Parmelina quercina (Willd.) Hale	4, 5, 6 & 9	Epiphytic on AM, AO, OE, *Pinus* sp., *Populus* sp., PrD, QF, QR and QP	n/a
Parmelina tiliacea (Hoffm.) Hale	4, 5, 6, 8 & 9	Epiphytic on several phorophytes: AM, AO, OE, PinS, PrD, PrM QF, QR and QP	VAL_Lich 33228
Parmeliopsis ambigua (Wulfen) Nyl.	4, 5 & 6	Epiphytic on PinN and PinS	VAL_Lich 11055 & 26671
Parmeliopsis hyperopta (Ach.) Vain.	4, 5 & 6	Epiphytic on PinN and PinS	VAL_Lich 33212
Parmotrema perlatum (Huds.) M. Choisy	4 & 6	Epiphytic on QF and QR	VAL_Lich 33456
Peltigera elisabethae Gyeln.	4	Terricolous or in cracks of calcareous rocks	VAL_Lich 29724 & 33293
Peltigera horizontalis (Huds.) Baumg.	5	Terricolous and muscicolous	VAL_Lich 32749
Peltigera membranacea (Ach.) Nyl.	4 & 5	Terricolous and muscicolous	VAL_Lich 28177 & 28178
Peltigera praetextata (Flörke ex Sommerf.) Zopf	4 & 5	Terricolous and muscicolous	VAL_Lich 29720, 32750 & 33251
Peltigera rufescens (Weiss) Humb.	4	Terricolous and muscicolous	
Pertusaria paramerae A. Crespo & Vězda	4 & 8	Epiphytic on PinS	VAL_Lich 29728
Pertusaria pertusa (L.) Tuck. var. *pertusa*	4	n/a	VAL_Lich 33718
Pertusaria pseudocorallina (Sw.) Arnold	4	n/a	n/a
Pertusaria rupicola (Fr.) Harm.	4	On acidic sandstone	n/a
Phaeophyscia cernohorskyi (Nádv.) Essl.	2 & 9	Epiphytic on JugR and PrD	n/a
Phaeophyscia hirsuta (Mereschk.) Essl.	2	Epiphytic on JugR	n/a
Phaeophyscia orbicularis (Neck.) Moberg	3, 4, 5, 6 & 9	Epiphytic on OE, PoN, PrA, PrD, and saxicolous on calcareous rocks	n/a
Phlyctis argena (Ach.) Flot.	6	Epiphytic on QF and QR	n/a
Physcia adscendens H. Olivier	1, 2, 3, 4, 5, 6, 8 & 9	Epiphytic on several phorophytes: AM, AO, CoA, CrM, Er, JugR, OE, PinH, PinN, PinS, PisL, PoN, PrA, PrD, PrM, PrS, RP, QF, QR, QP and saxicolous on orthoquartzite and calcareous rocks	VAL_Lich 29729, 29746 & 33221
Physcia aipolia (Ehrh. Ex Humb.) Fürnr.	4, 5, 6 & 9	Epiphytic on several phorophytes: AO, CrM, PinH, PinN, PrD, QF and QR	VAL_Lich 29234 & 33233
Physcia biziana (A. Massal.) Zahlbr. var. *biziana*.	4	Epiphytic on bark of an unknown phorophyte	VAL_Lich 33242
Physcia caesia (Hoffm.) Hampe ex Fürnr.	4	Saxicolous on acidic sandstone	VAL_Lich 33858
Physcia dubia (Hoffm.) Lettau	4	n/a	n/a
Physcia leptalea (Ach.) DC.	1, 3, 4, 5, 6 & 9	Epiphytic on several phorophytes: AM, AO, CoA, CrM, OE, PinS, PisL, PrD, PrS, QF, QR and QP	VAL_Lich 26561, 29244 & 33859
Physcia stellaris (L.) Nyl.	4, 5 & 6	Epiphytic on AO, JunO, PinS and QR	n/a

Scientific name	Localities	Habitat	Voucher
Physcia tenella (Scop.) DC.	3, 4, 5 & 6	Epiphytic on AO, OE, PrA, PisL, QF and QR	VAL_Lich 33231
Physconia distorta (With.) J.R. Laundon	4 & 6	Epiphytic on QF and QR	n/a
Physconia enteroxantha (Nyl.) Poelt	4 & 6	Epiphytic on QF and QR	VAL_Lich 33252 & 33462
Physconia grisea (Lam.) Poelt subsp. *grisea*	4	Epiphytic on PinH	VAL_Lich 27191
Physconia perisidiosa (Erichsen) Moberg	4, 5 & 6	Epiphytic on QF and QR	n/a
Physconia venusta (Ach.) Poelt	5 & 6	Epiphytic on QF and QR	n/a
Placocarpus schaereri (Fr.) Breuss	4 & 5	Saxicolous on calcareous rocks	n/a
Placynthium nigrum (Huds) Gray	4, 5, 6 & 8	Saxicolous on calcareous rocks	n/a
Platismatia glauca (L.) W.L. Culb. & C.F. Culb.	4, 5 & 6	Epiphytic on PinN and PinS	VAL_Lich 33260
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	4, 5, 6 & 9	Epiphytic on several phorophytes: AM, AO, PrD, QF, QR and QP	VAL_Lich 33261
Polycauliona phlogina (Ach.) Arup, Frödén & Søchting (≡ *Caloplaca phlogina* (Ach.) Flagey)	6	Epiphytic on *Juniperus* sp.	n/a
Porpidinia tumidula (Sm.) Timdal (≡ *Toninia tumidula* (Sm.) Zahlbr.)	2, 4, 5, 6 & 9	Saxicolous on calcareous rocks	n/a
Protoparmeliopsis muralis (Schreb.) M. Choisy var. *muralis*	3, 4, 5, 6, 7, 8 & 9	Saxicolous on calcareous and acidic rocks, also on mortar	VAL_Lich 33719
**Protousnea huuskonenii* (Räsänen) Divakar, Crespo & Lumbsch (≡ *Raesaenenia huuskonenii* (Räsänen) D. Hawksw., Boluda & H. Lindgr.)	4	Lichenicolous on *Bryoria fuscescens*	n/a
Pseudevernia furfuracea (L.) Zopf	4, 5 & 6	Epiphytic on PinN, PinS, QR and QP	VAL_Lich 25355, 26604, 29241, 29602, 29739, 33238, 33256, 33264 & 33269.
Psora decipiens (Hedw.) Hoffm.	4, 5, 7 & 9	Terricolous and saxicolous on calcareous rocks and mortar	n/a
Psora testacea Hoffm.	4 & 6	Saxicolous on calcareous rocks	VAL_Lich 11087 & 32820
Psora vallesiaca (Schaer.) Timdal	4, 5, 6 & 9	Saxicolous on calcareous rocks and in cracks	n/a
**Punctelia caseana* Lendemer & Hodkinson	4	Epiphytic on PrM	VAL_Lich 33124 (TLC: atranorin and lecanoric acid)
Punctelia subrudecta (Nyl.) Krog	4, 5, 6 & 9	Epiphytic on CrM, OE, PinH, PrD, QR and QP	VAL_Lich 33455 & 33460
Pyrenodesmia alociza (A. Massal.) Arnold (≡ *Caloplaca alociza* (A. Massal.) Mig.)	9	Saxicolous on calcareous rocks	n/a
Pyrenodesmia variabilis (Pers.) A. Massal. (≡ *Caloplaca variabilis* (Pers.) Müll. Arg.)	3	Saxicolous on calcareous sandstone	n/a
Ramalina calicaris (L.) Röhl.	6	Epiphytic on AO	n/a
Ramalina canariensis J. Steiner	6	Epiphytic on QR	n/a
Ramalina farinacea (L.) Ach.	3, 4, 5, 6 & 9	Epiphytic on several phorophytes: AM, AO, Er, PinH, PinN, PinS, PrD, QF, QR and QP	VAL_Lich 29237 & 33254

Scientific name	Localities	Habitat	Voucher
Ramalina fastigiata (Pers.) Ach.	4, 5, 6 & 9	Epiphytic on several phorophytes: AO, *Pinus* sp., PrD, QF and QR	VAL_Lich 33222
Ramalina fraxinea (L.) Ach.	3, 4, 5, 6 & 9	Epiphytic on several phorophytes: AO, PrA, QF, QR and QP	n/a
Ramalina requienii (De Not.) Jatta	4	n/a	n/a
Rhizocarpon disporum (Hepp) Müll. Arg.	4	Saxicolous on acidic sandstone	VAL_Lich 33717
Rhizocarpon geographicum (L.) DC.	4	Saxicolous on acidic sandstone	VAL_Lich 33717 & 33719
Rinodina confragosa (Ach.) Körb.	4	Saxicolous on acidic sandstone	VAL_Lich 33718
Rinodina pyrina (Ach.) Arnold	4	Epiphytic on AO	VAL_Lich 26554 & 29750_2
Rinodina sophodes (Ach.) A. Massal.	4	Epiphytic on bark of an unknown phorophyte	VAL_Lich 33235
Romjularia lurida (Ach.) Timdal	4, 5, 6 & 9	Saxicolous on calcareous rocks and in cracks	n/a
Rufoplaca arenaria (Pers.) Arup, Søchting & Frödén (≡ *Caloplaca arenaria* (Pers.) Müll. Arg.)	4	Saxicolous on siliceous sandstone	VAL_Lich 26526 & 26539
Rusavskia elegans (Link) S.Y. Kondr. & Kärnefelt subsp. *elegans* (≡ *Xanthoria elegans* (Link) Th. Fr.)	4 & 7	Saxicolous on calcareous rocks and mortar	VAL_Lich 33227, 33234, 33236 & 33249
Sanguineodiscus haematites (Chaub. ex St.-Amans) I.V. Frolov & Vondrák (≡ *Caloplaca haematites* (Chaub. ex St.-Amans) Zwackh)	4 & 6	Epiphytic on QR	n/a
Sarcogyne clavus (DC.) Kremp.	4	Saxicolous on acidic sandstone	VAL_Lich 33607
Sarcogyne pruinosa (Schaer.) A. Massal. (≡ *Sarcogyne regularis* Körb.)	4	Saxicolous on calcareous rocks	VAL_Lich 29737
Scytinium lichenoides (L.) Otálora, P.M. Jørg. & Wedin (≡ *Leptogium lichenoides* (L.) Zahlbr.)	4 & 8	Terricolous and muscicolous	n/a
Solenopsora candicans (Dicks.) J. Steiner	4	Saxicolous on calcareous rocks	n/a
Solorina saccata (L.) Ach.	4 & 6	Terricolous and in cracks of calcareous rocks	VAL_Lich 11054
Squamarina cartilaginea (With.) P. James	3, 4, 5, 6, 8 & 9	Terricolous and saxicolous on calcareous rocks and in cracks	VAL_Lich 29245, 29738 & 29743
Squamarina concrescens (Müll. Arg.) Poelt	3, 4 & 5	Saxicolous on calcareous rocks and in clayish slopes	n/a
Squamarina lentigera (Weber) Poelt	4	n/a	n/a
Squamarina stella-petraea Poelt	4	n/a	n/a
Straminella conizaeoides (Nyl. ex Cromb.) S.Y. Kondr., Lőkös & Farkas (≡ *Lecanora conizaeoides* Nyl. ex Cromb.)	4	n/a	n/a
Synalissa symphorea (Ach.) Nyl. (= *Synalissa ramulosa* (Bernh.) Fr.)	4	n/a	n/a
Tephromela atra (Huds.) Hafellner	4, 5 & 6	Saxicolous on acidic rocks, siliceous sandstones and orthoquartzitic rocks; rarely epiphytic on QR	VAL_Lich 33717 & 33862
Thalloidima candidum (Weber) A. Massal. (≡ *Toninia candida* (Weber) Th. Fr.)	2, 4, 5, 6, 8 & 9	Saxicolous on calcareous rocks	VAL_Lich 26535 & 33215

Scientific name	**Localities**	**Habitat**	**Voucher**
Thalloidima opuntioides (Vill.) Kistenich, Timdal, Bendiksby & S. Ekman (≡ *Toninia opuntioides* (Vill.) Timdal)	4	Saxicolous on calcareous rocks and in cracks	VAL_Lich 33292
Thalloidima sedifolium (Scop.) Kistenich, Timdal, Bendiksby & S. Ekman (≡ *Toninia sedifolia* (Scop.) Timdal)	4 & 9	Terricolous and saxicolous on calcareous rocks and in cracks	VAL_Lich 33214
Trapeliopsis flexuosa (Fr.) Coppins & P. James	4, 5 & 6	Epiphytic on PinN and PinS	VAL_Lich 27195
Trapeliopsis granulosa (Hoffm.) Lumbsch	5	Epiphytic on PinS	VAL_Lich 26675
**Tremella hypogymniae* Diederich & M.S. Christ.	4	Lichenicolous; parasitic on *Hypogymnia physodes*	VAL_Lich 33253
Umbilicaria polyphylla (L.) Baumg.	4	Saxicolous on sandstone rocks	n/a
Umbilicaria pustulata (L.) Hoffm. (≡ *Lasallia pustulata* (L.) Mérat)	4	Saxicolous on acidic sandstone	VAL_Lich 24861
Usnea hirta (L.) Weber ex F.H. Wigg.	4, 5 & 6	Epiphytic on PinN and PinS	VAL_Lich 26672, 29236, 29605, 33220 (TLC: usnic acid), 33239 & 33259
Varicellaria hemisphaerica (Flörke) I. Schmitt & Lumbsch (≡ *Pertusaria hemisphaerica* (Flörke) Erichsen)	4 & 5	Epiphytic on PinS	VAL_Lich 26676
Varicellaria lactea (L.) I. Schmitt & Lumbsch (≡ *Pertusaria lactea* (L.) Arnold)	4, 5 & 9	Saxicolous on calcareous and acidic rocks, also on orthoquartzite and mortar	VAL_Lich 29736
Variospora aurantia (Pers.) Arup, Frödén & Søchting (≡ *Caloplaca aurantia* (Pers.) Hellb.)	2, 3, 4, 5, 8 & 9	Saxicolous on calcareous rocks	n/a
Variospora dolomiticola (Hue) Arup, Søchting & Frödén (≡ *Caloplaca dolomiticola* (Hue) Zahlbr.)	4, 6 & 9	Saxicolous on calcareous rocks	n/a
Variospora flavescens (Huds.) Arup, Frödén & Søchting (≡ *Caloplaca flavescens* (Huds.) J.R. Laundon)	3, 4, 6 & 9	Saxicolous on calcareous rocks and mortar	VAL_Lich 29733
Variospora velana (A. Massal.) Arup, Søchting & Frödén (≡ *Caloplaca velana* (A. Massal.) Du Rietz)	4 & 5	Saxicolous on calcareous rocks	VAL_Lich 29735
Verrucaria macrostoma Dufour ex DC.	4 & 9	Saxicolous on calcareous rocks	n/a
Verrucaria nigrescens Pers.	2, 3, 4, 5, 6, 8 & 9	Saxicolous on calcareous, sandstone and orthoquartzite rocks; rarely epiphytic on OE	VAL_Lich 29731_5 & 29732
Xalocoa ocellata (Fr.) Kraichak, Lücking & Lumbsch (≡ *Diploschistes ocellatus* (Fr.) Norman)	4 & 9	Saxicolous on calcareous rocks	n/a
Xanthocarpia lactea (A. Massal.) A. Massal. (≡ *Caloplaca lactea* (A. Massal.) Zahlbr.)	4, 5 & 9	Saxicolous on calcareous and acidic rocks, also on orthoquartzite and mortar	VAL_Lich 29736
Xanthoparmelia camtschadalis (Ach.) Hale	4, 6 & 9	Terricolous	VAL_Lich 27190, 33229 & 33867 (TLC: usnic, salazinic and consalazinic acids)
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	4	Saxicolous on acidic rocks	n/a
Xanthoparmelia loxodes (Nyl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	4	n/a	n/a
Xanthoparmelia mougeotii (Schaer.) Hale	4	Saxicolous on acidic sandstone	n/a
Xanthoparmelia protomatrae (Gyeln.) Hale	4	Saxicolous on acidic sandstone	VAL_Lich 33719 (TLC: usnic, fumarprotocetraric and protocetraric acids)

Scientific name	Localities	Habitat	Voucher
Xanthoparmelia pulla (Ach.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	4	Saxicolous on orthoquartzite sandstone	n/a
Xanthoparmelia stenophylla (Ach.) Ahti & D. Hawksw. (= *Parmelia somloensis* Gyeln.)	5	Saxicolous on orthoquartzite sandstone	n/a
Xanthoparmelia tinctina (Maheu & A. Gillet) Hale	4	Saxicolous on acidic rocks	n/a
Xanthoparmelia verruculifera (Nyl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	4	Saxicolous on acidic rocks	VAL_Lich 33862
Xanthoria calcicola Oxner	3, 4, 5 & 9	Saxicolous on calcareous rocks	n/a
Xanthoria parietina (L.) Beltr.	1, 2, 3, 4, 5, 6, 8 & 9	Epiphytic on several phorophytes: AM, AO, CoA, CrM, JugR, JunO, OE, PinH, PinS, PisL PoN, PrA, PrD, PrM, PrS, RP, QF, QR and QP	n/a
Xanthoriicola physciae (Kalchbr.) D. Hawksw.	9	Lichenicolous; parasitic on *Xanthoria parietina* growing on *Prunus dulcis*	n/a
Zwackhiomyces cervinae Calat., Triebel & Pérez-Ortega	4	Lichenicolous; parasitic on *Acarospora cervina* growing on calcareous rocks	Holotype deposited in Herbarium M with code 0044788